PERFORMANCE, OXIDATIVE STRESS AND *IN VITRO* STUDIES OF KALAHARI, WAD, KALAWAD DOES AND THEIR KIDS FED DIETS CONTAINING TURMERIC POWDER

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September, 2018

DECLARATION

I hereby declare that this Thesis has been written by me and is a correct record of my own research work. It has not been presented in any previous application for a higher degree in this or any other university. All citations and sources of information are clearly acknowledged by means of references.

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ODERINWALE, OLATUNDE AKEEM

Date: ………………………………………

CERTIFICATION

We certify that this Thesis entitled "Performance, oxidative stress and *in vitro* studies of Kalahari, WAD, KalaWAD Does and their kids fed diets containing turmeric powder" is the outcome of the research carried out by O.A. Oderinwale in the Livestock Science and Sustainable Environment Programme, Federal University of Agriculture, Abeokuta.

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ABSTRACT

The overall wellbeing of animals is dependent partly on nutritional plane which in turns affect the growth and survivability of offsprings produced. When all the processes involved in the feeding to achieve production goals are not properly guided, this is bound to affect the animal and environment negatively. Thus, a study was conducted to evaluate the performance, oxidative stress (OS) and *in vitro* studies of Kalahari (KR), West African Dwarf (WAD) and KalaWAD (KWD) Does and their kids fed diets containing turmeric powder. Forty five dry and healthy primiparous Does consisting of 15 Does/breed and divided into 5 Does per/treatment/breed were used. Dietary treatments fed at 5% bodyweight were concentrate diet (CD) as TU-0; CD+2g/kg turmeric powder inclusion (TP) as TU-2g; and CD+5g/kg TP as TU-5g. *Brachaiaria ruziziensis* (BR) was used as basal diet. Oestrous synchronization was done twice using Lutalyse, while mating was done by KR bucks. Feeding trial for Does lasted for 162 days pre-natal and 90 days postnatal/lactation. Rumen liquor was collected from the Does at 20th week of prenatal feeding for *in vitro* studies of three feed types (concentrate; BR; and 75% concentrate+25% BR). A total of 5 kids produced/breed/treatment was used for kids' evaluation which lasted for 90days pre-weaning and 4weeks post-weaning after being fed the dietary treatments at 5% bodyweight. Data obtained were arranged in a 3x3 factorial layout in a Completely Randomized Design, while Analysis of Variance was done using SAS 9.2. Results of the study revealed that KR fed TP-2g had overall best ($p<0.05$) prenatal growth performance in terms of weight gains (17.65kg, 119.40g/day). WAD fed TP-2g and TP-5g had the lowest weight gains (9.51kg, 65.57g/day). For reproductive performance, KWD fed TP-5g and WAD fed TP-0 had significantly ($p<0.05$) highest (156.8 days) and lowest (144.2 days) values for gestation lengths respectively. KR fed TP-5g recorded kids with highest ($p<0.05$) birth weight (3596.67g), while WAD fed TP-2g had lowest birth weight of 1853.13g. KR fed TP-5g had highest ($p<0.05$) post-natal weight gains of 1.06kg and 11.80g/day while weight losses of 4.42kg and 50.26g/day were recorded for KWD fed TP-0. KR fed TP-2g had highest ($p<0.05$) milk yield which peaked at week 4 with 1560ml/24hrs, whereas WAD fed TP-0 recorded lowest milk yield that peaked at week 6 with 464ml/24hrs. Milk protein (5.12%) and total solid (22.80%) were highest ($p<0.05$) for KR fed TP-5g. For OS markers, KWD fed TP-2g had reduced ($p<0.05$) value of 2.70u/ml for TBARS, while KR fed TP-0 had highest value (7.17u/ml). Kids produced by KR fed TP-2g had highest ($p<0.05$) pre-weaning weight gains of 12.51kg and 148.93g/day. Highest ($p<0.05$) post-weaning weight gains of 1.80kg and 64.40g/day were recorded for KR kids fed TP-5g. KWD kids fed TP-2g had faecal egg count of 0, while 0.40×10^{3}EPG was obtained for KR kids fed TP-0. For *in vitro* studies, concentrate supplemented with TP-5g had highest ($p<0.05$) gas production. The study concluded that TP improved the overall performance of the goats especially KR and their kids, and also reduced methane production.

DEDICATION

This Thesis is dedicated to the glory of God, the Author and finisher of our faith.

I also dedicate this Thesis to my amiable wife; son (Oluwajomiloju Ise-Oluwa ODERINWALE); Prof and Prof (Mrs) Oluwatosin; and my parents for their support in all ramifications and most importantly for successful completion of this study.

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ODERINWALE Olatunde A.
September, 2018

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CHAPTER ONE

1.0 INTRODUCTION

Ruminant animals are dependent on forages as these are essential to maintain their health and production at various stages of their development and growth. In developed countries, sufficient grazing land is available, so ruminants can get adequate amount of green grasses during grazing seasons and when it is not possible in other season they are supplied with silage and other high quality conserved forages. Conversely, green forages are not abundantly available and are seasonal in some developing countries like Nigeria, so ruminants are mainly supplied with low quality forages and cereal straws. During the course of foraging on these low quality and poor feed resources, the animals are stressed due to long distance trekking, picking of many eggs and pathogens, and the animals suffer directly or indirectly from adverse effects of climate change. The longevity and productivity are adversely affected when ruminants are reared with low quality forage under these conditions coupled with the fact that the use of synthetic antibiotics and growth promoters are being banned in many countries of the world.

Supplementation is another tool to improve the quality of these forages, straws and other feed resources by adding nutrients that otherwise are low/deficient in these forages (Khandaker *et al.*, 1998; Muetzel *et al.*, 2003; Chaudhry, 2008), it can also come in form of some materials that can aid digestion or better feed utilisation by the animals. Supplements increase the utilization of low quality forages, but the requirement for these supplements is more than their availability in many developing countries (Devendra and Sevilla, 2002). Spices which have long been safely used for human consumption could be tested as alternative supplements to enhance forage utilization, reduce nutrient wastage, alleviate stress emanating from adverse climate change, promote growth, as antibiotics and improve overall performances and health status of ruminant animals. Recently, several researchers have used some plant extracts to manipulate rumen fermentation (Cardozo *et al.*, 2004; Patra *et al.*, 2006) in order to improve performances of ruminant animals.

Several chemical compounds and antibiotics have been identified in herbaceous plants by researchers, which play important roles in the health of human and animal. Series of researches have been conducted on plants like ginger, neem leaves, and moringa for their ethnoveterinary uses. Listed among these plants of ethnoveterinary importance is Turmeric-*Curcuma longa* (Lans *et al.,* 2007).

The medicinal plant turmeric (*Curcuma longa)* is commonly used as a spice in human food. The plant is a perennial herb, and a member of *Zingiberacae* family. The rhizome is the part used both as spice and medicine. It is usually cleaned, boiled and dried, yielding a yellow powder. The active ingredients found in turmeric are curcumin, demethoxy-curcumin, bisdemethoxy-curcumin (Wuthi-Udomler *et al*., 2000) and tetrahydro-curcuminoids (Osawa *et al*., 1995). These plant extracts have been found to have antifungal, (Wuthi-udomler *et al.*, 2000) and anti-oxidative value (Osawa *et al*., 1995). Some pharmacological activities of turmeric as nematocidal (Kiuchi *et al.*, 1993) and anti-inflammatory (Ammon *et al*., 1993) were reported. Furthermore, Soni *et al*. (1997) proved the protective effects of Turmeric as food additives on aflatoxin-induced mutagenicity and hepato-carcinogenicity. It has also being reported (Prasad *et al.*, 2011) that turmeric has antioxidant, anti-tumour, antibacterial, and antiviral activities among others. Turmeric is used as condiment, dye, drug and cosmetic in addition to its uses in religious ceremonies (Kandiannan *et al.*, 2009).

Turmeric possesses antioxidant properties which function as free radical scavengers that protect the body defence system against excessively produced free radicals thereby stabilizing the health status of the animal (Sivakumar e*t al.*, 2010). Oxidants are compounds capable of oxidising target molecules. According to Lykkesfeldt and Svendsen (2007) this can take place by one of three actions i.e. abstraction of a hydrogen atom; abstraction of an electron; or the addition of oxygen.

As the demand for animal protein continue to increase, global animal production faces several challenges in order to meet these demands because of environmental challenges (global warming and climate change). Furthermore, the intensification of animal production systems might compromise animal health and welfare and consequently increase the incidence of the metabolic diseases. Ruminant health and production is crucial for a sustainable animal production system, and this area of research is now attracting international interest, especially the mechanisms by which antioxidant supplementation may influence metabolism and health.

Oxidants play a central role in normal cellular function, providing an important feedback loop between metabolic activity and regulation of cellular functions. Oxidative stress (OS) arises due to an imbalance between pro-oxidants and antioxidants, which can occur under circumstances of increased antioxidant utilisation or immune function. In ruminant health and production, the study of redox homeostasis is contributing to the understanding of important pathways involved in metabolic disorders. Indeed, OS seems to play a central role in the regulation of the metabolic activity of some organs and productivity in farm animals (Celi, 2011). For example, during the last trimester of pregnancy and at the beginning of lactation the rapid foetal growth and the production of large amounts of colostrum and milk, an increase in both maternal and foetal metabolism result in increased reactive oxygen species production during late gestation and early lactation and increased requirements for micronutrients, including antioxidants (Pedernera *et al.*, 2010). Therefore manipulation of micronutrients and antioxidants has the potential to control the effects of oxidative damage, such as occurs during the transition period (Lean *et al*., 2014). This period is characterised by extremely high levels of nutrient utilisation due to the growing foetus and then lactation diverts micronutrients and antioxidants from the animal to the mammary gland. The relationship between OS, diseases and metabolic disorders is further demonstrated by lowered antioxidant status during mastitis, retained placenta, acidosis, ketosis and milk fever (Celi, 2011).

Climate change is a subject of global environmental concern. Increased anthropogenic Greenhouse Gas (GHG) emissions have increased the global temperature in the last 100 to 200 years (Mirzaei-Aghsaghali and Maheri-Sis, 2011). Methane is considered a potent greenhouse gas with capability of trapping 21 times more heat (Global Warming Potential) than carbon dioxide. Also, its life time in the atmosphere is 9-15 years and over the last two centuries, methane atmospheric concentrations have more than doubled, rising 1% yearly in comparison with 0.5% of carbon dioxide. Globally, ruminant livestock produce about 80 million metric tons of methane each year (representing 11% sheep and goat), accounting for about 28% of global emissions from human related activities (Muro-Reyes e*t al.,* 2011; Umeghalu and Okonkwo, 2012; Shrestha e*t al.,* 2013)

1.1 Justification

Livestock production nowadays is faced with many factors that hinder their growth, reproduction and yields in terms of meat, milk and skin among others. Some of these factors include imbalanced diet in terms of quantity and quality arising from feed (forage) scarcity/seasonality, mortality- most especially that of kid, poor management systems and practices; and unfavourable weather conditions due to cumulative effects of climate change as it is being experienced in this century. Poor performance and global warming resulting from greenhouse gases accumulation especially methane production emanating from enteric fermentation and faecal decomposition of ruminant animals exerts substantial effects on livestock production compared to others listed in the foregoing.

The greenhouse effect of methane is 20 to 50 times that of carbon dioxide (Beauchemin and McGinn, 2005) and its concentration in the atmosphere has doubled over the last century and continues to increase. Ruminants are major contributors to biogenic methane formation, and it has been estimated that preventing methane formation from domesticated ruminants could contribute to stabilizing atmospheric methane concentrations (Bodas *et al.*, 2008). For this reason, public and political pressure is intensifying for decreasing methane emissions from livestock, and numerous efforts are underway to achieve this goal (Medjekal *et al.*, 2016). Among these are a number of nutritive strategies designed to mitigate enteric methane formation by focusing on the potential addition of distinct plants or extracts rich in secondary compounds to animal feeds (Rira *et al.*, 2015). When all these factors act on an animal directly or indirectly, there is bound to be reduction in the performance and overall wellbeing of the animal.

Turmeric (*Curcuma longa*) is a spice that originates from Southwest India. Turmeric contains an active compound known as curcumin. This compound is believed to have a wide range of biological effects such as anti-inflammatory, antioxidant, anti-tumour, antibacterial, and antiviral activities among others (Prasad *et al.*, 2011). Research had shown that certain spices contain properties, which make the digestive process of ruminant animals more efficient thereby producing less waste- especially, methane.

The use of antibiotics as feed additives has been of increasing concern (Gunun *et al*., 2016) and even banned in many countries due to the risk of appearance of antibiotic residues in meat and milk (Russell and Houlihan, 2003). Due to this fact, researchers and livestock rearers have sought for alternative to synthetic growth promoters and antibiotics in livestock production for improved growth and reproductive performances of ruminant animals. There are more benefits of turmeric if supplemented to farm animals, most especially, pregnant Does and their offspring since no information is available for these categories of ruminant animals on turmeric supplementation.

The study therefore evaluated the effects of Turmeric powder supplementation on the performance, oxidative stress and *in vitro* studies of Kalahari, West African Dwarf and KalaWAD Does and their kids in South-Western part of Nigeria.

1.2 Objectives

1.2.1 Broad Objective

The study investigated the effects of turmeric powder inclusions in the diets of pregnant Kalahari Red, KalaWAD and West African Dwarf Does managed intensively in South-Western Nigeria on the growth performance and reproductive characteristics; blood chemistry, milk yield and composition; selected hormonal profile; *in vitro* studies and overall performance of their kids at pre and post-weaning periods.

1.2.2 Specific Objectives

The specific objectives of the study were to evaluate effects of turmeric powder supplementation at graded levels on:

1. Pre and post-natal growth performance characteristics; haematological parameters and serum biochemistry of pregnant Kalahari Red, KalaWAD and West African Dwarf Does;

2. Oxidative stress markers; cortisol; prolactin and oxytocin levels of pregnant Kalahari Red, KalaWAD and West African Dwarf Does;
3. Milk yield and composition of Kalahari Red, KalaWAD and West African Dwarf Does;
4. Pre and post-weaning growth performance; faecal egg count and identification; haematological parameters and serum biochemistry of kids produced by the Does;
5. *In vitro* digestibility, post-incubation parameters and gas production kinetics.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Turmeric in General

Turmeric (*Curcuma longa*) is a popular Indian spice, which is a member of the ginger family (Zingiberaceae). One active ingredient of Turmeric is curcumin, which has a distinctly earthy, slightly bitter, slightly hot peppery flavor and a mustardy smell (Wikipedia, 2018). Curcumin is the principal curcuminoid, while other two curcuminoids are desmethoxy-curcumin and bis-desmethoxy-curcumin. The curcuminoids are polyphenols and are responsible for the yellow colour of turmeric. Curcumin can exist in at least two tautomeric forms, keto and enol (Akram *et al.,* 2010). The -enol form is more energetically stable in the solid phase and in solution. Curcumin is brightly yellow coloured and may be used as a food colouring.

2.2 Some Health benefits of Turmeric

Listed below are some of the health benefits of Turmeric in the body according to Nutrition-and-you (2018):

- Turmeric has been in use since antiquity for its anti-inflammatory (painkiller), carminative, anti-flatulent and anti-microbial properties.
- The herb contains health benefiting essential oils such as *turmerone, curlone, curumene, cineole, and p-cymene.*

- Curcumin, a poly-phenolic compound in the root, is the principal pigment that imparts deep orange color to the turmeric. *In vitro* as well as in laboratory animal studies have suggested that the *curcumin* may have anti-tumor, antioxidant, anti-arthritic, anti-amyloid, anti-ischemic, and anti-inflammatory properties.

- This popular herb contains no cholesterol; however, it is rich in anti-oxidants and dietary fiber, which helps to control blood LDL or "bad cholesterol" levels.

- It is a very rich source of many essential vitamins such as pyridoxine (vitamin B6), choline, niacin, and riboflavin, etc. 100g herb provides 1.80mg or 138% of daily-recommended levels of pyridoxine. Pyridoxine is employed in the treatment of homocystinuria, sideroblastic anemia and radiation sickness. Niacin helps prevent "pellagra" or dermatitis.

- Fresh root contains very good levels of vitamin C. 100g of root compose of 23.9 mg of this vitamin. Vitamin C is a water-soluble vitamin and a powerful natural anti-oxidant, which helps the body develop immunity against infectious agents, and remove harmful free oxygen radicals.

- Turmeric contains very good amounts of minerals like calcium, iron, potassium, manganese, copper, zinc, and magnesium. Potassium is an important component of cell and body fluids that helps in controlling heart rate and blood pressure. Manganese is utilized by the human body as a co-factor for the antioxidant enzyme, superoxide dismutase. Iron is an important co-factor for cytochrome oxidase enzymes at cellular level metabolisms and required for red blood cell (RBC's) productions.

Table 1: Nutrient compositions (per 100 g) of Turmeric (*Curcuma longa*)

Principle	**Nutrient Value**	**Percentage of RDA**
Energy	354 Kcal	17%
Carbohydrates	64.9 g	50%
Protein	7.83 g	14%
Total Fat	9.88 g	33%
Cholesterol	0 mg	0%
Dietary Fibre	21 g	52.5%
Vitamins		
Folates	39 µg	10%
Niacin	5.140 mg	32%
Pyridoxine	1.80 mg	138%
Riboflavin	0.233 mg	18%
Vitamin A	0 IU	0%
Vitamin C	25.9 mg	43%
Vitamin E	3.10 mg	21%
Vitamin K	13.4 µg	11%
Electrolytes		
Sodium	38 mg	2.5%
Potassium	2525 mg	54%
Minerals		
Calcium	183 mg	18%
Copper	603 µg	67%

Iron	41.42 mg	517%
Magnesium	193 mg	48%
Manganese	7.83 mg	340%
Phosphorus	268 mg	38%
Zinc	4.35 mg	39.5%

Source: USDA National Nutrient data base (2015); Nutrition-and-you (2018)

Table 2: Scientific Classification of Turmeric

Kingdom:	Plantae
(unranked):	Angiosperms
(unranked):	Monocots
(unranked):	Commelinids LP
Order:	Zingiberales
Family:	Zingiberaceae
Genus:	*Curcuma*
Species:	*C. longa*
Binomial name	
Curcuma longa	
Synonyms	
Curcurma domestica Valeton	

Source: Wikipedia (2018)

2.3 Properties of Curcumin

Curcumin has antioxidant, anti-inflammatory, antiviral and antifungal actions. Studies have shown that curcumin is not toxic to humans. Curcumin exerts anti-inflammatory activity by inhibition of a number of different molecules that play an important role in inflammation. Turmeric is effective in reducing post-surgical inflammation. Turmeric helps to prevent atherosclerosis by reducing the formation of bloods clumps. Curcumin inhibits the growth of Helicobacter pylori, which causes gastric ulcers and has been linked with gastric cancers. Curcumin can bind with heavy metals such as cadmium and lead, thereby reducing the toxicity of these heavy metals. This property of curcumin explains its protective action to the brain. Curcumin acts as an inhibitor for cyclooxygenase, 5-lipoxygenase and glutathione S-transferase. It is a common spice, known mostly for its use in Indian dishes as a common ingredient in curries and other ethnic meals. Turmeric has also been used for centuries in "Ayurvedic" medicine, which integrates the medicinal properties of herbs with food. This extraordinary herb has found its way into the spotlight in the west because of its wide range of medicinal benefits. Turmeric is a potent antioxidant.

Curcumin is a powerful antioxidant as vitamins C, E and Beta-Carotene, making turmeric usage a consumer choice for cancer prevention, liver protection and premature aging (Akram *et al.*, 2010). Several published studies also showed that turmeric inhibits the growth of several different types of cancer cells. In addition, turmeric is a powerful anti-inflammatory, easing conditions such as bursitis, arthritis and back pain. Turmeric's anti-inflammatory action is likely due to a combination of three different properties.

Firstly, turmeric lowers the production of inflammation-inducing histamine. Secondly, it increases and prolongs the action of the body's natural anti-inflammatory adrenal hormone, cortisol, and finally, turmeric improves circulation, thereby flushing toxins out of small joints where cellular wastes and inflammatory compounds are frequently trapped. Research has also confirmed the digestive benefits of turmeric. Turmeric acts as a cholagogue, stimulating bile production, thus, increasing the bodies' ability to digest fats, improving digestion and eliminating toxins from the liver.

2.4 Active Constituents of Turmeric

The active constituents of turmeric are the flavonoid curcumin (diferuloylmethane) and various volatile oils, including turmerone, atlantone, and zingiberone (Akram *et al.*, 2010). Other constituents include sugars, proteins, and resins. The best-researched active constituent is curcumin, which comprises 0.3–5.4 percent of raw turmeric.

2.5 Pharmacokinetics of Turmeric

Pharmacokinetic studies in animals have demonstrated that 40-85 percent of an oral dose of curcumin passes through the gastrointestinal tract unchanged, with most of the absorbed flavonoid being metabolized in the intestinal mucosa and liver. Due to its low rate of absorption, curcumin is often formulated with bromelain for increased absorption and enhanced anti-inflammatory effect.

2.6 Mechanisms of Action of Turmeric

2.6.1 Antioxidant Effects of Turmeric

Water- and fat-soluble extracts of turmeric and its curcumin component exhibit strong antioxidant activity, comparable to vitamins C and E. A study of ischemia in the feline heart demonstrated that curcumin pre-treatment decreased ischemia-induced changes in the heart. An *in vitro* study measuring the effect of curcumin on endothelial heme-oxygenase-1, an inducible stress protein, was conducted utilizing bovine aortic endothelial cells. Incubation (18 hours) with curcumin resulted in enhanced cellular resistance to oxidative damage.

2.6.2 Hepato-protective Effects of Turmeric

Turmeric has been found to have a hepato-protective characteristic similar to silymarin. Animal studies have demonstrated turmeric's hepato-protective effects from a variety of hepatotoxic insults, including carbon tetrachloride (CCl_4), galactosamine, acetaminophen (paracetamol), and Aspergillus aflatoxin (Akram *et al.,* 2010). Turmeric's hepato-protective effect is mainly a result of its antioxidant properties, as well as its ability to decrease the formation of pro-inflammatory cytokines. In rats with CCl_4-induced acute and sub-acute liver injury, curcumin administration significantly decreased liver injury in test animals compared to controls. Turmeric extract inhibited fungal aflatoxin production by 90 percent when given to ducklings infected with *Aspergillus parasiticus*. Turmeric and curcumin also reversed biliary hyperplasia, fatty changes, and necrosis induced by aflatoxin production. Sodium curcuminate, a salt of curcumin, also exerts choleretic effects by increasing biliary excretion of bile salts, cholesterol, and bilirubin, as well as increasing bile solubility, therefore possibly preventing and treating cholelithiasis.

2.6.3 Anti-inflammatory Effects of Turmeric

The volatile oils and curcumin of *Curcuma longa* exhibit potent anti-inflammatory effects. Oral administration of curcumin in instances of acute inflammation was found to be as effective as cortisone or phenylbutazone, and one-half as effective in cases of chronic inflammation. In rats with Freund's adjuvant-induced arthritis, oral administration of *Curcuma longa* significantly reduced inflammatory swelling compared to controls. In monkeys, curcumin inhibited neutrophil aggregation associated with inflammation. *C. longa*'s anti-inflammatory properties may be attributed to its ability to inhibit both biosynthesis of inflammatory prostaglandins from arachidonic acid, and neutrophil function during inflammatory states. Curcumin may also be applied topically to counteract inflammation and irritation associated with inflammatory skin conditions and allergies, although care must be used to prevent staining of clothing from the yellow pigment.

2.6.4 Anti-carcinogenic Effects of Turmeric

Animal studies involving rats and mice, as well as *in vitro* studies utilizing human cell lines, have demonstrated curcumin's ability to inhibit carcinogenesis at three stages: tumour promotion, angiogenesis, and tumour growth (Akram *et al.,* 2010). In two studies of colon and prostate cancer, curcumin inhibited cell proliferation and tumour growth. Turmeric and curcumin are also capable of suppressing the activity of several common mutagens and carcinogens in a variety of cell types in both *in vitro* and *in vivo* studies. The anti-carcinogenic effects of turmeric and curcumin are due to direct antioxidant and free-radical scavenging effects, as well as their ability to indirectly increase glutathione levels, thereby aiding in hepatic detoxification of mutagens and carcinogens, and inhibiting nitrosamine formation.

2.6.5 Antimicrobial Effects of Turmeric

Turmeric extract and the essential oil of *Curcuma longa* inhibit the growth of a variety of bacteria, parasites, and pathogenic fungi. A study of chicks infected with the caecal parasite- *Eimera maxima* demonstrated that diets supplemented with 1-percent turmeric resulted in a reduction in small intestinal lesion scores and improved weight gain (Akram *et al.*, 2010). Another animal study, in which guinea pigs were infected with either dermatophytes, pathogenic moulds, or yeast, found that topically applied turmeric oil inhibited dermatophytes and pathogenic fungi, but neither curcumin nor turmeric oil affected the yeast isolates. Improvements in lesions were observed in the dermatophyte- and fungi-infected guinea pigs, and at seven days post-turmeric application the lesions disappeared. Curcumin has also been found to have moderate activity against *Plasmodium falciparum* and Leishmania major organisms.

2.6.6 Cardiovascular Effects of Turmeric

Turmeric's protective effects on the cardiovascular system include lowering cholesterol and triglyceride levels, decreasing susceptibility of low density lipoprotein (LDL) to lipid peroxidation, and inhibiting platelet aggregation. These effects have been noted even with low doses of turmeric. A study of 18 atherosclerotic rabbits given low-dose (1.6–3.2 mg/kg body weight daily) turmeric extract demonstrated decreased susceptibility of LDL to lipid peroxidation, in addition to lower plasma cholesterol and triglyceride levels (Akram *et al.*, 2010). The higher dose did not decrease lipid peroxidation of LDL, but cholesterol and triglyceride level decreases were noted, although to a lesser degree than with the lower dose. Turmeric extract's effect on cholesterol levels may be due to decreased cholesterol uptake in the intestines and increased conversion of cholesterol to bile acids in the liver. Inhibition of platelet aggregation by *C. longa* constituents is thought to be *via* potentiation of prostacyclin synthesis and inhibition of thromboxane synthesis.

2.6.7 Gastrointestinal Effects of Turmeric

Constituents of *Curcuma longa* exert several protective effects on the gastrointestinal tract. Sodium curcuminate inhibited intestinal spasm and p-tolymethylcarbinol, a turmeric component, increased gastrin, secretin, bicarbonate, and pancreatic enzyme secretion. Turmeric has also been shown to inhibit ulcer formation caused by stress, alcohol, indomethacin, pyloric ligation, and reserpine, significantly increasing gastric wall mucus in rats subjected to these gastrointestinal insults (Akram *et al.*, 2010).

2.6.8 Pregnancy and Lactation

Although there is no evidence that dietary consumption of turmeric as a spice adversely affects pregnancy or lactation, the safety of curcumin supplements in pregnancy and lactation has not been established.

2.7 BREEDS OF GOAT

2.7.1 Kalahari Red Goats

The Kalahari Red is regarded as an indigenous goat breed originating from South Africa. Records indicated that the goats have been selected from lop-eared animals that migrated with various tribes of people to the southern part of Africa more than 2000 years ago (Epstein, 1971). Breeders from the Northern Cape Province in South Africa and the southern part of Namibia, specifically the Kalahari Desert area, selected animals slightly smaller than the red and white improved Boer goat, but with uniform red pigmentation. The Kalahari Red was recognized as a landrace breed in 1998 with the establishment of a breeder's organization. Today, this breed of goat is an important meat-producing animal in South Africa with characteristics such as adaptation to arid and semi-arid savannah, good foraging and excellent mothering abilities. It is regarded as a "minimum care/maximum profit" breed (Ramsay *et al.*, 2001).

2.7.2 West Africa Dwarf Goat

This breed is confined to the tropical forest belt of Southern Nigeria and other West African countries such as the Cameroon. The West African Dwarf goats are found in the region south of latitude 14°N across West Africa in the coastal area, which is humid and favours high prevalence of disease (Adeloye, 1998). The WAD goats appear to be the only breed that is able to survive and successfully reproduced in tsetse fly infested humid forest areas of west and central Africa i.e. it is trypanotolerant (Odubote *et al*., 1992). They are of small size and short legged, higher than 50cm height at withers, with an average live weight of 20kg (Steele, 1996). This breed has a variety of coat colour, but black and brown colours predominate. Mature females have tassels. It is not uncommon for both mature males and females to have beard. The breed is rated high for its hardiness and tolerance to trypanosomiasis. The breed is highly prolific with a high percentage of twining and triplets. However, the West African Dwarf goats thrive well in Nigeria and reproduce with twins and triplet births (Adeloye, 1998), thereby satisfying a part of the meat requirement in this region.

2.7.3 Sahel/Desert Goat

This breed is common in the arid or Sahel region of Nigeria. Sahel goats are found in the semi-arid zone of Northern parts of the country (Igbokwe *et al*., 1998). The breed is medium to large in size, long legged, covered with coat of short fine hair. The breed is highly adapted to nomadic life and wide range of vegetation in desert to semi-desert condition. It is tolerant of hot, dry environment but unsuited to humid regions. Many produce grade skins. Sahel goats are used for meat and skin production, and a few can be described as good milker. Ears are short, males are horned. There is little information on fertility, but indications are that it may be lower than in West African Dwarf goat.

Sahel goats have average live weight and height at wither of 33.5kg and 67.5cm respectively (Steele, 1996).

2.7.4 Maradi (Red Sokoto) Goat

This is one of the few well-defined breeds of goat in Africa. It is the most numerous goat breed in Nigeria originally confined to the Niger Republic and Sokoto province but has spread throughout the Savannah and forest belt. Ears are short and carried horizontally, both sexes are horned; it is uniformly dark red in colour. The legs are shorter than the Sahel breed. The skin of the Maradi is among the most valuable of all goat skins. The breed is a good meat animal. In Niger, it is commonly milked with milk yielding about 0.5kg in dry season and up to 1.5kg in wet season. Birth weight varies from 1.0 – 2.5kg. It is relatively small with average live weight and height at wither of 26kg and 67cm respectively (Steele, 1996)

2.7.5 KalaWAD Goat

KalaWAD is the offspring resulting from the crossing of pure Kalahari Red bucks and West African Dwarf (WAD) Does.

KalaWAD= Kalahari Red Buck x West African Dwarf Doe

The crosses were bred in Institute of Food Security, Environmental Resources and Agricultural Research (IFSERAR), Federal University of Agriculture Abeokuta, Ogun State, Nigeria in year 2013. The crosses are better in terms of weight and growth than WAD goats. Their skin coat colours can be pure brown; brown with black patches; black with brown patches and amalgamation of more than two colours just like WAD goats. KalaWAD adapt well to the environment and is also trypanotolerant.

2.8 Reproduction and Reproductive Performance of Goats

Simply defined, reproduction is giving birth to offspring. The survival of a species largely depends on its ability to reproduce its own kind. Reproduction is a series of events (gamete production, fertilization, gestation, reproductive behavior, kidding, etc.) that terminates when a young is born (Girma, 2012). Reproduction in goats is described as seasonal; the onset and length of the breeding season is dependent on various factors such as latitude, climate, breed, physiological stage, presence of the male, breeding system and specifically photoperiod (Fatet *et al.*, 2011).

Reproductive performance of goats is a major determinant of productivity and economic viability of commercial goat farms (Mellado *et al.*, 2006). The reproductive process is regulated by genetic and environmental factors (Mellado *et al.*, 2006; Alexandre *et al.*, 2010; Guerra *et al.*, 2011; Notter, 2012). Fertility is influenced by pre-pubertal nutrition, postpartum nutrition, body condition, use of biotechnologies, management system and age in healthy goat flocks (Song *et al.*, 2006; Nunes and Salgueiro, 2011). With excellent management and controlled feeding throughout breeding lifetime, puberty can be stimulated to start at young ages and first parturition can be expected during their first kidding season without reducing life expectancy of Does, but increasing productive longevity (Perez-Razo *et al.*, 2004). Litter size varies depending on breed, parity number, season, and environmental conditions (Holtz, 2005; Mellado *et al.*, 2006). The natural breeding season is limited to autumn and early winter in breeds from temperate zones (Holtz, 2005).

Neonatal kid mortality in goat breeding has an important influence on the productivity of the farm and the sustainability of the flock (Mellor and Stafford, 2004; Konyalı *et al.*, 2007; Nunes and Salgueiro, 2011). Factors that may be implicated in the survival rate of kids include birth weight of the kid, genetics, mothering ability and milk production of the dam, adverse environmental or feeding conditions, diseases and predators (Snyman, 2010). The advanced age, breed, parity, mating season, difficulty in conceiving, low social status and pregnancy with two and more fetuses, previous abortion, malnutrition and low energy intake in dairy goats are described as causes of non-infectious abortions (Mellado *et al.*, 2004).

2.9 Oxidative Stress

Oxidative stress is commonly defined as an imbalance between oxidants and reductants (antioxidants) at the cellular or individual level (Lykkesfeldt and Svendsen, 2007). Oxidative stress, a particular kind of chemical stress, is caused by an imbalance between the productions of free radicals and the capability of an organism to absorb their excess. It is extremely dangerous because it Does not exhibit any symptoms and is recognizable with great difficulty by means of common methods of analysis (Piccione *et al.*, 2008). The alteration of oxidative balance, if not adequately restored by the antioxidant barrier, induces an oxidative stress with cellular damage (Trevisan *et al.*, 2001) which makes the organism sensitive to serious degenerative diseases (Fridovich, 1999). The formation of free radicals is a normal event in many pathological conditions and an overproduction is common during strenuous activities. Therefore, determination of free radicals is an index of oxidative stress, which is directly proportional to the condition of the organism.

Oxidative damage is one result of such an imbalance and includes oxidative modification of cellular macromolecules, cell death by apoptosis or necrosis, as well as structural tissue damage. Recent developments in the evaluation of oxidative stress in farm animals have contributed significantly to the understanding of fundamental processes involved in metabolic disorders (Lykkesfeldt and Svendsen, 2007). Oxidative stress is believed to play an important role in regulating the metabolic activity of some organs and productivity in farm animals. Oxidative stress results when pro-oxidants (free radicals) exceed the capacity of antioxidants. A free radical is defined as any species capable of independent existence that contains one or more unpaired electrons (Halliwell and Gutteridge, 1989). Reactive oxygen metabolites (ROMs) are capable of attacking all of the major classes of biomolecules, although lipids are particularly susceptible (Miller *et al.*, 1993). Oxidative stress can be particularly dangerous because no clinical symptoms are shown and the condition is diagnosed by means of dedicated analytical methods. ROMs have several normal physiological functions (Droge, 2002), but 'oxidative stress' will occur when excess production cannot be counteracted by antioxidant mechanisms, potentially leading to pathological changes (Lykkesfeldt and Svendsen, 2007). Several defence mechanisms are available to prevent oxidative damage (Lykkesfeldt and Svendsen, 2007), including scavenging systems, such as the enzymes glutathione peroxidase (GSH-Px) and superoxide dismutase (SOD). In addition, thiol (SH) groups, commonly found in the cysteine side chain, are the most chemically reactive sites on proteins, such as albumin, and have strong reducing properties (Soriani *et al.*, 1994; Moran *et al.*, 2001). In dairy cows, pregnancy and lactation are physiological stages considered to induce metabolic stress (Drackley, 1999). For example, dairy cows can experience oxidative stress (Bernabucci *et al.*, 2005; Castillo *et al.*, 2006), which may be associated with metabolic diseases during the peripartum period (Miller *et al.*, 1993). A number of recent studies have reported variable levels of oxidative stress during the peri-parturient period in dairy cows (Bernabucci *et al.*, 2005; Castillo *et al.*, 2005; Gaál *et al.*, 2006). Activity of oxidative stress biomarkers can be influenced by nutrition and season (Bernabucci *et al.*, 2002; Di Trana *et al.*, 2006). For example, feeding high levels of starch in the diet to cows for 80 days lactation increased oxidative stress, possibly due to cellular changes related to oxidative phosphorylation (Gabai *et al.*, 2004). The adoption of intensive methods of husbandry in goats for higher milk yields (Rubino *et al.*, 1995) is likely to increase the incidence of metabolic diseases. The relationship between diet composition and oxidative stress has received little research interest in goats during late pregnancy and the beginning of lactation although, based on studies in dairy cows (Bernabucci *et al.*, 2005; Sordillo *et al.*, 2007), the oxidative status of dairy goats may be impaired during the transition period.

2.10 Applications of Turmeric and other herbal plants in Livestock Production

Usage of Turmeric has not been fully employed in livestock production (especially for ruminant) as Does in human medicine. Various parts of turmeric plant and extract have been used by different researchers to access its effects on various parameters on different classes of animal- sheep, cattle, broilers, and swine including human beings. In an experiment conducted by Salih (2013) on the effect of Turmeric (*Curcuma longa*) powder on growth performance, carcass traits, meat quality, and serum biochemical parameters in broilers with inclusion rates of 0g (control), 5g, 7g and 9g/kg of Turmeric powder. The result of the study revealed that birds fed diet containing 7 g/kg of diet significantly improved the weight gain, dressing percentage, liver, gizzard, proventriculus, breast, thigh, back, drum stick, neck and wings the of broiler chicken. 7g/kg inclusion rate also recorded significant best feed conversion ratio compared to other treatments. On the other hand, turmeric supplementation at 7 g/kg of broiler diet reduced serum concentration of cholesterol and triglycerides when compared with the control and other treatments. But 5g/kg of turmeric supplementation recorded significant reduction in the abdominal fat of the broiler chickens compared to other treatments. Similarly, the effect of different levels of feed added turmeric (*Curcuma longa*) on the performance of broiler chicks was conducted by Durrani *et al.* (2006) where four experimental diets consisting 0%, 0.25%, 0.50% and 1% of Turmeric were fed to broiler chicks. Broiler chicks fed 0.5% recorded highest significant weight gain and best feed conversion ratio per chick at both the starter and finisher phases. The 0.5% inclusion rates of turmeric also recorded highest significant values for breast weight, thigh weight, dressing percentage and the most reduced feed cost/chick.

The effects of garlic oil (*Allium sativa*), turmeric powder (*Curcuma longa* Linn) and monensin on total apparent digestibility of nutrients, ruminal and blood metabolite responses of Baloochi lambs were investigated by Hodjatpanah *et al.* (2010) and Khalesizadeh *et al.* (2011) where basal diets were supplemented with 420mg/sheep/day Garlic; 20g Turmeric/sheep/day; and 200mg Monensin/sheep/day. None of the supplementations had significant effect on mean and minimum of ruminal pH and ammonia nitrogen concentration, but maximum value of ruminal pH was significantly decreased by Monensin and turmeric supplementation. The supplementations had no significant effect on the total apparent digestibility of the sheep.

An experiment was also conducted by Vorlaphim *et al.* (2011) to investigate the influence of dietary curcumin on rumen fermentation, macronutrient digestion and nitrogen balance in beef cattle fed urea-treated rice straw and concentrates without or with 0.1% or 0.2% added curcumin. Voluntary feed intake was not influenced by the addition of curcumin to the ration. Dietary curcumin raised bacterial counts in the rumen fluid, but lowered the protozoa counts. Ruminal ammonia concentrations were decreased by curcumin. The intake of curcumin did not affect apparent digestibility of dry matter, organic matter, ether extract and neutral detergent fibre, but it reduced the digestibility of acid detergent fibre. Dietary curcumin diminished faecal nitrogen excretion and raised nitrogen absorption and retention. This study showed that the feeding of curcumin changes the ruminal flora and nitrogen metabolism in beef cattle. The curcumin-induced stimulation of nitrogen retention may be considered as a potentially positive effect, but the observed decrease in apparent digestibility of acid detergent fibre could limit the utilization of roughage.

A study was conducted (Kim *et al.*, 2013) to evaluate the effects of indigenous herbal supplements on growth, blood metabolites and carcass characteristics in the late fattening period of Hanwoo steers. Feeding trial involved steers fed control (basal diet contained lasalocid), 0.5% licorice, 0.5% clove, 0.5% turmeric and 0.5% silymarin. All groups received *ad libitum* concentrate and 1kg rice straw/animal/day throughout the feeding trial. Blood urea nitrogen and creatinine concentrations were highest in steers treated with silymarin. Alanine aminotransferase activity was lower for licorice and silymarin compared with the control group. There were no alterations in serum aspartate aminotransferase and gamma glutamyltransferase activities as a consequence of herb treatments. Final body weight, body weight gain, average dairy gain and dry matter intake were not significantly different among treatments. Yield grade, marbling score and quality grade were higher for silymarin group than those of other treatments.

2.11 Applications of Turmeric in Human Medicine

The use of Turmeric has received much use by human medicine to prevent and treat various health disorders. Some of these applications include the following:

According to Turmeric for Health (2018), Turmeric has been used for:

1. **Leukorrhea:** this is a term used to denote thick, whitish or yellowish vaginal discharge. It is believed to be caused due to various factors (main one being imbalance of hormones) and can continue for years. Turmeric can prove to be helpful

by taking 10g of turmeric and boil in water. Let it cool down and then use it as a douche 3-4 times a day. It is believed to provide long term relief.

2. **Back pain and overall body ache**: these are the common complaints associated with menstrual cycles. Women generally resort to over the counter available painkillers. The use of painkillers or non-steroidal anti-inflammatory drugs (NSAIDS) for long term can pose side effects such as gastrointestinal upset, gastritis, acidity, kidney failure etc. As an herbal alternative to painkillers turmeric powder can be consumed within the limit of 400-600mg thrice a day. Curcumin is a strong anti-inflammatory agent and it combats pain in a similar way as painkillers but Does not cause adverse effects.

Report also had it according to Turmeric for Health (2018) that turmeric helps in the following:

1. **Normalizing menstruation:** Turmeric has a property of being an 'emmenagogue'. Emmenagogues are herbs which stimulate blood flow in the pelvic area and uterus, also some of them stimulate menstruation. Turmeric purifies and moves stagnant blood which normalizes menstruation.
2. **Endometriosis:** Endometriosis is a disease in which endometrium- cells lining the uterus, grows outside the uterine cavity. This disease affects around 15% of women of reproductive age and leads to infertility. The exact cause behind the occurrence of the disease is not yet understood but oxidative stress and hormonal imbalance is said to play important roles in its mediation. Curcumin is reported to inhibit the growth of endometrial cells by modulating the secretion of oestrogen. Curcumin's potent

antioxidant activity is also exploited to serve as an aid against oxidative stress mediated infertility in endometrium.

3. **Menstrual toxic shock syndrome (mTss):** Toxic shock syndrome is a potentially fatal condition caused by bacterial toxin. Toxic shock syndrome affects menstruating women, especially those who use super-absorbent tampons or use a single tampon for long time periods. Toxic shock syndrome can also occur with skin infections, burns, and after surgery. $^{1}/_{3}$ of the toxic shock cases involve women under 19. High fever and vomiting during menstruation, rash and low blood pressure are few of the symptoms. A study conducted in Minnesota, USA investigated the effect of curcumin on mTss in a rabbit model. Curcumin was found to be non-toxic to cells lining the vagina and it not only inhibited the infection but also reduced the inflammation caused by it. This effect was deemed to be caused due to curcumin's anti-inflammatory and anti-microbial properties. Curcumin reduced toxic shock syndrome induced lethality by 60% in rabbits.

4. **Uterine Fibroids:** Fibroids are non-cancerous tumours that grow in the wall of the uterus. 1 out of 5 women are affected with fibroids during their reproductive age. 20-80% of women develop fibroids by the age of 50. Surgical procedures and hormone therapy are the common line of treatment. Curcumin is found to inhibit the growth of cells that make up uterine fibroids and prevents proliferation. The anti-inflammatory property of curcumin mediates this therapeutic effect.

5. **Cancer:** Medical science is slowly accepting the benefits of turmeric against various types of cancer. Turmeric has been proved effective against tumours and cancers in many scientific studies conducted in labs and there are large number of people praising turmeric for the benefit they felt in their health condition. Research proves that curcuminoids can prevent growth of breast cancer cells and also prevent the

spread of breast cancer in bones by inhibiting the breast cancer cells from secreting factors that are necessary for the progression of cancer to other organs. Interestingly India has the lowest incidence of breast cancer in the world and it also has the highest consumption as well as production of dietary turmeric worldwide.

6. **Turmeric is also proven to inhibit the growth of ovarian cancer cells:** ovarian cancer is the leading cause of death when it comes to gynaecological cancer. Curcumin is reported to cause cell death of cervical cancer cells by acting against estradiol- a primary female sex hormone which under adverse conditions helps in progression of cervical cancer (cancer in the lower part of the uterus).

2.12 Dosage of Turmeric has recommended by Different Authors for Human Use

Turmeric can be consumed daily in diet as curries or rice preparations, soups or even with milk. Turmeric supplements in the form of capsules and tinctures are also available. The prescribed dose is as follows according to Turmeric for Health (2018):

1. Standardized powder: 400-600mg 3 times a day
2. Fluid extract with 1:1 concentration: 30-90 drops per day
3. Tincture of 1:2 ratio: 15-30 drops 4 times a day

Willett (2018) recommended the use of turmeric as follows:

1. Capsule: 400 to 600 mg three times a day
2. 1:1 Liquid Extract: 5-14 ml per day taken in 4-5 equal doses throughout the day

3. Powdered rhizome: 1 teaspoon (approx. 4 g) 1-2 times a day added to fertility diet.

According to GINSENG (2018), to benefit from Turmeric's anti-inflammatory effects, 1000mg/day of curcumin between meals should be taken. The anti-inflammatory properties of Turmeric are more powerful when it is consumed outside meals. A study showed that daily consumption of 2-3g of Turmeric for a period of 2 months led to the healing of stomach ulcer in 75% of treated patients (GINSENG, 2018).

2.13 Parasites of Goat

Parasitism, and gastrointestinal nematode parasitism in particular, is arguably the most serious constraint affecting small ruminant production world-wide. Economic losses are caused by decreased production, cost of prevention, cost of treatment, and the death of infected animals. It is difficult by any form of major survey or other estimation to establish precise figures on losses incurred in production from infection and disease. Even minimal accuracy of loss estimates is difficult because production diseases or disorders may result from interaction with nutritional and environmental stresses, management methods, concurrent diseases, genetic predispositions, or other factors.

The effects of parasitic infection can be influenced by the nutritional status of the host. It is well known that well-fed animals can better withstand parasite infection than animals on an imbalance diet. It is also true that parasites interfere with the ability of the host to utilize nutrients efficiently. The better an animal is fed, the better it is able to tolerate increasing infection levels, but eventually a point may be reached, depending on the worms and conditions involved, where parasitism overwhelms the host's ability to function properly. To satisfy body demands, most nutrients are absorbed from the gut during digestion and additional nutrients are available as needed from body reserves.

2.13.1 Internal Parasites of Goats

Gastrointestinal nematodes (worms)

***Haemonchus contortus* (Barberpole worm)- Abomasal worms**

Haemonchus contortus is a voracious blood-feeding worm. It gets its name due to the barberpole appearance consisting of white ovaries that twist around the red blood filled gut. This worm is rather large compared to other stomach and intestinal worms of goats, measuring up to 3/4 of an inch. When large numbers are present, worms can readily be seen as thin (diameter of a paper clip wire) red hair-like worms on the stomach surface. Female worms are prolific egg laying machines and in large numbers with favourable conditions, they can contaminate the environment with a very large number of eggs. These worms thrive under hot and moist environmental conditions, which are conducive for survival and development of the free-living stages, and are found predominantly in tropical and subtropical regions of the world. *H. contortus* transmission and infection is at the lowest level during the winter. Transmission and infection increases with the warmer temperatures and increasing moisture during the spring and peaks during the summer. As temperatures and moisture dissipate during the fall, transmission and infection decreases. Goats infected with *H. contortus* show symptoms associated with blood loss (anaemia), which include pale mucous membranes (most visible by viewing inside the lower eyelid) and bottle jaw (an accumulation of fluid under the chin). The greater the infection level the more blood is lost and eventually the animal may die.

***Telodorsagia (Ostertagia) circumcincta* (Brown stomach worm)**

The other abomasal worm of importance is *Telodorsagia circumcincta* which is smaller than *H. contortus* and is not readily visible since it is about as big as an eyelash (Jim, 2012). These worms feed mostly on nutrients in mucous and do not feed on blood *per se*, but can ingest some blood if present. Female worms do not produce as many eggs as *H. contortus*. Infection causes direct damage to the stomach lining thereby interfering with digestion and appetite. Infection is usually considered a production disease as animals do not grow very well. However, under very high infection conditions, death can result. When infections reach levels that cause disease to be seen, the primary symptom is diarrhoea. This worm thrives in cooler wet environmental conditions which are encountered in the more temperate regions. Hypobiosis occurs when environmental conditions are too cold (winter) or too dry (summer).

2.13.2 Small intestinal worms of Goats

***Trichostrongylus colubriformis* (Bankrupt worm)**

Trichostrongylus colubriformis is a very small threadlike worm and is the most predominant small intestinal worm. It thrives better under more cool and wet conditions similar to *Telodorsagia circumcincta*. However, this worm is the next most common and important after *Haemonchus* and on some farms can cause considerable problems (Jim, 2012). As with *Telodorsagia*, this worm feeds on nutrients in mucous and interferes with digestive function resulting in diarrhoea. It is called the bankrupt worm because death is seldom the end result and animals just become poor Doers leading to loss of production and income.

Eimeria* spp. *(Coccidia)

Coccidiosis is one of the most ubiquitous and economically important diseases of goat (Foreyt, 1990). It has been reported in a large number of regions and countries of Europe, Africa, Asia and America (Penzhorn *et al*., 1994; Faizal *et al*., 1999; Agyei *et al*., 2004).

Different species of *Eimeria* have been recorded from goats in different parts of the world (Soe and Pomroy, 1992; Zajac and Conboy, 2006). The disease is more serious in 4-6 months old kids and also when animals of any age are kept in unhygienic and overcrowded houses (Varghese and Yayabu, 1985).

Adult goats in a herd keep their infections year-round, continually contaminating the environment with oocysts which serve as a source of re-infection and of new infections for young kids (Baker, 1975). Eimeria infection is more common in females (Soliman and Zalat, 2003). Affected animals usually develop a strong immunity with increasing age. Immunity to coccidiosis produced by infection with *E. bovis* apparently involves both humoral and cellular responses (Faber *et al*., 2002). Calves that recover from infection are either solidly immune from reinfection (species specific) or can be infected without showing clinical disease. Goat coccidiosis causes high mortality in kids that may reach up to 58% (Jalila *et al*., 1998). The high mortality rates and lowered productivity due to poor growth, together with costs of anti-coccidials, drug administration and disinfection, are all factors causing losses by coccidiosis in domestic animals (Cornelius, 1980).

There is usually a lag of 14-18 days between a massive ingestion and the presence of oocytes in the faeces. There is also a delay of 2-4 days between when dysentery or diarrhea begins and when oocytes are found in the faeces. It is, therefore, best to evaluate the faeces of several individuals over several days to fully assess the coccidia burden. A count of over 5000 oocytes/g of faeces is considered significant. While counts below 5000/g do not ordinarily suggest a clinical infestation, they may indicate a potential source of severe infestation if environmental conditions become favorable for rapid spread (David, 2012). In severe outbreaks, counts in excess of 100,000/g are common but still need to be correlated with clinical signs because similar counts may also be encountered occasionally in clinically normal animals.

2.14 Enteric Fermentation

Enteric fermentation is fermentation that takes place in the digestive systems of animals. In particular, ruminant animals (cattle, buffalo, sheep, goats, and camels) have a large "fore-stomach," or rumen, within which microbial fermentation breaks down food into soluble products that can be utilized by the animal (Gibbs and Leng, 1993; *State Workbook*, 1995). Approximately 200 species and strains of microorganisms are present in the anaerobic rumen environment, although only a small portion, about 10 to 20 species, are believed to play an important role in ruminant digestion (*Anthropogenic Methane Emissions*, 1990). The microbial fermentation that occurs in the rumen enables ruminant animals to digest coarse plant material that monogastric animals cannot digest. Methane is produced in the rumen by bacteria as a by-product of the fermentation process. This CH_4 is exhaled or belched by the animal and accounts for the majority of emissions from ruminants. Methane is also produced in the large intestines of ruminants and it is expelled.

2.14.1 Methane Emission from Livestock

Livestock are one of the largest single sources of methane emission with 80–115 million tonnes per year, equivalent to 15–20% of total anthropogenic methane (IPCC, 2001). Ruminal microorganisms are responsible for the emission of methane from livestock (cattle, buffalo, sheep, goats, camel, *etc.*). The global cattle population is responsible for 73% of methane emissions of all livestock and in tropical regions, where at least half of the global ruminant livestock population is located and is fed mainly low-quality diets, 10-12 per cent of the gross energy ingested is lost through methane (McCrabb and Hunter, 1999). Grasslands in the tropics constitute a large natural feed resource, which is mainly suited for grazing by ruminants. Tropical grasses are of low to moderate digestibility (on average 13% lower dry matter (DM) digestibility than temperate grasses) and are often deficient in critical nutrients such as protein and phosphorus (Minson, 1990). Under such conditions, methane produced during ruminal fermentation represents a loss of 10–11% of gross energy intake (McCrabb and Hunter, 1999). The enteric methane contributes approximately 30-40 per cent of total methane produced from agricultural sources (Moss *et al.*, 2000).

Methane production during ruminal fermentation as a result of methanogenic bacteria and protozoa is an unavoidable and inefficient product of rumen fermentation (Johnson and Johnson, 1995). In ruminants, feed is converted to short chain fatty acids in the rumen, which are used as a source of energy and the hydrogen generated as an intermediate is converted rapidly to methane by the methanogens (Stewart *et al.*, 1997). The methane synthesis in rumen is usually associated with decreased propionate production and increased acetate to propionate ratio (Russell, 1998). Rumen microbial utilization of carbohydrates in the gut of animals results in the production of volatile fatty acids, microbial protein, CO_2 and CH_4 with little hydrogen (H_2). Methane generation should be viewed as an energy sink where H_2 from all rumen microorganisms drains, allowing a greater total yield of ATPs.

Reaction:

$$4H_2 + CO_2 \text{-----}\rightarrow CH_4 + 2H_2O$$

This is the most common mode of methane production in the rumen.

CH_4 from enteric fermentation by ruminants is not only an important greenhouse gas associated with environmental problems, but it also represents a loss of feed energy (20–150 kJ/MJ) intakes (Singh *et al.*, 2005). Therefore, developing feeding strategies to minimize CH_4 emission is desirable in long-term mitigation of emission of greenhouse gases into the atmosphere and for short-term economic benefits.

2.14.2 Micro-Organisms Involved in Methane Production in Rumen

Methane is produced by strict anaerobes belonging to the sub-group of the Archaea domain. There is a large phylogenetic diversity of methanogens in natural media. Also, the different genera and species of methanogens have various shapes and physiological characteristics: cocci, rods, spirilla, and thermophylic and mesophylic species, motile and non-motile cells (Woese *et al*., 1990). Methanogens like *Methanobacterium formicicum, M. ruminantium, M. bryanti, Methanobrevibacter ruminantium, Methanosarcina barkeri, Methanomicrobium mobile* and *Methanoculleus olentangyi* are present in the rumen in a large number in rumen liquor depending upon the type of diet given to animals, especially the fibre content in the ration. On a fibre rich diet, production of acetic acid is more coupled with more production of methane (Baker, 1999). Rumen methanogens grow only in environments with a redox potential below –300 mV. More than sixty species were isolated from various anaerobic habitats like sanitary landfills, peat bogs, waterlogged soils, salt lakes, thermal environments, and intestinal tracts of animals. Only five of these species belonging to *Methanobrevibacter* and *Methanosarcina* genera, were isolated from rumen digesta. Only two of these species have been found at a population level greater than 106 ml–1 of rumen liquor (Steudler *et al*., 1989).

2.14.3 Methanogenesis by Methanogens

The reactions involved in methane production in the rumen, which have been described by Rouviere and Wolfe (1988), are their sole energy-generating mechanism. They show that specific co-factors are needed for the methane to be produced and inhibition of some of them could be a way to reduce the activity of methanogens. Although, H_2 is one of the major end products of fermentation by protozoa, fungi and pure monocultures of some bacteria, it Does not accumulate in the rumen, because it is immediately used by other bacteria which are present in the mixed microbial ecosystem. The collaboration between fermenting species and H_2-utilising bacteria (e.g. methanogens) is called "interspecies hydrogen transfer". Some physical associations between fermentative species and H_2-users may facilitate interspecies transfer in the rumen. Attachment of methanogens to the external pellicle of protozoa has been reported by Krumholz *et al.* (1983) and Stumm *et al.* (1982). The molar percentage of volatile fatty acids (VFAs) influences the production of methane in the rumen. Acetate and butyrate promote methane production, while propionate formation can be considered as a competitive pathway for hydrogen use in the rumen.

2.15 Some Animal Hormones

2.15.1 Estrogen

Estrogen or oestrogen is the primary female sex hormone and it is responsible for development and regulation of the female reproductive system and secondary sex characteristics. Estrogen may also refer to any substance, natural or synthetic that mimics the effects of the natural hormone. The steroid 17β-estradiol is the most potent and prevalent endogenous estrogen, but several metabolites of estradiol also have estrogenic hormonal activity. Estrogens are synthesized in all vertebrates (Ryan, 1982) as well as some insects (Mechoulam *et al.,* 2005). Their presence in both vertebrates and insects suggests that estrogenic sex hormones have an ancient evolutionary history. Quantitatively, estrogens circulate at lower levels than androgens in both sexes (Burger, 2002). The three major naturally occurring estrogens in female are estrone (E1), estradiol (E2), and estriol (E3).

Estrogens, in females, are produced primarily by the ovaries, and during pregnancy, the placenta. Follicle-stimulating hormone (FSH) stimulates the ovarian production of estrogens by the granulosa cells of the ovarian follicles and corpora lutea. Some estrogens are also produced in smaller amounts by other tissues such as the liver, adrenal glands, and the breasts. These secondary sources of estrogens are especially important in postmenopausal women. Fat cells produce estrogen as well (Nelson and Bulun, 2001).

Functions of Estrogen

While estrogens are present in both sexes, they are usually present at significantly higher levels in female of reproductive age. They promote the development of female secondary sexual characteristics, such as mammary glands, and are also involved in the thickening of the endometrium and other aspects of regulating the estrous cycle. In males, estrogen regulates certain functions of the reproductive system important to the maturation of sperm (Hess *et al.*, 1997) and may be necessary for a healthy libido (Hill *et al.*, 2004). Furthermore, there are several other structural changes induced by estrogen in addition to other functions. These include:

a) Promote formation of female secondary sex characteristics
b) Accelerate metabolism
c) Increase fat store
d) Stimulate endometrial growth
e) Increase uterine growth
f) Increase vaginal lubrication
g) Thicken the vaginal wall
h) Maintenance of vessel and skin
i) Reduce bone resorption, increase bone formation
j) Increase cortisol
k) Increase cholesterol in bile
l) Promotes lung function by supporting alveoli

m) Estrogen together with progesterone promotes and maintains the uterus lining in preparation for implantation of fertilized egg and maintenance of uterus function during gestation period, also upregulates oxytocin receptor in myometrium

n) Surge in estrogen level induces the release of luteinizing hormone, which then triggers ovulation by releasing the egg from the Graffian follicle in the ovary.

o) Promotes sexual receptivity (Christensen *et al.*, 2011), and induces lordosis behavior (Handa *et al.*, 2012). In non-human mammals, it also induces estrus (in heat) prior to ovulation, which also induces lordosis behavior. Female non-human mammals are not sexually receptive without the estrogen surge, i.e., they have no mating desire when not in estrus.

p) Sex drive is dependent on androgen levels (Warnock *et al.*, 2005) only in the presence of estrogen, but without estrogen, free testosterone level actually decreases sexual desire (instead of increases sex drive), as demonstrated for those women who have hypoactive sexual desire disorder, and the sexual desire in these women can be restored by administration of estrogen- using oral contraceptive (Heiman *et al.*, 2011). In non-human mammals, mating desire is triggered by estrogen surge in estrus.

2.15.2 Oxytocin

Oxytocin is a nonapeptide and neurohypophysial hormone that is made in mammals. It is also available as a medication. Oxytocin is normally produced in the hypothalamus (Barberis *et al.,* 1998) and stored in the posterior pituitary gland. It plays a role in intimacy, sexual reproduction of both sexes, and during and after parturition as well as social bonding (Olff *et al.,* 2013). It is released in large amounts after distension of the cervix and uterus during labor and with stimulation of the teats following parturition. This helps with birth, maternal bonding, and lactation. Studies have looked at oxytocin's role in various behaviors, including orgasm, social recognition, pair bonding, anxiety, and maternal behaviors (Lee *et al.*, 2009). As a medication, it is used to cause contraction of the uterus, which is used to start labor, increase the speed of labor, and to stop bleeding following delivery.

- **Letdown reflex:** In lactating (breastfeeding) dams, oxytocin acts at the mammary glands, causing milk to be 'let down' into sub-areolar sinuses, from where it can be excreted via the teat.
- **Uterine contraction:** Important for cervical dilation before birth, oxytocin causes contractions during the second and third stages of labor. Oxytocin release during breastfeeding causes mild but often painful contractions during the first few weeks of lactation. This also serves to assist the uterus in clotting the placental attachment point postpartum. However, in knockout mice lacking the oxytocin receptor, reproductive behavior and parturition are normal (Takayanagi *et al.*, 2005).
- **Social behavior and wound healing:** Oxytocin is also thought to modulate inflammation by decreasing certain cytokines. Thus, the increased release in oxytocin following positive social interactions has the potential to improve wound healing.
- Due to its similarity to vasopressin, it can reduce the excretion of urine slightly. In several species, oxytocin can stimulate sodium excretion from the kidneys (natriuresis), and, in humans, high doses can result in hyponatremia.
- **Modulation of hypothalamic-pituitary-adrenal axis activity:** Oxytocin, under certain circumstances, indirectly inhibits release of adrenocorticotropic hormone and cortisol and, in those situations, may be considered an antagonist of vasopressin.
- **Sexual arousal:** Oxytocin injected into the cerebrospinal fluid causes spontaneous erections in rats (Gimpl and Fahrenholz, 2001), reflecting actions in the hypothalamus and spinal cord. Centrally administrated oxytocin receptor antagonists can prevent

noncontact erections, which is a measure of sexual arousal. Studies using oxytocin antagonists in female rats provide data that oxytocin increases lordosis behavior, indicating an increase in sexual receptivity (Bancroft, 2005).

- **Bonding:** In the prairie vole, oxytocin released into the brain of the female during sexual activity is important for forming a monogamous pair bond with her sexual partner. Vasopressin appears to have a similar effect in males. Oxytocin has a role in social behaviors in many species, so it likely also Does in humans.
- **Maternal behaviour:** Female rats given oxytocin antagonists after giving birth do not exhibit typical maternal behavior (Van-Leengoed et al., 1987). By contrast, virgin female sheep show maternal behavior toward foreign lambs upon cerebrospinal fluid infusion of oxytocin, which they would not do otherwise (Kendrick, 2004). Oxytocin is involved in the initiation of maternal behavior, not its maintenance; for example, it is higher in mothers after they interact with unfamiliar children rather than their own (Bick and Dozier, 2010).
- **Preparing fetal neurons for delivery:** Crossing the placenta, maternal oxytocin reaches the fetal brain and induces a switch in the action of neurotransmitter GABA from excitatory to inhibitory on fetal cortical neurons. This silences the fetal brain for the period of delivery and reduces its vulnerability to hypoxic damage (Tyzio *et al.*, 2006).

2.15.3 Progesterone

Progesterone also known as pregn-4-ene-3,20-dione (Norman *et al.*, 2012), is an endogenous steroid and progestogen sex hormone involved in the estrous cycle, pregnancy, and embryogenesis of humans and other species (Tekoa and Mary, 2010). It belongs to a group of steroid hormones called the progestogens (Tekoa and Mary, 2010), and is the major progestogen in the body. Progesterone is also a crucial metabolic intermediate in the production of other endogenous steroids, including the sex hormones and the corticosteroids, and plays an important role in brain function as a neurosteroid (Baulieu and Schumacher, 2000).

Sources of Progesterone in Animal

Progesterone is produced in high amounts in the ovaries (by the corpus luteum) from the onset of puberty to menopause, and is also produced in smaller amounts by the adrenal glands after the onset of adrenarche in both males and females. To a lesser extent, progesterone is produced in nervous tissue, especially in the brain, and in adipose (fat) tissue, as well.

During pregnancy, progesterone is produced in increasingly high amounts by the ovaries and placenta. At first, the source is the corpus luteum that has been "rescued" by the presence of human chorionic gonadotropin (hCG) from the conceptus. However, after the 8th week, production of progesterone shifts to the placenta. The placenta utilizes maternal cholesterol as the initial substrate, and most of the produced progesterone enters the maternal circulation, but some is picked up by the fetal circulation and used as substrate for fetal corticosteroids. An additional animal source of progesterone is milk products. After consumption of milk products the level of bioavailable progesterone goes up (Godson *et al.*, 2007).

Progesterone is sometimes called the "hormone of pregnancy" and it has many roles relating to the development of the fetus:

- Progesterone converts the endometrium to its secretory stage to prepare the uterus for implantation. At the same time, progesterone affects the vaginal epithelium and cervical mucus, making it thick and impenetrable to sperm. Progesterone is anti-mitogenic in endometrial epithelial cells, and as such, mitigates the tropic effects of estrogen (Patel *et al.*, 2014). If pregnancy Does not occur, progesterone levels will decrease, leading to signs of estrous.

- During implantation and gestation, progesterone appears to decrease the maternal immune response to allow for the acceptance of the pregnancy.
- Progesterone decreases contractility of the uterine smooth muscle.
- In addition, progesterone inhibits lactation during pregnancy. The fall in progesterone levels following delivery is one of the triggers for milk production.
- A drop in progesterone levels is possibly one step that facilitates the onset of labor.

2.15.4 Prolactin

Prolactin (PRL), also known as luteotropic hormone or luteotropin, is a protein that is best known for its role in enabling mammals, usually females, to produce milk; however, it is influential over a large number of functions with over 300 separate actions of PRL having been reported in various vertebrates (Bole-Feysot *et al.*, 1998). Prolactin is secreted from the pituitary gland in response to eating, mating, estrogen treatment, ovulation, and nursing. Prolactin is secreted in a pulsatile fashion in between these events. Prolactin also plays an essential role in metabolism, regulation of the immune system, and pancreatic development.

Although often associated with human milk production, prolactin plays a wide range of other roles in both humans and other vertebrates. For example, in fish—the oldest known vertebrates—an important function is probably related to control of water and salt balance. Prolactin also acts in a cytokine-like manner and as an important regulator of the immune system. It has important cell cycle related functions as a growth-, differentiating- and anti-apoptotic factor. As a growth factor, binding to cytokine like receptors, it also has profound influence on haematopoiesis, angiogenesis and is involved in the regulation of blood clotting through several pathways. The hormone acts in endocrine, autocrine, and paracrine manner through the prolactin receptor and a large number of cytokine receptors (Bole-Feysot *et al.*, 1998).

Effects of Prolactin

Prolactin has a wide range of effects. It stimulates the mammary glands to produce milk (lactation): increased serum concentrations of prolactin during pregnancy cause enlargement of the mammary glands of the breasts and prepare for the production of milk. Milk production normally starts when the levels of progesterone fall by the end of pregnancy and a suckling stimulus is present. Sometimes, newborn babies (males as well as females) secrete a milky substance from their nipples known as witch's milk. This is in part caused by maternal prolactin and other hormones. Prolactin also has been found to play an important role in maternal behavior (Lucas *et al.*, 1998).

i. Prolactin provides the body with sexual gratification after sexual acts: The hormone counteracts the effect of dopamine, which is responsible for sexual arousal. This is thought to cause the sexual refractory period. The amount of prolactin can be an indicator for the amount of sexual satisfaction and relaxation. Unusually high amounts are suspected to be responsible for impotence and loss of libido.
ii. Highly elevated levels of prolactin decrease the levels of sex hormones — estrogen in female and testosterone in male. The effects of mildly elevated levels of prolactin are much more variable, in female both substantial increase and decrease of estrogen levels may result.
iii. Prolactin also has a number of other effects including contributing to pulmonary surfactant synthesis of the fetal lungs at the end of the pregnancy and immune tolerance of the fetus by the maternal organism during pregnancy.
iv. Prolactin delays hair regrowth in mice (Craven *et al.*, 2006).

v. Prolactin promotes neurogenesis in maternal and fetal brains (Shingo *et al.*, 2003; Larsen and Grattan, 2012).

2.16 CONGO GRASS (*Brachiaria ruziziensis*)

2.16.1 Common names of Congo Grass

Brachiaria ruziziensis has varieties of names in different languages which include the following:

English Language: Congo grass, Congo signal, Congo signal grass, Kennedy ruzi, Kennedy ruzi grass, prostrate signal grass, ruzi, ruzi grass

Spanish: Congo, Congo señal, gambutera, Kenia, pasto Congo, pasto ruzi, ruzi

Portuguese: Ruzisiensis, capim congo

French: herbe à bengali, ruzi

Indonesian: Rumput ruzi

Thai: Ya ruzi

2.16.2 Morphological Description of Congo Grass

Congo grass is a short-lived perennial grass (Husson *et al.*, 2008). It is tufted, creeping (semi-prostrate) and rhizomatous. It roots from the nodes and forms a dense leafy cover (Cook *et al.*, 2005; Urio *et al.*, 1988). Congo grass has a dense system of bunched, quickly growing roots that can go down to a depth of 1.8 m (Husson *et al.*, 2008). Culms grow from the nodes of the rhizomes and may reach a height of 1.5 m when flowering (Cook *et al.*, 2005). The leaves are soft but hairy on both sides, lanceolate in shape and up to 25 cm long x 1-1.5 cm broad, light-green in colour. The inflorescence consists of 3-9 relatively long racemes (4-10 cm) that bear spikelets in 1 or 2 rows on one side of a broad, flattened and winged rachis (Cook *et al.*, 2005). The spikelets are hairy and 5 mm long. The weight of 1000 grains is about 4 g (Husson et al., 2008). Congo grass is very similar to signal grass (*Brachiaria decumbens*) and is often mistaken for it (Cook *et al.*, 2005). Genetic material from Congo grass has been used to hybridize with *Brachiaria brizantha* yielding a series of cultivars known as Mulato (Argel *et al*., 2007; Argel *et al.*, 2005).

2.16.3 Uses of Congo Grass

Congo grass is a valuable forage for livestock. It is palatable and its nutritive value is good (Schultze-Kraft *et al.*, 1992). It is mostly used for direct grazing of permanent pastures, in the open or under coconut plantations. Congo grass can be cut for hay or fed fresh to stalled ruminants (Schultze-Kraft *et al*., 1992; Cook *et al.*, 2005).

2.16.4 Distribution of Congo Grass

Congo grass is native to the Ruzizi valley in the east of the Democratic Republic of the Congo, and to Rwanda and Burundi (Schultze-Kraft *et al.*, 1992). In East Africa, Congo grass is one of the most important grasses of the *Brachiaria* (or *Urochloa*) genus, with bread grass (*Brachiaria brizantha)* and Para grass (*Brachiaria mutica*) (Urio et al., 1988). Though not as persistent as *Brachiaria brizantha*, Congo grass is the main *Brachiaria* grown in Thailand because seed production is easier (Partridge, 2003). Congo grass is naturalized in most humid tropics: West-Central Africa, western Indian Ocean, South-East Asia, the Pacific region, together with many countries of Western, Central and South America including Brazil (Schultze-Kraft *et al.*, 1992; Clayton *et al.*, 2006).

In Africa, Congo grass is common as a pioneer species of cleared rain forest (Ecoport, 2014). It is generally found in grasslands from sea level up to an altitude of 2000 m in the humid tropics of Africa, and up to an altitude of 1200 m in Panama (FAO, 2015). It grows where annual rainfall is at least 1200 mm with a dry season of no more than 4-5 months (Schultze-Kraft *et al.*, 1992; Cook *et al.*, 2005). Temperatures can range from 19°C to 33°C, although optimal growth is obtained when day/night temperatures are 33°C/28°C. Congo grass has no frost tolerance and only moderate shade tolerance. It Does better in well drained fertile soils such as light to loam soils with a pH ranging from 5 to 6.8 (Cook *et al.*, 2005). Congo grass has a low tolerance of waterlogging. In Brazil, some genotypes of Congo grass were found to have some aluminium tolerance (Miguel *et al.*, 2011).

2.16.5 Forage Management of Congo Grass

Yield

Congo grass is a summer growing species yielding large amounts of biomass with high N supply. DM yield exceeded 20 t/ha in Australia and South America, and up to 25 t DM/ha in Sri Lanka when 366 kg N/ha fertilizer were applied (Cook *et al.*, 2005; Husson *et al.*, 2008). In the low fertile soils of Coronel Pacheco (Brazil) with no N fertilizer, Congo grass yielded only 6 t DM/ha. However, biomass yields up to 12 t DM/ha were possible after applying 150 kg/ha N fertilizer (Cook *et al.*, 2005). Biomass production is at its highest during the second year of establishment. Congo grass is markedly less productive than signal grass, which reduces its potential as a forage crop, particularly in low-fertile soils (Schultze-Kraft *et al.*, 1992).

Propagation

Congo grass can be propagated both from root stock and from seeds (Urio *et al.*, 1988). If propagation by seeds is intended, the dormancy of the seeds will be broken after 6 month storage, or by chemical scarification. Seeds can be broadcast on a well-prepared seedbed and should not be planted deeper than 2 cm. The vigour of Congo grass seedlings is high and prevents weed development (Husson *et al.*, 2008). If Congo grass is vegetatively propagated, stem cuttings with rooting nodes are necessary. As Congo grass requires good soil fertility, it is important to provide N, P and K fertilizers prior to planting and during growth (Cook *et al.*, 2005). Once it is established, and provided it receives enough N fertilizer, Congo grass spreads readily. Congo grass flowers later than signal grass (Schultze-Kraft *et al.*, 1992). It should be cut before first flowering and then at six week intervals (ILRI, 2013). When grazed, Congo grass withstands limited heavy grazing (Cook *et al.*, 2005).

Association with legumes

Congo grass can be grown in association with a wide range of legumes such as stylo (*Stylosanthes guianensis*), puero (*Pueraria phaseoloides*), greenleaf desmodium (*Desmodium intortum*), centro (*Centrosema molle*) and leucaena (*Leucaena leucocephala*). In mixed swards, Congo grass should be heavily grazed so that the sward becomes open and allows legumes to establish and persist (Cook *et al.*, 2005). When grown in association with stylo, both plants can be harvested together to make good quality silage (FAO, 2015). It is possible to make pure Congo grass silage with formic acid as an additive, the best quality being obtained with 2 L formic acid/t (Lowilai *et al.*, 2002).

2.16.6 Environmental Impact of Congo Grass

Cover crop, erosion and weed controller, soil conditioner

Congo grass provides both fodder to livestock and good mulch material in no-till soybean plantations and no-till soybean-maize crop rotations (Ceccon *et al.*, 2014; Lima *et al.*, 2014). It was assessed (Giancotti *et al.*, 2015) in no-till sunflower crops where its high sensitivity to glyphosate provided rapid desiccation, and its high C:N ratio allowed the mulch to remain as a soil cover over an extended period. Congo grass has been used to control erosion in different situations. When used to make contour hedgerows around cassava crops in Asian hills, it was found to decrease cassava yields (Howeler *et al.*, 1998). Congo grass was used (EDE. Consulting, 2015) as a cover crop to decrease soil temperature and conserve soil moisture in coffee plantations where temperatures were above 30°C.

Soil nutrients recycling and phosphorus availability enhancer

Congo grass has a valuable nutrient recycling activity, and enhances soil properties (Calonego and Rosolem, 2013; Garcia *et al.*, 2013). Congo grass was reported to decrease soil P fixation through acid phosphatase activity and the promotion of P-metabolizing micro-organisms (Janegitz *et al.*, 2013). It subsequently enhances soil P availability for the next crops (Janegitz *et al.*, 2013).

2.16.7 Nutritional Attributes of Congo Grass

Congo grass is a useful forage in the humid tropics. Its nutritive value can be good, especially during the rainy season: different authors reported crude protein concentrations between 8% and 15% of DM, and NDF concentrations between 61 and 67% of DM (Ibrahim *et al.*, 1995; Herrero *et al.*, 2001; Meale *et al.*, 2012). However, drought has an adverse effect on its nutritive value: in Cameroon, protein content decreased from 16 to 5%, and NDF and ADF increased from 71 to 76% and 34 to 48% of DM, respectively, between rainy and dry seasons (Tedonkeng Pamo *et al.*, 2007). The nutritive quality of Congo grass hay is lower, with a protein content about 5% of DM.

2.16.8 Green forage of Congo Grass

Congo grass is a common pasture grass for ruminants in Central Africa, Thailand and Brazil. Palatability is good, but decreases with age. *In vitro* DM digestibility ranged between 38% (Meale *et al.*, 2012) and 66% (Herrero *et al.*, 2001), but decreased with the stage of growth. DM digestibility of fresh Congo grass averaged 57%, and protein digestibility 53% in sheep (Khanum *et al.*, 2010). *In situ* OM, DM and protein degradabilities were reported to be 47%, 51% and 65%, respectively (Lopes *et al.*, 2010; Ibrahim *et al.*, 1995). It has been observed that early lactating Holstein cows eating 15 kg DM/d of a diet composed of 50% Congo grass and 50% concentrate produced 17 kg milk/d (Wanapat *et al.*, 2012).

In Thailand, Congo grass in mixtures with legumes such as leucaena, lablab (Tudsri *et al.*, 2001) or rice bean (Wanapat *et al.*, 2012), is often grazed in order to support satisfactory milk yields in dairy cattle. In West Africa, combinations of Congo grass with centro and round leaf cassia (*Chamaecrista rotundifolia*) resulted in higher nutritive values and palatability indices than others grass-legume mixtures (Olanite *et al.*, 2004).

2.16.9 Silage and hay of Congo Grass

Congo grass can be preserved as silage or hay. OM digestibility of Congo grass hay ranged from 55% in cattle to 47% in sheep, and protein digestibility from 37% in cattle to 24% in sheep (Kawashima *et al.*, 2006; Kawashima *et al.*, 2007). The supplementation of Congo grass hay with soybean meal improved DM intake and nutrient digestibility in cattle and sheep (Kawashima *et al.*, 2007). In goats, voluntary feed intake of Congo grass hay was higher than that of the silage (Insung *et al.*, 2004).

2.16.10 Fresh Foliage of Congo Grass

Congo grass is considered as a palatable fresh forage being rich in fibre, but it is poor in protein (Ghosh *et al.*, 2009). Congo grass, used with a concentrate, is a typical fresh forage for rabbits in countries such as Burkina Faso (Lebas *et al.*, 1997) and India (Das and Sikka, 2007; Gupta *et al.*, 2007). For growing or breeding rabbits, fresh Congo grass is fed in limited quantities, for example 50% of the daily DM intake (Das *et al.*, 2006), or is distributed *ad libitum* with a limited quantity of concentrate (Gupta *et al.*, 2007; Das and Sikka, 2007). When compared to other fresh forages such as rice bean (*Vigna umbellata*), soybean forage and Job's tears (*Coix lacryma-jobi*) (Gupta *et al.*, 2007), or lettuce head residue (*Lactuca sativa*) and *Mimosa pigra* (Nakkitset *et al.*, 2008), Congo grass gave the poorest growth performance, probably due to its low protein content, but otherwise it did not cause health problems.

2.16.11 Hay of Congo Grass

Ground Congo grass hay can be used as a fibre source in balanced complete feeds at up to 22% of the diet (Bianospino *et al.*, 2010). At this level of inclusion, it is possible to estimate a digestible energy content of 7.3 MJ/kg DM and a protein digestibility of 46-47% (Lebas, 2013).

Table 3: Proximate analysis and chemical composition of Congo grass

Parameters	**Unit**	**Average**	**SD**	**Min**	**Max**	
Proximate Analysis						
Dry matter	% as fed	89.5	4.3	81.4	95.4	
Crude protein	% DM	4.6	1.0	2.5	6.7	
Crude fibre	% DM	38.4	2.6	33.6	43.9	
NDF	% DM	70.7		70.7	73.8	*
ADF	% DM	44.9	1.3	43.0	45.5	*
Lignin	% DM	6.9				*

Ether extract	% DM	1.2	0.2	0.8	1.7	
Ash	% DM	8.3	1.8	5.0	11.5	
Gross energy	MJ/kg DM	18.0	0.8	17.5	19.2	*
Minerals						
Calcium	g/kg DM	4.4	0.7	2.8	6.1	
Phosphorus	g/kg DM	1.6	0.7	0.3	3.2	
Potassium	g/kg DM	21.6	5.6	10.1	31.3	
Sodium	g/kg DM	0.1				
Magnesium	g/kg DM	2.1	0.5	1.4	3.0	
Manganese	mg/kg DM	153				
Zinc	mg/kg DM	23				
Copper	mg/kg DM	4				
Ruminant Nutritive Values						
OM digestibility, ruminants	%	45.8				*
Energy digestibility, ruminants	%	43.7				*
DE ruminants	MJ/kg DM	7.9				*
ME ruminants	MJ/kg DM	6.4				*

The asterisk * indicates that the average value was obtained by an equation.

Source: Feedipedia (2018)

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Preparation of Turmeric Powder

Fresh turmeric rhizomes were sourced from a reputable market in Ibadan, Oyo State, Nigeria. The rhizomes after purchase were sorted to remove foreign materials and dirt. Washing with ordinary water was done after sorting to further cleanse the rhizomes, this was followed by draining and spreading in a cool dry place on clean trays to allow air-drying for about 24 hours. Slicing was done afterwards with the use of sharp knives into smaller pieces and oven dried at 60^oC to a constant weight. The dried rhizomes were then milled into fine powder using electric blender (Panasonic, Malaysia) before its inclusion in the experimental diets and necessary analyses. The flow chart for the preparation is presented in Figure 1.

3.2 EXPERIMENT ONE

Evaluation of performance, oxidative stress, selected hormonal profile, blood chemistry, milk yield and composition of Kalahari Red; West African Dwarf; and KalaWAD Does fed diets containing graded levels of turmeric powder

3.2.1 Site of the Experiment

The experiment was conducted at Institute of Food Security, Environmental Resources and Agricultural Research (IFSERAR) Farm, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. The region is 76m above the sea level and falls within Latitude 7^{o}13’47.41’’N and Longitude 3^{o}23’43.48’’E. The climate is humid and located in the forest zone of South-Western Nigeria.

Fresh Turmeric Rhizomes

↓

Sorting
(to remove dirt and foreign materials)

↓

Washing
(with ordinary water to clean the rhizomes)

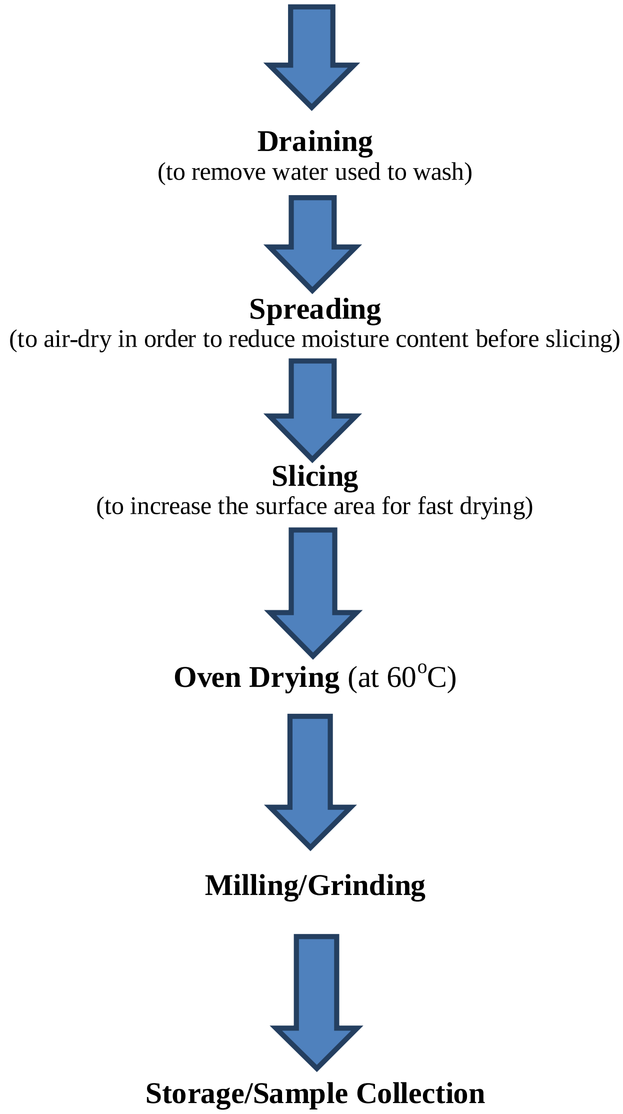

Figure 1: Flow chart showing preparation of turmeric powder

3.2.2 Source of Experimental Animals

The Kalahari Red, KalaWAD and West African Dwarf goats used for the experiment were sourced from IFSERAR, Federal University of Agriculture Abeokuta, Nigeria.

3.2.4 Atmospheric Data Collection

The mean annual precipitation and temperature of the experimental site were 1,330mm and 29.3^{0}C respectively. It had an average relative humidity of 80% throughout the year. The ambient temperature taken in the morning (8:00am) and afternoon (1:00pm) on daily basis using atmospheric thermometer during the course of the study is presented in Table 4.

3.2.5 Proximate and Fibre Analyses of Concentrate and Basal Feed

Samples were taken from dietary concentrate, milled turmeric powder and *Brachiaria ruziziensis* forage. The samples were milled, and kept until needed for proximate composition and fibre fractions according to the procedure of AOAC (2005).

3.2.6 Animal Management Procedure

A total of 45 matured non-pregnant, and non-lactating Does of one parity within age range of 2-2$^{1}/_{2}$ years were used. These included 15 Kalahari Red, 15 KalaWAD and 15 West African Dwarf (WAD) Does. The Does each from Kalahari Red, KalaWAD and WAD were randomly allotted to 3 treatment groups comprising of 5 Does per treatment in each breed. Flock treatments were done prior to mating to control any infection from insect vectors and disease causing organisms. Oxytetracycline 20% (Oxytetracycline 200mg/ml as dihydrate) was administered intramuscularly at 1ml per 20kg body weight, while Vita-Strong® Injection was administered intramuscularly at 1ml per 10kg body weight as vitamin supplement and anti-stress. Ivanor® Ivermectin injection (Ivermectin Injection 10mg/ml) was administered subcutaneously at 1ml per 50kg body weight to control gastro-intestinal worms, fly larvae, lice, ticks and mites.

Experimental Diets

1. **TP-0**: Basal concentrate diet (Control);
2. **TP-2g**: Basal concentrate diet + 2g/kg Turmeric powder (2g/kg);

3. **TP-5g**: Basal concentrate diet + 5g/kg Turmeric powder (5g/kg).

The composition of basal concentrate diet is presented in Table 5.

The dietary treatments were used for flushing of the Does 2 weeks before the commencement and throughout the experimental period. The dietary treatments were fed at the rate 5% bodyweight of the Does.

3.2.7 Oestrous Synchronisation, Mating and Scanning

The Does selected for the study were synchronized after flushing with first intramuscular injection of Lutalyse® which contains 5mg/ml Dinoprost Triomethamine injection. It was administered at the rate of 1ml/Doe, while the second injection was done 10 days later (Heise, 2012) at same initial dosage. Thereafter, mating was done when the synchronized Does came on heat by introducing 6 proven Kalahari Red bucks (i.e. 2 bucks per breed of goat) into the pens where the Does were housed for at least 5 hours/day for a week. Proper observation was done to ensure successful mating before data collection commenced. After 30 days of successful mating, the Does were scanned by ultrasonography method using 3.5MHz linear array probe (Kaikin, China) ultra-sound scanning machine (Draminski Animal Profi Ultrasound Scanner NimH 12V; 3.8Ah; 45^{o}C). All the Does that did not conceive after scanning were made to go through the cycle again.

Table 4: Monthly ambient temperature (^{0}C) in the morning (8:00am) and afternoon (1:00pm) at the experimental site in year 2016.

	Temperature (^{0}C)	**Temperature (^{0}C)**

	at 8:00am			at 1:00pm		
Months	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
January	24.82	21.00	28.00	33.25	30.50	35.50
February	25.38	17.50	30.00	34.38	31.50	37.00
March	26.58	24.00	29.00	35.11	29.50	37.50
April	26.05	24.00	29.00	34.22	31.00	37.00
May	25.03	24.00	26.00	32.65	29.50	35.50
June	24.19	22.00	26.00	31.23	27.00	35.50
July	23.83	22.00	25.00	29.11	27.00	30.50
August	24.38	24.00	25.00	29.12	27.00	31.00
September	24.79	24.00	26.00	30.20	27.50	34.00
October	24.76	23.00	29.50	31.78	29.00	34.00
November	26.67	26.00	27.00	33.67	33.00	34.00
December	25.47	21.00	27.00	33.50	32.00	35.00

Table 5: Gross compositions (%) of basal experimental concentrate supplement

Ingredients	**% Inclusion**
Maize	15.0

Wheat Offal	42.0
Palm Kernel Cake	30.0
Soybean Meal	4.0
Groundnut Cake	3.0
Bone Meal	3.0
Limestone	1.5
Common Salt	1.0
*Premix	0.5
Total (kg)	**100**
Calculated Analysis (%)	
Crude Protein	16.8
Ether Extract	7.8
Crude Fibre	6.0
Calcium	1.4
Available Phosphorus	0.5
Lysine	1.1
Methionine	0.4
Metabolizable Energy (Kcal/kg)	2451.2

*****contains Vitamin A (I.U.) 10,000.000; Vitamin D_2 (I.U.) 2,000,000; Vitamin E (I.U) 20,000; Vitamin K (mg) 2,250; Riboflavin (mg) 5000; Pyridoxine (mg) 275; Biotin (mg) 50; Pantothenic acid (mg) 7500; Vitamin B_1 (mg) 175; Vitamin B_{12} (mg) 15.0; Niacin (mg) 27,500; Folic acid (mg) 7500. Choline Chloride (mg) 400; Antioxidant (mg) 125; Fe (g) 20.0; Zn (g) 50.0; Mn (g) 80.0; Cu (g) 5.0g; I (g) 12.0; Co (mg) 200; Se (mg) 200.

3.2.8 Feeding Trial

The pregnant Does were fed for 24 weeks (162 days) until all the Does kidded. Live weights of the Does were taken when mating was confirmed successful as initial weight. Thereafter, individual weight were taken fortnightly before feeding throughout the experimental period.

Final live weights (24 hours prior to kidding and within 24 hours after kidding) of each Doe were taken at the end of the study.

The experimental diets were administered to the Does at 5% of their body weight twice a day throughout the feeding trial. The Does were fed on daily basis with concentrate diet in the morning by 08hr, while stall-feeding was done using Congo grass (*Brachiaria ruziziensis*) in the evening by 016hr. Concentrate and grass refused each day were recorded before fresh ones were offered the following day. Cool and clean drinkable water was made available to the Does daily *ad libitum*.

3.2.9 Data Collection

Data collected on the Does for experiment one included the following, while weights were taken using Avery Weigh-Tronix Electronic scale- 500kg capacity

Performance Parameters

i. **Initial weight of the Does**: this is the weight of experimental Does which was taken at mating;
ii. **Final weight of the Does:** this is the weight of the Does which was taken within 24 hours before kidding;
iii. **Does' Live-weight after Kidding:** this is the weights of the Does which was taken within 24 hours after kidding. Before the weight was taken, it was ensured that the placenta, umbilical cord together with other foetal membranes like allantois, chorion and amnion (together with amniotic fluid) were expelled;
iv. **Live-weight Changes of Does during Gestation:** this was determined by taking initial weight of the Does at buck's introduction followed by weighing of the pregnant Does fortnightly until the last Doe kidded on the 24th week of the study;

v. **Feed consumption and refusal:** this was determined by taking weights of feed (concentrate and grass) fed to the Does and weights of feed refused each day by the Does throughout the experimental period. The difference between total feed consumed and total feed refused daily gave feed consumed/Doe/day.

Reproductive Parameters

i. **Percent Abortion:** this was obtained by recording the number or the occurrence(s) of abortion(s) i.e. natural expulsion of dead or live pre-term foetus(es) from the uterus before it was able to survive independently by each of the Does under each of the treatment groups;

ii. **Gestation Length of the Does:** this was estimated by determining length of time (in days) between successful mating and kidding for each of the Does i.e. difference between kidding date and date of successful mating (in days) of the Does under each of the treatment groups;

iii. **Incidence of Dystocia:** this is difficulty in parturition/kidding by pregnant Does. This was determined with the use of scale of 1-5 as described by Lusby (1979) at the time of kidding by the experimental Doe.

Where 1 = no difficulty;

2 = some difficulty with no assistance rendered;

3 = light assistance;

4 = hard pull; and

5 = caesarean section.

iv. **Litter Size/Prolificacy:** this was obtained by counting number of kids (both live and dead) born per Doe;

v. **Percent Stillbirth:** this was obtained by recording the number or occurrence(s) of stillbirth(s) i.e. birth of dead foetus by the Doe (that was due for kidding) at the kidding time;

vi. **Birth Type:** this was obtained by recording the number of kids born by the Does, where Does that kidded 1 kid were assigned single and 2 kids as twins;

vii. **Litter Weight:** this was obtained by taking weight(s) of all the new-born kid(s) per Doe together after their bodies were dried off either by natural air or with the use of dry towel to absorb fluid on their bodies within 24 hours after kidding, using a platform scale of 20kg capacity;

viii. **Birth Weight:** this was obtained by taking the weight of individual new-born kids after their bodies were dried off either by natural air or with the use of dry towel to absorb fluid on their bodies within 24 hours after kidding using a platform scale of 20kg capacity;

ix. **Afterbirth Weight:** This was the weights of placenta, umbilical cord and foetal membranes such as allantois, chorion and amnion (together with amniotic fluid) that were expelled from uterus after kidding. This was determined by taking the weights of Does that were about to kid and the weights of Does that kidded within 24 hours post-kidding (after the expulsion of placenta). The resultant difference between the weight before kidding and Doe's weight within 24hrs post-kidding plus litter weight per Doe gave the afterbirth weight;

x. **Kid's Sex:** Sex was recorded as either male or female kid.

3.2.10 Blood Samples Collection and Analyses

Haematological Parameters

Blood samples were collected from all the experimental animals before feeding trial (as initial) and within 24hrs after kidding (as final) via jugular vein punctured with new hypodermic needle fitted on a new 10ml calibrated syringe in the morning before feeding. 10ml of blood sample was collected from each of the pregnant Does, out of which 5ml was put in a bottle containing EDTA which were taken to the Department of Veterinary Physiology and Pharmacology Laboratory, FUNAAB for haematological analysis. The haematological parameters that were determined included; Packed Cell Volume (PCV), red blood cell count (RBC), white blood cell count (WBC), haemoglobin concentration (Hb) and white blood cell differentials using the method described by Jain (1993). While the Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular haemoglobin Concentration (MCHC) were calculated using formula.

Serum Biochemistry

The remaining 5ml of blood collected in well labelled non EDTA bottles before feeding trial (as initial) and within 24hrs after kidding (as final) were taken to the Department of Veterinary Physiology and Pharmacology Laboratory, FUNAAB for serum biochemistry analysis. The following serum biochemistry parameters were evaluated using Randox® Kit (BT 294QY, United Kingdom) spectrophotometrically- total protein (Tietz, 1995); albumin (Doumas *et al.*, 1971); globulin; glucose (Barham and Trinder, 1972); cholesterol (Tietz, 1995); urea; creatinine (Henry, 1974); bilirubin; Aspartate transaminase, AST (Reitman and Franket, 1957); Alanine transaminase, ALT (Reitman and Franket, 1957); and Alkaline phosphate, ALP.

Determination of the Antioxidant Enzyme Activities (Oxidative Stress Markers)

Blood samples were collected at the beginning of the experiment (before feeding trial and mating), at 1st trimester (50 days), 2nd trimester (100 days) and within 24hrs after kidding.

The blood samples were collected via the external jugular vein with a 5ml gauge syringe from each animal into a well labelled plain universal bottles, centrifuged for serum collection and kept at -4°C for subsequent use for the determination of antioxidant enzymes activities spectrophotometrically- superoxide dismutase, SOD; glutathione peroxidase, GSH-Px (Ellman, 1959); and glutathione, GSH (Ellman, 1959) while serum lipid peroxidation was determined as thiobarbituric reactive substances, TBARS (Ohkawa *et al.*, 1929).

Selected Hormonal Profile

Blood samples were collected from the Does within 24hrs of kidding and at 3rd month of lactation of the Does for hormonal analysis. The blood samples were collected via the external jugular vein puncture with a 5ml gauge syringe from each Doe, 3ml blood sample was withdrawn from each of the animal into plain universal bottles and was taken to the laboratory where the serum was separated and stored at -20˚C until when it was used for the hormonal analysis. The hormones that were analysed for included Prolactin and Oxytocin using enzyme-linked immunosorbent assay (ELISA) technique (Ekins, 1998).

3.2.11 Milk Yield, Composition and Quality Analyses

Milk was collected from the Does a week after kidding by hand milking into clean containers from which samples were taken to determine the milk composition and some and its physico-chemical properties. About 50ml of the fresh milk was aseptically drawn from milk collected using a sterile syringe into sterile bottles for laboratory analyses. The samples were kept in a cool box on melting ice and transported within 5hours of collection to the laboratory for analyses. The pH of the milk was determined using a digital pH meter. The pH meter was standardized with standard buffer solutions prior to use. Subsequent collection for milk yield was done on weekly basis till 12th week of lactation, while the quantity of milk produced (in ml) was taken using graduated measuring cylinder.

3.2.12 Milk Composition and Quality Analyses

The milk samples collected were kept in a freezer at -10^{o}C until required for analysis. The %Protein, %Lactose, %Fat content, %Total solids, %Moisture Content, and %Ash were then determined for milk composition by the use of AOAC (2005) procedure.

Percent lactose was determined by difference using the formula below:

%Lactose = %Total Solids - (%Fat + % Protein + % Total Ash)

%Total Solid= 100 - %Moisture Content

%Solid Non-Fat= %Total Solid - %Fat

Total Bacteria Count: Estimation of total bacteria count in milk sample was done according to method of Miles and Mistra described by Hedges (2003)

Total Coliform Count: Estimation of total coliform count in milk sample was done according to method of Miles and Mistra described by Hedges (2003).

Somatic Cell Count: Somatic cell count was done according to modified method of Gonzalo *et al*., (2008)

Milk Cholesterol: Estimation of cholesterol in milk sample was determined using enzymatic endpoint method described by Moss *et al.* (1999).

Statistical Analysis and Experimental Model

Data obtained were arranged in a 3x3 factorial layout in a Completely Randomized Design, while Analysis of Variance was done using the procedures of Statistical Analysis System (SAS) (2004). Level of significance were taken as ($p<0.05$) while means were separated using Duncan's Multiple Range Test of the same statistical package.

$Y_{ijkl}=\mu+T_i+R_j+(TR)_{ij}+\varepsilon_{ijkl}$

Where:

Y_{ijkl}= Observed value of dependent variable

μ= Population mean

T_i= Effects of breed

R_j= Effect of diet

$(TR)_{ij}$= Interactive effects of breed and diet.

ε_{ijkl}= Residual Effect

3.3 EXPERIMENT TWO

Evaluation of pre and post-weaning growth performance, blood chemistry and faecal egg count of kids of Does fed diets supplemented with turmeric powder.

3.3.1 Site of the Experiment

The experiment was conducted at Institute of Food Security, Environmental Resources and Agricultural Research (IFSERAR) Farm, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.

3.3.2 Kids Management Procedure

The live weight of each of the kids per Doe per treatment were taken within 24hours of birth using a 20kg platform scale after the body was either dried naturally or artificially. All the kids produced by the Does were used for pre-weaning growth performance and survivability that lasted for 3 months. Thereafter, 15 kids were randomly selected from Does fed each treatment group. The selected Does were monitored for post-weaning performance, survivability, blood chemistry, faecal egg count and identification.

Feeding Trial for Post-Weaning Performance

The selected kids from each breed under different dietary treatments were fed for 4 weeks in order to monitor them for post-weaning performance. Live weight of each kid was taken at the start of post-weaning as initial weight. Thereafter, individual weight of the kids was taken weekly before feeding throughout the period.

Experimental diets were administered to the kids at 5% of their body weight twice a day throughout the feeding trial. The kids were fed on daily basis with concentrate diet in the morning by 08hr, while stall-feeding was done using Congo grass (*Brachiaria ruziziensis*) in the evening by 016hr. Concentrate and grass refused each day were recorded before fresh one are offered the following day. Cool and clean drinkable water was made available to the kids daily *ad libitum*.

3.3.3 Data Collection

Data collected on the kids for Experiment two include the following:

3.3.3.1 Performance parameters

i. **Initial weight of the kids**: this was the weight of the kids which was taken at birth and at the beginning of week 13 after birth for pre and post-weaning initial weights respectively;
ii. **Final weight of the kids:** this was the weight of selected kids which was taken at the end of weeks 12 and 16 after birth for pre and post-weaning final weights;
iii. **Kids' Live-weight changes:** weights of the selected kids were taken fortnightly to know their weight changes. All weights were taken using a 20kg capacity weighing scale

3.3.3.2 Blood Samples Collection and Analyses

Haematological Parameters

Blood samples were collected at the end of 4th week of post-weaning performance from all the experimental kids via jugular vein punctured with new hypodermic needle fitted on a new 10ml calibrated syringe in the morning before feeding. 10ml of blood sample was collected from each of the kids, out of which 5ml was put in a bottle containing EDTA which were taken to the Department of Veterinary Physiology and Pharmacology Laboratory, FUNAAB for haematological analysis. The haematological parameters that were determined included; Packed Cell Volume (PCV), red blood cell count (RBC), white blood cell count (WBC), haemoglobin concentration (Hb) and white blood cell differentials using the method described by Jain (1993). While Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular haemoglobin Concentration (MCHC) were calculated using formula.

Serum Biochemistry

The remaining 5ml of blood collected at the end of 4^{th} week of post-weaning performance from all the experimental kids were put in a well labelled plain bottles without anticoagulant which were taken to the Department of Veterinary Physiology and Pharmacology Laboratory, FUNAAB for serum biochemistry analysis. The following serum biochemistry parameters were evaluated using Randox® Kit (BT 294QY, United Kingdom) spectrophotometrically- total protein (Tietz, 1995); albumin (Doumas *et al.*, 1971); globulin; glucose (Barham and Trinder, 1972); cholesterol (Tietz, 1995); urea; creatinine (Henry, 1974); bilirubin; Aspartate transaminase, AST (Reitman and Franket, 1957); Alanine transaminase, ALT (Reitman and Franket, 1957); and Alkaline phosphate, ALP.

3.4 Kids Survivability and Faecal Egg Count

Survivability of kids kidded by the experimental Does under each treatment groups was monitored from kidding to 16^{th} week (4 months) after birth. Any case of kid mortality within the period was recorded. Effort was made to determine the cause(s) of any kid mortality that occurred during the period with the assistance of veterinarians on the farm.

Faecal samples were collected by veterinarians from the selected kids for post-weaning performance at the end of the study at 4^{th} week. Faecal egg count was performed according to the procedure of Zajac *et al.* (2012).

Statistical Analysis and Experimental Model

Data obtained were arranged in a 3x3 factorial layout in a Completely Randomized Design, while Analysis of Variance was done using the procedures of Statistical Analysis System (SAS) (2004). Level of significance were taken as ($p<0.05$) while means were separated using Duncan's Multiple Range Test of the same statistical package.

$$Y_{ijkl}=\mu+T_i+R_j+(TR)_{ij}+\varepsilon_{ijkl}$$

Where:

Y_{ijkl}= Observed value of dependent variable

μ= Population mean

T_i= Effects of kids' breed

R_j= Effect of diet

$(TR)_{ij}$= Interactive effects of breed and diet.

ε_{ijkl}= Residual Effect

3.5 EXPERIMENT THREE

Evaluation of *in vitro* digestibility, gas production and post-incubation parameters of feed resources supplemented with different levels of turmeric powder.

3.5.1 Site of the Experiment

The study was conducted at Department of Pasture and Range Management Laboratory, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.

3.5.2 Experimental Procedure

Samples from each of the feed resources were taken at the commencement of the study and milled, while rumen liquor from Kalahari Red, KalaWAD and WAD was obtained using suction tube with the help of veterinarians on the farm.

The feed resources included the following:

1 Experimental concentrate diet (ECD) without turmeric powder

ECD + 2g/kg turmeric powder

ECD + 5g/kg turmeric powder

2 *Brachiaria ruziziensis* (BR) without turmeric powder

BR + 2g/kg turmeric powder

BR + 5g/kg turmeric powder

3 Mixture of 75% ECD and 25% BR without turmeric powder

Mixture of 75% ECD and 25% BR + 2g/kg turmeric powder

Mixture of 75% ECD and 25% BR + 5g/kg turmeric powder

3.5.3 Collection of rumen fluid and *In vitro* gas production measurement

Rumen fluid was collected before morning feeding from three Does from each treatment group at week 20 of the feeding trial. Approximately 500ml rumen fluid was collected using suction tube from donor animals, mixed, strained through four layers of cheese cloth, and transferred to thermo-flasks preheated at 39^0C. The flasks were taken to the laboratory for necessary analyses.

3.5.3.1 *In vitro* gas production

This was determined following the procedure of Menke and Steingass (1988). A sensitive scale was used to measure out 200mg of the feed samples in three replicates and then placed into 100ml graduated glass syringes. The filtered rumen fluid (inoculum) was mixed with sodium and ammonium bicarbonate buffer (35g $NaHCO_3$ plus 4g NH_4HCO_3 per litre) at a ratio of 1:2(v/v) to prevent lowering of the pH of the rumen fluid which could result in decreased microbial activities.

Thirty millimetres of the buffered inoculums was then added to each syringe containing the milled samples and the gas released was read directly on the graduated syringe. The syringes were positioned vertically in an incubator kept at 39^0C. A blank syringe containing 30ml of the buffered inoculums only was included as control. All the syringes were gently shaken 30 minutes after commencement of incubation and four times daily at regular intervals thereafter. Gas production was recorded at 0, 3, 6, 12, 24, 36 and 48hours of incubation.

The data obtained from *in vitro* gas production was fitted to the non-linear equation (Larbi *et al.*, 1996):

V(ml/0.2 g DM)=GV(I-e^{-ct})

Where:

V is the potential gas production

GV is the volume of gas and

ct is the fractional rate of gas production.

Organic matter digestibility (OMD) was estimated as

OMD = 14.88 + 0.889 GV + 0.45 CP + 0.651 ash (Menke and Steingass, 1988).

Short-chain fatty acids (SCFA) were estimated as

SCFA = 0.0239 GV – 0.0601 (Getachew *et al*., 2000).

Metabolizable energy (ME) was calculated as

ME = 2.20 + 0.136 GV + 0.057CP + 0.029CP^2 (Menke and Steingass, 1988).

3.5.4 Methane Determination

The volume of methane gas produced by each feed type was determined by dispensing 4 ml of 10N sodium hydroxide into each incubated sample at the end of 48hr. of incubation periods. Sodium hydroxide was added to absorb carbon-dioxide produced during the process of fermentation and the remaining volume of gas was recorded as methane according to the method of Fievez *et al.* (2005).

Statistical Analysis and Experimental Model

Data obtained were arranged in a 3x3 factorial layout in a Completely Randomized Design, while Analysis of Variance was done using the procedures of Statistical Analysis System (SAS) (2004). Level of significance were taken as ($p<0.05$) while means were separated using Duncan's Multiple Range Test of the same statistical package.

$$Y_{ijkl}=\mu+T_i+R_j+(TR)_{ij}+\varepsilon_{ijkl}$$

Where:

Y_{ijkl}= Observed value of dependent variable

μ= Population mean

T_i= Effects of feed types

R_j= Effect of turmeric supplementation

$(TR)_{ij}$= Interactive effects of breed and turmeric supplementation

ε_{ijkl}= Residual Effect

3.6 Experimental Formulae

3.6.1 Feed Composition

Organic Matter (%)= 100- %Ash

Hemicellulose (%)= %NDF- %ADF

Cellulose (%)= %ADF- %ADL

3.6.2 Reproductive Indices

$$\text{Fertility Rate} = \frac{\text{Number of Does that gave birth}}{\text{Number of Does mated}} \times 100\%$$

$$\text{Prolificacy} = \frac{\text{Number of kids kidded}}{\text{Number of Does that kidded}}$$

$$\text{Percent Abortion} = \frac{(\text{Number of Does that conceived} - \text{Number of Does that kidded})}{\text{Number of Does that conceived}} \times 100$$

or

$$\frac{\text{Occurrence of abortion in Does that conceived}}{\text{Number of Does that conceived}} \times 100$$

$$\text{Percent Stillbirth} = \frac{(\text{Number of kids kidded} - \text{Number of live kids at birth})}{\text{Number of kids kidded}} \times 100$$

or

$$\frac{\text{Occurrence of stillbirth at kidding}}{\text{Number of kids kidded}} \times 100$$

$$\text{Percent Dystocia} = \frac{\text{Occurrence of dystocia in Does that kidded}}{\text{Number of Does that kidded}} \times 100$$

Fecundity= Fertility x Prolificacy

$$\text{Kidding Rate} = \frac{\text{Total number of kids kidded}}{\text{Number of Does mated}} \times 100$$

$$\text{Birth Type (\%)} = \frac{\text{Total number of same birth type (i.e. single, twins or triplet)}}{\text{Number of Does that kidded}} \times 100$$

$$\text{Gender/Sex (\%)} = \frac{\text{Total number of kids kidded with same sex (i.e. male or female)}}{\text{Total number of kids kidded}} \times 100$$

Products of Pregnancy (kg)= 13.4-(0.03035x PGDG) (Akingbade *et al.*, 2001)

Foetal Growth Rate ($gday^{-1}$)= 112-(0.235x PGDG) (Akingbade *et al.*, 2001)

Where:

PGDG is Pregnant goat's average daily gains (g)

Afterbirth Weight (kg)= Weight within 24hours before kidding (kg)- (weight 24hours after kidding (kg)+ Litter weight within 24hours but after drying (kg)

3.6.3 Performance Characteristics

Metabolic weight gain ($gday^{-1}W^{-0.75}$)= $[(\text{Initial Weight (kg)} + \text{final weight (kg)})/2]^{0.75}$

Metabolic Initial Weight ($gday^{-1}W^{-0.75}$)= $(\text{Initial Weight (kg)})^{0.75}$

Metabolic Final Weight ($gday^{-1}W^{-0.75}$)= $(\text{Final Weight (kg)})^{0.75}$

Weight Gain (kg)= Final weight (kg)- Initial weight (kg)

Weight Gain ($gday^{-1}$)= $\frac{\text{Weight gained (g)}}{\text{Gestation Length (days)}}$

Feed Conversion Ratio= $\frac{\text{Total Feed Consumed (g)}}{\text{Weight gained (g)}}$

Protein Efficiency Ratio= $\frac{\text{Weight gained (g)}}{\text{Total CP Intake (g)}}$

3.6.4 Blood Chemistry

Mean Corpuscular Haemoglobin MCH (g/mg) = $Hb \times \frac{10}{RBC}$

Mean Corpuscular Haemoglobin Concentration MCHC (Pg) = $Hb \times \frac{100}{Hct}$ or $MCH \times \frac{100}{MCV} \times 1$

Mean Corpuscular Volume MCV (fl) = $PCV \times \frac{10}{RBC}$

Serum Globulin (g/dl) = Total protein – Serum Albumin

CHAPTER FOUR

4.0 RESULTS

4.1 Proximate and fibre composition (%) of experimental diets

Table 6 shows the proximate and fibre composition (%) of experimental diets fed to the Does. The dry matter (DM) content of the diets ranged between 86.55-88.19%. Diet without Turmeric powder inclusion (TP-0) had the highest value, followed by diet containing 5g/kg Turmeric powder inclusion (TP-5g) having 86.60%, while diet containing 2g/kg Turmeric powder inclusion (TP-2g) had the least value. Crude protein content was highest in TP-2g (18.47%), followed by TP-0 (16.49%), while the least value of 12.68% was obtained for TP-5g. The percent ether extract (EE) for the diets ranged between 1.82-2.51%. Where TP-2g had the highest value, followed by TP-0 with 2.48%, while TP-5g had the least value. TP-0 had highest values for crude fibre (CF) and Ash with 27.50% and 10.98% respectively. These values are least for TP-5g, where 24.64% was obtained for CF and 6.51% for ash contents. Nitrogen free extract (NFE) ranged between 40.48-47.43%. TP-5g had the highest value, followed by TP-0 with 41.72%, while TP-2g had the least value. TP-5g recorded the highest value (93.50%) for organic matter content, followed by TP-2g (90.65%), while TP-0 had the least value of 89.02%.

For fibre fractions composition, TP-2g had highest value (66.04%) for neutral detergent fibre, followed by TP-0 with 62.67%, while the least value was obtained for TP-5g (62.38%). Acid detergent fibre ranged between 38.00-44.29% for the experimental diets where TP-5g had the highest value followed by TP-2g (40.91%), while TP-0 recorded the least value. TP-5g had the highest value (16.42%) for acid detergent lignin, followed by TP-2g (11.32), while the least value of 10.67% was obtained for TP-0. TP-2g had highest values for hemicellulose, cellulose and Metabolisable Energy (ME), the values which are 25.13%, 29.29% and

12.27MJ/kg DM respectively. TP-5g had the least values for hemicellulose (18.09%) and ME (12.15MJ/kg DM), whereas TP-0 recorded the least value of 27.33% for cellulose.

4.2 Proximate composition, fibre fractions and some vitamins assay of *Brachiaria ruziziensis* and Turmeric powder

Table 7 shows the proximate composition, fibre fractions and some vitamins assay of *Brachiaria ruziziensis* and Turmeric powder. The proximate composition such as the dry matter (DM), Crude protein (CP), Ether extract (EE), Crude fibre (CF), Ash, Nitrogen free extract (NFE) and Organic matter (OM) for *Brachiaria ruziziensis* were 89.12, 8.01, 2.41, 24.54, 7.78, 54.17 and 92.22% respectively. Fibre fractions like neutral detergent fibre (NDF), Acid detergent fibre (ADF), Acid detergent lignin (ADL), Hemicellulose and Cellulose contents for *Brachiaria ruziziensis* were 65.33, 45.33, 13.33, 20.00 and 32.00% respectively. The metabolisable energy (ME) for *Brachiaria ruziziensis* was 12.21MJ/kg DM.

Turmeric powder had percent DM, CP, EE, CF, Ash, NFE and OM of 86.36, 13.27, 2.74, 24.21, 5.07, 46.15 and 94.93% respectively. It also had NDF, ADF, ADL, Hemicellulose and Cellulose contents of 66.67, 38.67, 8.00, 28.00 and 30.67% respectively. The metabolisable energy (ME) was 12.44MJ/kg DM. Vitamins A, C and E contents of Turmeric powder were 18.98, 1.40 and 5.59mg/kg respectively.

Table 6: Proximate and fibre fraction compositions of experimental diets

Parameters (%)	**TP-0**	**TP-2g**	**TP-5g**
Dry Matter	88.19	86.60	86.55
Crude Protein	16.49	18.47	12.68
Ether Extract	2.48	2.51	1.82
Crude Fibre	27.50	25.16	24.64
Ash	10.98	9.35	6.51
Nitrogen Free Extract	41.74	40.48	47.43
Organic Matter	89.02	90.65	93.50
Neutral Detergent Fibre	62.67	66.04	62.38
Acid Detergent Fibre	38.00	40.91	44.29
Acid Detergent Lignin	10.67	11.32	16.42
Hemicellulose	24.67	25.13	18.09
Cellulose	27.33	29.29	27.87
*ME (MJ/kg DM)	12.27	12.27	12.15

ME= Metabolisable Energy
*Calculated using MAFF (1984) equation

Table 7: Proximate composition, fibre fractions and some vitamins assay of *Brachiaria ruziziensis* and Turmeric powder

Parameters (%)	***Brachiaria ruziziensis***	**Turmeric Powder**
Dry Matter	89.12	86.36
Crude Protein	8.01	13.27
Ether Extract	2.41	2.74
Crude Fibre	24.54	24.21
Ash	7.78	5.07
Nitrogen Free Extract	54.17	46.15
Organic Matter	92.22	94.93
Neutral Detergent Fibre	65.33	66.67
Acid Detergent Fibre	45.33	38.67
Acid Detergent Lignin	13.33	8.00
Hemicellulose	20.00	28.00
Cellulose	32.00	30.67
*ME (MJ/kg DM)	12.21	12.44
Vitamins Assay (mg/kg)		
A	NA	18.98
C	NA	1.40
E	NA	5.59

ME= Metabolisable Energy NA= Not Analysed

*Calculated using MAFF (1984) equation

4.3 Monthly ambient temperature (^oC) in the morning (8:00am) and afternoon (1:00pm) at the experimental site for year 2016

The monthly ambient temperature (^0C) taken in the morning by 8:00 and afternoon by 1:00 at the experimental site in the year 2016 is presented in Figure 2. January had mean temperature of 24.82 and 33.25^0C at 8am and 1pm respectively. Temperature taken at 8am had minimum value of 21^0C and maximum value of 28^0C, while minimum and maximum values of 30.50^0C and 35.50^0C respectively were recorded for temperature take at 1pm. February had mean temperature of 25.38 and 34.38^0C at 8am and 1pm respectively. Temperature taken at 8am had minimum value of 17.50^0C and maximum value of 30^0C, while minimum and maximum values of 31.50^0C and 37.00^0C respectively were recorded for temperature take at 1pm. The mean temperature for the month of March was 26.58 and 35.11^0C at 8am and 1pm respectively. Temperature taken at 8am had minimum value of 24^0C and maximum value of 29^0C, while minimum and maximum values of 29.50^0C and 37.50^0C respectively were recorded for temperature taken at 1pm. April had mean temperature of 26.05 and 34.22^0C at 8am and 1pm respectively. Temperature taken at 8am had minimum value of 24^0C and maximum value of 29^0C, while minimum and maximum values of 31.00^0C and 37.00^0C respectively were recorded for temperature take at 1pm. The mean temperature for the month of May was 25.03 and 32.65^0C at 8am and 1pm respectively. Temperature taken at 8am had minimum value of 24^0C and maximum value of 26^0C, while minimum and maximum values of 29.50^0C and 35.50^0C respectively were recorded for temperature taken at 1pm. June had mean temperature of 24.19 and 31.23^0C at 8am and 1pm respectively. Temperature taken at 8am had minimum value of 22^0C and maximum value of 26^0C, while minimum and maximum values of 27^0C and 35.50^0C respectively were recorded for temperature take at 1pm.

The mean temperature for the month of July was 23.83 and 29.11^{0}C at 8am and 1pm respectively. Temperature taken at 8am had minimum value of 22^{0}C and maximum value of 25^{0}C, while minimum and maximum values of 27^{0}C and 30.50^{0}C respectively were recorded for temperature take at 1pm. August had mean temperature of 24.38 and 29.12^{0}C at 8am and 1pm respectively. Temperature taken at 8am had minimum value of 24^{0}C and maximum value of 25^{0}C, while minimum and maximum values of 27^{0}C and 31^{0}C respectively were recorded for temperature take at 1pm. The mean temperature for the month of September was 24.79 and 30.20^{0}C at 8am and 1pm respectively. Temperature taken at 8am had minimum value of 24^{0}C and maximum value of 25^{0}C, while minimum and maximum values of 27^{0}C and 31^{0}C respectively were recorded for temperature take at 1pm. October had mean temperature of 24.76 and 31.78^{0}C at 8am and 1pm respectively. Temperature taken at 8am had minimum value of 23^{0}C and maximum value of 29.50^{0}C, while minimum and maximum values of 29^{0}C and 34^{0}C respectively were recorded for temperature take at 1pm. The mean temperature for the month of November was 26.67 and 33.67^{0}C at 8am and 1pm respectively. Temperature taken at 8am had minimum value of 26^{0}C and maximum value of 27^{0}C, while minimum and maximum values of 33^{0}C and 34^{0}C respectively were recorded for temperature take at 1pm. December had mean temperature of 25.47 and 33.50^{0}C at 8am and 1pm respectively. Temperature taken at 8am had minimum value of 21^{0}C and maximum value of 27^{0}C, while minimum and maximum values of 32^{0}C and 35^{0}C respectively were recorded for temperature take at 1pm.

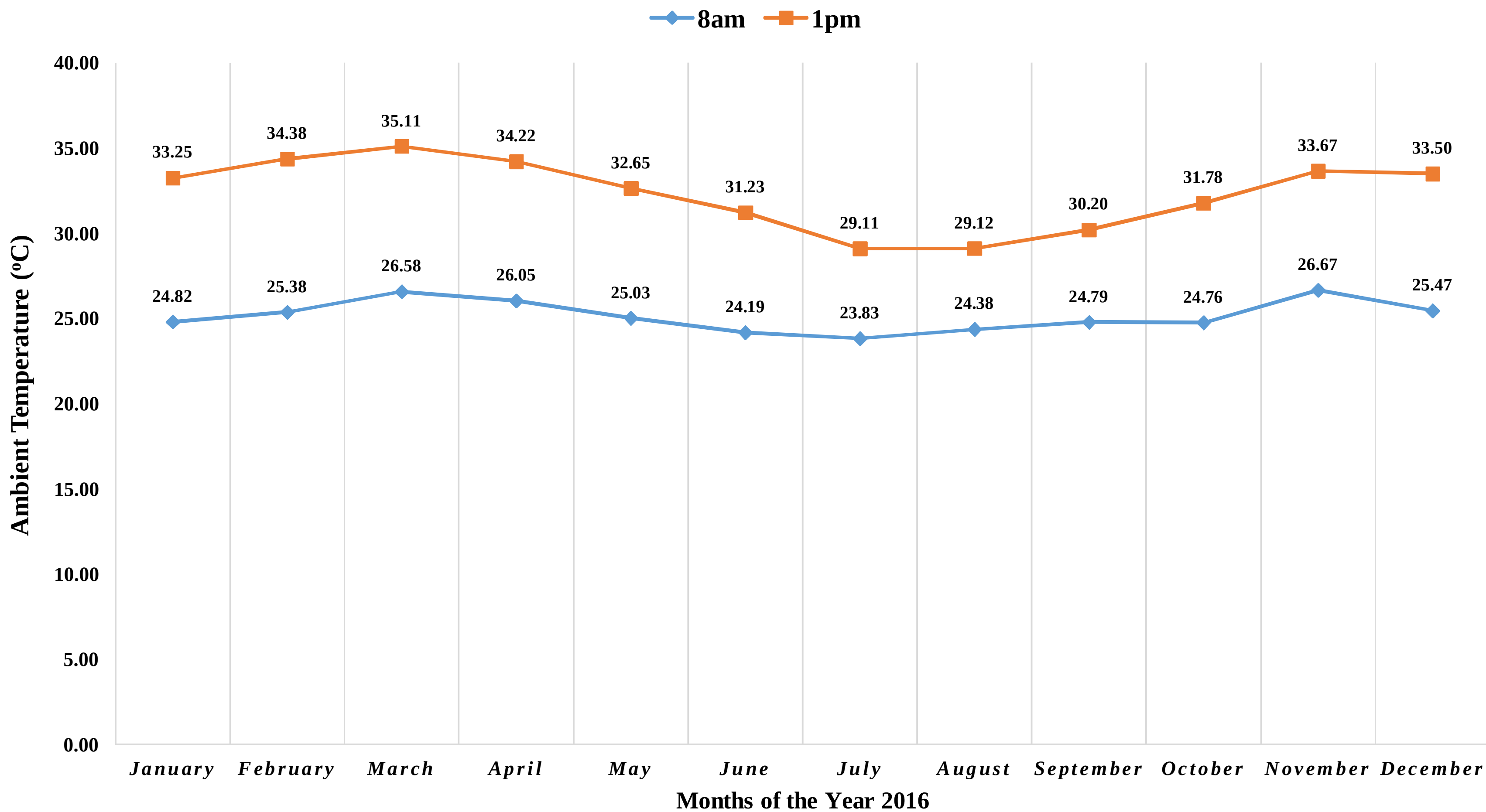

Figure 2: Monthly ambient temperature (^oC) in the morning (8:00am) and afternoon (1:00pm) at the experimental site for year 2016

4.4 Main effect of breeds of goat on prenatal performance

Main effect of breeds of goat on prenatal performance is presented in Table 8. Breeds of goat had significant ($p<0.05$) effects on grass, concentrate and total feed intakes; weight within 24hrs before kidding; weight within 24hrs post-kidding; metabolic weight gain and final weight; gross weight gain; net weight gain; and daily weight gain less foetal and afterbirth weight. Kalahari Red (KR) Does had highest ($p<0.05$) values for all the intakes, followed by KalaWAD Does, while West African Dwarf (WAD) Does recorded lowest values for the parameters. For grass intake on dry matter basis (DMB), KR Does had 99.70g/day, KalaWAD Does had 97.67g/day, while WAD Does recorded 77.87g.day. KR Does recorded 867.10g/day, KalaWAD Does had 595.85g/day, while WAD Does recorded 551.60g/day for concentrate intake on DMB. 966.80, 693.53 and 629.50g/gay on DMB was recorded for KR, KalaWAD and WAD Does respectively. For total feed intake, KR Does had 966.80g/day, followed by KalaWAD Does with 693.53g/day, while WAD Does recorded 629.50g/day.

KR Does had highest ($p<0.05$) value of 42.13kg for weight within 24hrs before kidding, followed by KalaWAD Does with 39.46kg, while lowest value of 37.24kg was obtained for WAD Does. Similarly, KR Does recorded 36.90kg for weight within 24hrs post-kidding, followed by KalaWAD Does with 33.96kg, while WAD Does recorded 30.64kg for same parameter. Metabolic weight gain and final weight of 14.21 and 16.41g/day/ $W^{0.75}$ respectively were recorded for KR Does. KalaWAD Does had 13.78g/day/ $W^{0.75}$ for metabolic weight gain and 15.64 g/day/ $W^{0.75}$ for final metabolic weight. WAD Does recorded 13.27 and 14.79g/day/ $W^{0.75}$ for weight gain and final weight respectively. Gross weight gain of 14.78kg was recorded by KR Does, followed by KalaWAD Does with 12.12kg, while 9.88kg was recorded by WAD Does for same parameter. Net weight gain of 9.55kg was recorded by KR Does, followed by KalaWAD Does with 6.62kg, while WAD

Does had 3.28kg. KR Does recorded 64.15g/day for daily weight gain less foetal and afterbirth weight, followed by KalaWAD Does with 43.41g/day, while WAD Does recorded 22.85g/gay for same parameter. Breeds of goats had no significant effects ($p>0.05$) on metabolic initial weight, daily weight gain, feed conversion ratio and protein efficiency ratio.

4.5 Main effect of levels of Turmeric powder inclusions on prenatal performance of goat

Table 9 shows the main effect of levels of Turmeric powder inclusions on prenatal performance of goat. Does fed TP-0 had highest ($p<0.05$) values for concentrate and total feed intakes. Concentrate and total feed intakes on dry matter basis (DMB) ranged between 657.89-680.87g/day and 747.09-773.67g/day respectively. Does fed TP-0 and TP-5g recorded highest and lowest values for the respective parameters. Weights within 24hrs before and after kidding were significantly ($p<0.05$) highest and lowest for Does fed TP-2g and TP-0 respectively. Weight within 24hrs before kidding ranged between 38.27-40.76kg, while weight within 24hrs post-kidding ranged between 31.76-34.98kg. Similarly, metabolic weight gain and metabolic final weight were significantly ($p<0.05$) highest and lowest for Does fed TP-2g and TP-0. Metabolic weight gain ranged between 13.55-13.89 g/day/$W^{0.75}$, while metabolic final weight ranged between 15.22-15.91g/day/$W^{0.75}$.

Does fed TP-2g had highest ($p<0.05$) values of 13.42kg, 7.63kg, 91.20g/day and 51.81g/day for gross weight gain, net weight gain, daily weight gain; and daily weight gain less foetal and afterbirth weight respectively. Does fed TP-0 recorded lowest values which were 10.93kg, 4.41kg, 73.61g/day and 29.61g/day for respective parameters. Does fed TP-0 had highest ($p<0.05$) value of 10.85 for feed conversion ratio, while Does fed TP-2g had the least value of 8.98. Protein efficiency ratio ranged between 0.61-0.91, where Does fed TP-5g and TP-0 had highest and lowest significant ($p<0.05$) values respectively.

Inclusion of Turmeric powder in the diet exerted no significant effect ($p>0.05$) on grass intake of the Does.

Table 8: Main effect of breeds of goat on prenatal performance

Parameters	**Kalahari Red**	**KalaWAD**	**WAD**	**SEM**
Grass Intake (g/day on DMB)	99.70^{a}	97.67^{a}	77.87^{b}	2.51
Conc. Intake (g/day on DMB)	867.10^{a}	595.85^{b}	551.60^{c}	11.15
Total Feed Intake (g/day on DMB)	966.80^{a}	693.53^{b}	629.50^{c}	11.14
Weight within 24hrs BK (kg)	42.13^{a}	39.46^{a}	37.24^{b}	0.97
Weight within 24hrs PK (kg)	36.90^{a}	33.96^{a}	30.64^{b}	1.34
Weight Gain (g/day/$W^{0.75}$)	14.21^{a}	13.78^{a}	13.27^{b}	0.18
Initial Weight (g/day/$W^{0.75}$)	11.88	11.83	11.69	0.57
Final Weight (g/day/$W^{0.75}$)	16.41^{a}	15.64^{a}	14.79^{b}	0.31
Gross Weight Gain (kg)	14.78^{a}	12.12^{a}	9.88^{b}	1.08
Net Weight Gain (kg)	9.55^{a}	6.62^{a}	3.28^{b}	1.34
Daily Weight Gain (g/day)	99.09	79.84	68.55	7.41
Daily Weight Gain less foetal and afterbirth weight (g/day)	64.15^{a}	43.41^{ab}	22.85^{b}	8.68
Feed Conversion Ratio	10.44	8.83	9.96	0.76
Protein Efficiency Ratio	0.68	0.79	0.72	0.06

[abc] Means on the same row having different superscripts are significantly different ($p<0.05$)

DMB is *Dry Matter Basis*

Gross weight= Weight within 24hrs before kidding (**BK**) - Initial weight at mating

Net weight gain= Weight within 24hrs post-kidding (**PK**) - Initial weight at mating

Table 9: Main effect of levels of Turmeric powder inclusions on prenatal performance of goat

Parameters	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Grass Intake (g/day on DMB)	92.80	93.25	89.20	1.65
Conc. Intake (g/day on DMB)	680.87^{a}	675.86^{ab}	657.89^{b}	6.45
Total Feed Intake (g/day on DMB)	773.67^{a}	769.11^{a}	747.09^{b}	6.45
Weight within 24hrs BK (kg)	38.27^{b}	40.76^{a}	39.79^{ab}	0.62
Weight within 24hrs PK (kg)	31.76^{b}	34.98^{a}	34.77^{a}	0.80
Weight Gain (g/day/$W^{0.75}$)	13.55^{b}	13.89^{a}	13.81^{ab}	0.11
Initial Weight (g/day/$W^{0.75}$)	11.80	11.77	11.82	0.03
Final Weight (g/day/$W^{0.75}$)	15.22^{b}	15.91^{a}	15.70^{ab}	0.19
Gross Weight Gain (kg)	10.93^{b}	13.42^{a}	12.43^{ab}	0.80
Net Weight Gain (kg)	4.41^{b}	7.63^{a}	7.41^{a}	0.80
Daily Weight Gain (g/day)	73.61^{b}	91.20^{a}	82.67^{ab}	4.16
Daily Weight Gain less foetal and afterbirth weight (g/day)	29.61^{b}	51.81^{a}	48.99^{a}	5.35
Feed Conversion Ratio	10.85^{a}	8.98^{b}	9.41^{b}	0.46
Protein Efficiency Ratio	0.61^{b}	0.67^{b}	0.91^{a}	0.03

^{ab} Means on the same row having different superscripts are significantly different ($p<0.05$)
DMB is *Dry Matter Basis*

Gross weight= Weight within 24hrs before kidding (**BK**) - Initial weight at mating
Net weight gain= Weight within 24hrs post-kidding (**PK**) - Initial weight at mating

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.6 Interaction effects of breeds of goat and levels of Turmeric powder inclusions on prenatal performance

Table 10 shows interaction effects of breeds of goat and levels of Turmeric powder inclusions on prenatal performance. KalaWAD and West African Dwarf (WAD) Does fed TP-2g had highest and lowest ($p<0.05$) values of 105.47 and 75.59g/day on dry matter basis (DMB) respectively for grass intake. Kalahari Red (KR) Does fed TP-2g had highest ($p<0.05$) values of 883.50 and 982.10g/day on DMB for concentrate and total feed intakes respectively. WAD Does fed TP-5g recorded lowest values of 548.20 and 624.30g/day on DMB for concentrate and total feed intakes respectively. KR Does had highest ($p<0.05$) values for weights within 24hrs before kidding and within 24hrs post-kidding; metabolic weight gain and metabolic final weight with 45kg, 38.97kg, 14.61g/day/$W^{0.75}$ and 17.18g/day/$W^{0.75}$ respectively.

KR Does fed TP-5g had highest ($p<0.05$) value for metabolic initial weight (11.91g/day/$W^{0.75}$). WAD Does fed TP-0 had lowest values for weight within 24hrs before kidding (37.23kg); weight within 24hrs post-kidding (29.15kg); metabolic weight gain (13.22g/day/$W^{0.75}$); metabolic initial weight (11.65g/day/$W^{0.75}$); and metabolic final weight (14.73g/day/$W^{0.75}$).

KR Does had highest ($p<0.05$) values for gross weight gain (17.65kg); net weight gain (11.62kg); daily weight gain (119.40g/day); and daily weight gain less foetal and afterbirth weights (78.50g/day). WAD Does fed TP-0 had lowest values for net weight gain (1.81kg); and daily weight gain less foetal and after birth weights (12.70g/day), while WAD Does fed TP-2g had lowest values for gross weight gain and daily weight gain with 9.51kg and 65.75g/day respectively.

KR Does fed TP-0 had highest ($p<0.05$) value for feed conversion ratio (11.92), while KalaWAD Does fed TP-2g had lowest value of 7.82 for same parameter. Protein efficiency ratio ranged between 0.52 to 0.97, where KR Does fed TP-0 and KalaWAD Does fed TP-5g had lowest and highest ($p<0.05$) values respectively.

Table 10: Interaction effects of breeds of goat and levels of Turmeric powder inclusion on prenatal performance

	Kalahari Red			**KalaWAD**			**West African Dwarf**			
Parameters	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Grass Intake (g/day on DMB)	103.30^{a}	98.67^{ab}	97.14^{ab}	93.21^{b}	105.47^{a}	94.34^{b}	81.88^{c}	75.59^{c}	76.13^{c}	3.05
Conc. Intake (g/day on DMB)	873.60^{ab}	883.50^{a}	844.40^{b}	618.10^{c}	588.40^{cd}	581.1^{de}	551.00^{e}	555.70^{e}	548.20^{e}	14.50
Total Feed Intake (g/day on DMB)	976.90^{a}	982.10^{a}	941.50^{b}	711.30^{c}	693.90^{cd}	675.40^{d}	632.90^{e}	631.30^{e}	624.30^{e}	15.40
Weight within 24hrs BK (kg)	39.64^{bc}	45.00^{a}	41.73^{ab}	37.95^{bc}	40.44^{abc}	40.00^{abc}	37.23^{c}	36.85^{c}	37.63^{bc}	1.33
Weight within 24hrs PK (kg)	33.92^{abc}	38.97^{a}	37.81^{a}	32.19^{bc}	34.63^{ab}	35.06^{ab}	29.15^{c}	31.34^{bc}	31.44^{bc}	1.78
Weight Gain (g/day/$W^{0.75}$)	13.83^{abc}	14.61^{a}	14.18^{ab}	13.40^{bc}	13.85^{ab}	13.88^{ab}	13.22^{c}	13.23^{c}	13.37^{bc}	0.24
Initial Weight (g/day/$W^{0.75}$)	11.85^{ab}	11.87^{ab}	11.91^{a}	11.90^{a}	11.73^{abc}	11.85^{ab}	11.65^{c}	11.71^{bc}	11.72^{bc}	0.08
Final Weight (g/day/$W^{0.75}$)	15.72^{bc}	17.18^{a}	16.33^{ab}	15.23^{bc}	15.87^{abc}	15.82^{abc}	14.73^{c}	14.69^{c}	14.95^{bc}	0.41
Gross Weight Gain (kg)	12.30^{bc}	17.65^{a}	14.39^{ab}	10.60^{bc}	13.10^{abc}	12.66^{bc}	9.89^{c}	9.51^{c}	10.23^{bc}	1.38
Net Weight Gain (kg)	6.57^{bc}	11.62^{a}	10.46^{ab}	4.85^{bc}	7.29^{ab}	7.72^{ab}	1.81^{c}	3.99^{bc}	4.04^{bc}	0.70
Daily Weight Gain (g/day)	82.20^{bc}	119.40^{a}	95.70^{ab}	69.84^{bc}	88.64^{abc}	81.03^{bc}	68.81^{bc}	65.57^{c}	71.27^{bc}	8.41
Daily Weight Gain less foetal and afterbirth weight (g/day)	44.20^{bc}	78.50^{a}	69.80^{ab}	31.93^{bc}	49.30^{ab}	49.00^{ab}	12.70^{c}	27.70^{bc}	28.20^{bc}	10.90
Feed Conversion Ratio	11.92^{a}	8.91^{ab}	10.50^{ab}	10.31^{ab}	7.82^{c}	8.36^{bc}	10.32^{ab}	10.21^{ab}	9.36^{bc}	1.37
Protein Efficiency Ratio	0.52^{d}	0.67^{cd}	0.83^{abc}	0.63^{cd}	0.75^{cd}	0.97^{a}	0.68^{cd}	0.59^{cd}	0.90^{ab}	0.08

^{abcde}Means on the same row having different superscripts are significantly different ($p<0.05$)

DMB is *Dry Matter Basis*

Gross weight= Weight within 24hrs before kidding (**BK**) - Initial weight at mating;

Net weight gain= Weight within 24hrs post-kidding (**PK**) - Initial weight at mating

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.7 Main effects of breeds of goat on some reproductive performance and pregnancy variables

Main effects of breeds of goat on some reproductive performance and pregnancy variables is presented in Table 11. Kalahari Red (KR) Does had the only case of stillbirth recorded which was 5%. KalaWAD and WAD Does had 0% stillbirth. It was only KalaWAD Does that recorded 6.67% for dystocia, while KR and WAD Does had 0% for same parameter. Fertility rate of 100% was recorded for all the Does irrespective of breed. WAD had the highest prolificacy of 1.53, followed by KR and KalaWAD Does with 1.33 for same parameter. Similarly, highest value of 153% was recorded for fecundity and kidding rate for WAD Does, while KR and KalaWAD Does had 133% for same parameters. KalaWAD Does had highest ($p<0.05$) value of 152.58 days for gestation length, followed by KR Does with 148.47 days, while WAD Does had the least value (144.64 days) for gestation length. No case of abortion was recorded for the breeds of goat used. Breeds of goat had significant ($p<0.05$) effect on product of pregnancy within 24hrs before kidding, foetal growth rate, and afterbirth weight. WAD Does had highest value of 11.58kg for product of pregnancy, followed by KalaWAD Does with 11.12kg, while KR Does had the least value (10.08kg) for same parameter. Foetal growth rate value ranged between 86.26-97.90g/day where WAD and KR Does had highest and lowest values respectively. Conversely, KR Does had highest value of 3233.33g for afterbirth weight, followed by WAD Does with 1495.67g, while KalaWAD Does had lowest value (856.25g) for same parameter.

4.8 Main effects of levels of Turmeric powder inclusions on some reproductive performance and pregnancy variables of goats

Table 12 shows main effects of levels of Turmeric powder inclusions on some reproductive performance and pregnancy variables of goats. Does fed TP-0 had the only case of stillbirth recorded which was 4.76%. Does Fed TP-2g and TP-5g had 0% stillbirth. Does fed TP-0 also recorded 6.67% for dystocia, while Does fed TP-2g and TP-5g had 0% for same parameter. Fertility rate of 100% was recorded for all the Does irrespective of their dietary treatments. Does fed TP-2g had the highest prolificacy of 1.47, followed by Does fed TP-0 with 1.40, while Does fed TP-5g had the least value (1.33) for same parameter. Similarly, highest value of 147% was recorded for fecundity and kidding rate for Does fed TP-2g, followed by Does fed TP-0 with 140%, while Does fed TP-5g had the least value (133%) for same parameters. No case of abortion was recorded for the Does fed diets containing Turmeric powder at different levels. Level of Turmeric powder inclusions had significant ($p<0.05$) effects on product of pregnancy within 24hrs before kidding and foetal growth rate of the Does. Does fed TP-0 had highest value of 11.25kg for product of pregnancy followed by Does fed TP-5g with 10.90kg, while Does fed TP-2g recorded lowest value (10.63kg) for same parameter. Similarly, Does fed TP-0 had highest value (95.36g/day) for foetal growth rate followed by Does fed TP-5g with 92.62g/day, while Does fed TP-2g recorded lowest value (90.52g/day) for same parameter. Levels of Turmeric powder inclusions had no significant ($p>0.05$) effects on gestation length and afterbirth weight of the Does. Does fed TP-5g had highest value of 150.18 days for gestation length, followed by Does fed TP-0 with 148.67 days, while Does fed TP-2g had the least value (146.84 days) for gestation length. Afterbirth weight of the Does ranged between 1519.17-2320.00g where Does fed TP-0 and TP-5g had highest and lowest values respectively.

Table 11: Main effects of breeds of goat on some reproductive performance and pregnancy variables

Parameters	Kalahari Red	KalaWAD	WAD	SEM
Reproductive Performance				
Abortion (%)	0.00	0.00	0.00	
Stillbirth (%)	5.00	0.00	0.00	
Dystocia (%)	0.00	6.67.00	0.00	
Fertility Rate (%)	100.00	100.00	100.00	
Prolificacy	1.33	1.33	1.53	
Fecundity (%)	133.00	133.00	153.00	
Kidding Rate (%)	133.00	133.00	153.00	
Gestation Length (days)	148.47^{b}	152.58^{a}	144.64^{c}	0.69
Pregnancy Variables				
Product of Pregnancy within 24hrs before kidding (kg)	10.08^{c}	11.12^{b}	11.58^{a}	0.12
Foetal Growth Rate (g/day)	86.26^{c}	94.34^{b}	97.90^{a}	0.93
Afterbirth Weight (g)	3233.33^{a}	856.25^{b}	1495.67^{b}	203.98

^{abc} Means on the same row having different superscripts are significantly different ($p<0.05$)

Table 12: Main effects of levels of Turmeric powder inclusions on some reproductive performance and pregnancy variables of goats

Parameters	TP-0	TP-2g	TP-5g	SEM
Reproductive Performance				
Abortion (%)	0.00	0.00	0.00	
Stillbirth (%)	4.76	0.00	0.00	
Dystocia (%)	6.67	0.00	0.00	
Fertility Rate (%)	100.00	100.00	100.00	
Prolificacy	1.40	1.47	1.33	
Fecundity (%)	140.00	147.00	133.00	
Kidding Rate (%)	140.00	147.00	133.00	
Gestation Length (days)	148.67	146.84	150.18	0.69
Pregnancy Variables				
Product of Pregnancy within 24hrs before kidding (kg)	11.25^{a}	10.63^{b}	10.90^{ab}	0.12
Foetal Growth Rate (g/day)	95.36^{a}	90.52^{b}	92.62^{ab}	0.93
Afterbirth Weight (g)	2320.00	1746.08	1519.17	203.98

[ab] Means on the same row having different superscripts are significantly different ($p<0.05$)

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.9 Interaction effects of breeds of goat and levels of Turmeric powder inclusions on some reproductive performance and pregnancy variables

Table 13 shows interaction effects of breeds of goat and levels of Turmeric powder inclusions on some reproductive performance and pregnancy variables. Kalahari Red (KR) Does fed TP-0 had the only case of stillbirth recorded which was 14.28%. Other Does i.e. KR, KalaWAD and WAD fed the dietary treatments had 0% stillbirth. KalaWAD Does fed TP-0 also recorded 20% for dystocia, while other Does fed the dietary treatments had 0% for same parameter. Fertility rate of 100% was recorded for all the Does irrespective of their breeds and dietary treatments. WAD Does fed TP-2g and TP-5g had the highest prolificacy of 1.60, while KR and KalaWAD Does fed TP-5g had the least value (1.20) for same parameter. Similarly, highest value of 160% was recorded for fecundity and kidding rate for WAD Does fed TP-2g and TP-5g, while KR and KalaWAD Does fed TP-5g had the least value (120%) for same parameters. No case of abortion was recorded for the breeds of goat fed diets containing Turmeric powder at different levels. Interaction had significant effects on gestation length, product of pregnancy within 24hrs before kidding, foetal growth rate, and afterbirth weight of the Does fed diets containing Turmeric powder at different inclusion levels. KalaWAD Does fed TP-5g had highest value of 156.80 days for gestation length, while WAD Does fed TP-0 had the least value (144.20 days) for same parameter.

Table 13: Interaction effects of breeds of goat and levels of Turmeric powder inclusion on some reproductive performance and pregnancy variables

	Kalahari Red			KalaWAD			WAD			
Parameters	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Reproductive Performance										
Abortion (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Stillbirth (%)	14.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Dystocia (%)	0.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00	
Fertility Rate (%)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	
Prolificacy	1.40	1.40	1.20	1.40	1.40	1.20	1.40	1.60	1.60	
Fecundity (%)	140.00	140.00	120.00	140.00	140.00	120.00	140.00	160.00	160.00	
Kidding Rate (%)	140.00	140.00	120.00	140.00	140.00	120.00	140.00	160.00	160.00	
Gestation Length (days)	149.20^{cb}	147.60^{cde}	148.60^{cd}	152.60^{b}	148.33^{cd}	156.80^{a}	144.20^{e}	144.60^{de}	145.13^{de}	0.69
Pregnancy Variables										
Product of Pregnancy within 24hrs before kidding (kg)	10.68^{de}	9.38^{f}	10.16^{e}	11.39^{abc}	10.91^{cd}	11.06^{bcd}	11.69^{a}	11.59^{ab}	11.46^{abc}	0.12
Foetal Growth Rate (g/day)	90.94^{de}	80.91^{f}	86.94^{e}	96.41^{abc}	92.69^{cd}	93.91^{bcd}	98.75^{a}	97.97^{ab}	96.99^{abc}	0.93
Afterbirth Weight (g)	3107.50^{ab}	3837.50^{a}	2755.00^{ab}	1265.00^{c}	638.75^{c}	665.00^{c}	2587.50^{b}	762.00^{c}	1137.50^{c}	203.98

^{abcdef} Means on the same row having different superscripts are significantly different ($p<0.05$)

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.10 Main effects of breeds of goat on birth types and sex of kids produced by dams

Table 14 shows the main effects of breeds of goat on birth types and sex of kids produced by dams. WAD Does produced highest number of kids which was 23, while Kalahari Red (KR) and KalaWAD Does had same number of kids (20). Litter size of the Does was not significantly (p>0.05) influenced by breeds of goat. WAD Does had highest number of kids at birth i.e. 1.53 kids, whereas litter size of 1.33 kids was recorded by KR and KalaWAD Does. For birth type, singleton ranged between 46.67-66.67%. KR and KalaWAD Does had the highest value, while WAD Does had the least value. Conversely, for percent twins, 53.33% was recorded for WAD Does, the value which was the highest. KR and KalaWAD Does recorded same value i.e. 33.33% for twin birth. For the kid's sex, male kids ranged between 40-65%, where WAD Does had highest value followed by KalaWAD Does with 50%, while KR Does had the least value for same parameter. Conversely, KR Does had highest number of female kids i.e. 60%, followed by KalaWAD Does with 50%, while 35% for female kids was recorded by WAD Does. Sex ratio for KR Does was 1:1.5, 1:1 for KalaWAD Does and 1:0.54 for WAD Does.

4.11 Main effect of levels of Turmeric powder inclusions on birth types and sex of kids produced by dams

Main effect of levels of Turmeric powder inclusions on birth types and sex of kids produced by dams is presented in Table 15. Does fed TP-2g produced highest number of kids which was 22, followed by Does fed TP-0 with 21 kids, while Does fed TP-5g had least number of kids (20). Litter size of the Does was not significantly (p>0.05) influenced by levels of Turmeric powder inclusion. Litter size of 1.4 kids was recorded by all the Does irrespective of dietary treatment fed to them. For birth type, singleton ranged between 53.33-66.67%.

Does fed TP-5g recorded highest value, followed by Does fed TP-0 with 60 kids, while Does fed TP-2g had the least value for same parameter. Conversely, for percent twins, 46.67% was recorded for Does fed TP-2g, the value which was the highest, followed by Does fed TP-0 with 40%, while Does fed TP-5g had the least value i.e. 33.33% for twin birth. For the kid's sex, male kids ranged between 35-61.90%, where Does fed TP-0 had highest value followed by Does fed TP-2g with 50%, while Does fed TP-5g recorded the least value for same parameter. Conversely, Does fed TP-5g had highest number of female kids i.e. 65%, followed by Does fed TP-2g with 50%, while 38.10% for female kids was recorded by Does fed TP-0. Sex ratio for Does fed TP-0 was 1:0.61, 1:1 for Does fed TP-2g and 1:1.86 for Does fed TP-5g.

4.12 Interaction effects of breeds of goat and levels of Turmeric powder inclusions on birth types and sex of kids produced by dams

Table 16 shows the interaction effects of breeds of goat and levels of Turmeric powder inclusions on birth types and sex of kids produced by dams. WAD Does fed TP-2g and TP-5g recorded highest number of kids i.e. 8 kids, while Kalahari Red and KalaWAD Does fed TP-5g had least value of 6 kids for same parameters. Similarly, WAD Does fed TP-2g and TP-5g recorded highest ($p>0.05$) value of 1.6 kids kidded at birth, while KR Does fed TP-5g and KalaWAD Does fed TP-2g had least litter size of 1.2 kids. For birth type, percent singleton ranged between 40-80%. KR and KalaWAD Does fed TP-5g had highest value, while WAD Does fed TP-2g and TP-5g had least value. Twin birth type ranged between 20-60%, where KR and KalaWAD Does fed TP-5g had least value, while WAD Does fed TP-2g and TP-5g had highest value. For kid's sex, male kids ranged between 28.57-71.43%, where KR Does fed TP-2g produced male kids with least value, while WAD Does fed TP-0 produced kids with highest male kids with 71.43%. Conversely, WAD Does fed TP-0 produced kids with least value of 28.57% female kids, while KR Does fed TP-2g produced kids with highest number of female kids which was 71.43%.

Sex ratio ranged between 1:0.04 to 1:2.50. KR Does fed TP-2g and WAD Does fed TP-0 recorded highest and least values respectively.

Table 14: Main effects of breeds of goat on birth types and sex of kids produced by dams

Parameter	Kalahari Red	KalaWAD	WAD	SEM
Total no. of kids kidded	20	20	23	
Litter Size (kids)	1.33	1.33	1.53	0.07
Birth Type				
Singleton (%)	66.67	66.67	46.67	
Twins (%)	33.33	33.33	53.33	
Kid's Sex				
Male kids (%)	40	50	65	
Female kids (%)	60	50	35	
Sex ratio (Male:Female)	1:1.5	1:1	1:0.54	

Table 15: Main effect of levels of Turmeric powder inclusions on birth types and sex of kids produced by dams

Parameters	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Total no. of kids kidded	21	22	20	
Litter Size (kids)	1.4	1.4	1.4	0.07
Birth Type				
Singleton (%)	60	53.33	66.67	
Twins (%)	40	46.67	33.33	
Kid's Sex				
Male kids (%)	61.90	50	35	
Female kids (%)	38.10	50	65	
Sex ratio (Male:Female)	1:0.61	1:1	1:1.86	

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

Table 16: Interaction effects of breeds of goat and levels of Turmeric powder inclusions on birth types and sex of kids produced by dams

	Kalahari Red			KalaWAD			WAD			
Parameter	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Total no. of kids kidded	7	7	6	7	7	6	7	8	8	
Litter Size (kids)	1.4	1.4	1.2	1.4	1.2	1.4	1.4	1.6	1.6	0.07
Birth Type										
Singleton (%)	60	60	80	60	60	80	60	40	40	
Twins (%)	40	40	20	40	40	20	40	60	60	
Kid's Sex										
Male kids (%)	57.14	28.57	33.33	57.14	57.14	33.33	71.43	62.50	37.50	
Female kids (%)	42.86	71.43	66.67	42.86	42.86	66.67	28.57	37.50	62.50	
Sex ratio (Male:Female)	1:0.75	1:2.50	1:2.0	1:0.75	1:0.75	1:2.0	1:0.04	1:0.60	1:1.67	

Means on the same row having same superscripts are not significantly different ($p>0.05$)

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.13 Main effects of breed of goat on weight distribution of kids based on sex and birth types

Table 17 shows main effects of breed of goat on weight distribution of kids based on sex and birth types. Kalahari Red (KR) Does had highest ($p<0.05$) value of 3248.75g for kids' birth weight, followed by KalaWAD Does with 2397.00g while WAD Does had least value (1951.96g) for same parameter. Litter weight ranged between 2993.30-4331.70g, where KR and WAD Does had highest and lowest ($p<0.05$) values respectively. For weight distribution on birth type, kids from KR had highest ($p<0.05$) values of 3447.50 and 3050.00g for singleton and twin birth types respectively. Kids kidded by WAD Does had least values of 2093.57 and 1890.00g for singleton and twins respectively. For weight distribution on kid's sex, males kids from KR Does had highest ($p<0.05$) value, which was 3153.75g. The value (1980.77g) which was least for kids from WAD Does for same parameter. Similarly, kids from KR Does had highest ($p<0.05$) value of 3312.08g for female kids at birth, followed by KalaWAD Does kids with 2545.50g, while least value of 1914.50g was recorded for female kids from WAD.

4.14 Main effects of levels of Turmeric powder inclusions on weight distribution of kids based on sex and birth types

Main effects of levels of Turmeric powder inclusions on weight distribution of kids based on sex and birth types is presented in Table 18. Levels of Turmeric powder inclusion had no significant ($p>0.05$) influence on kids' birth weight, litter weight, kid's weight distribution on based on sex and birth types. Birth weight of kids from Does fed TP-5g and TP-0 had highest and lowest ($p>0.05$) values of 2655.00 and 2375.48g respectively. Litter weight of kids from Does fed TP-2g and TP-0 had highest and lowest ($p>0.05$) values of 3655.67 and 3325.67g respectively. Based on birth types, singletons from Does fed TP-5g and TP-0 had highest and lowest ($p>0.05$)

values of 3137.00 and 2666.11g respectively. Twin kids from Does fed TP-2g and TP-0 had highest and lowest ($p>0.05$) values of 2335.71 and 2157.50g respectively. Based on kid's sex at birth, male kids from Does fed TP-5g and TP-2g had highest and lowest ($p>0.05$) values of 2602.86 and 2243.18g respectively. Female kids of Does fed TP-5g and TP-0 had highest and lowest ($p>0.05$) values of 2701.54 and 2384.38g respectively.

4.15 Interaction effects of breeds of goat kids and levels of Turmeric powder inclusions on weight distribution of kids based on sex and birth types

Table 19 shows the interaction effects of breeds of goat kids and levels of Turmeric powder inclusions on weight distribution of kids based on sex and birth types. Kids kidded by Kalahari Red (KR) Does fed TP-5g had highest significant ($p<0.05$) value of 3596.67g for kids' birth weight, while kids of WAD Does fed TP-2g had least value (1853.13g) for same parameter. For weight distribution based on birth type, kids from KR Does fed TP-5g had highest significant ($p<0.05$) value of 3770.00g for singleton, while kids kidded by WAD Does fed TP-5g had least value of 2040.00g for singleton. Kids from KR Does fed TP-2g and KalaWAD Does fed TP-0 had highest and lowest significant ($p<0.05$) values of 3287.50 and 1760.00g for twin birth type respectively. For weight distribution on kid's sex, males kids from KR Does fed TP-5g recorded highest significant ($p<0.05$) value, which was 3740.00g. Least value which was 1800.00g was recorded for male kids from WAD Does fed TP-2g. Similarly, kids from KR Does fed TP-5g had highest significant ($p<0.05$) value of 3525.00g for female kids at birth, while least value of 1775.00g was recorded for female kids from WAD Does fed TP-0.

There was no significant ($p>0.05$) interaction effect of breeds of goat and levels of Turmeric powder inclusion on litter weight of kids. Litter weight of kids kidded ranged between

2860.00-4515.00g, where kids of KR Does fed TP-2g and WAD Does fed TP-0 had highest and lowest values respectively.

Table 17: Main effects of breed of goat on weight distribution of kids based on sex and birth types

Parameters	Kalahari Red	KalaWAD	WAD	SEM
Birth Weight (g)	3248.75[a]	2397.00[b]	1951.96[c]	91.53
Litter Weight (g)	4331.70[a]	3196.30[b]	2993.30[b]	183.08
Birth Type				
Singleton (g)	3447.50[a]	2836.00[b]	2093.57[c]	145.23
Twins (g)	3050.00[a]	2014.00[b]	1890.00[b]	99.00
Kid's Sex at Birth				
Male kids (g)	3153.75[a]	2272.50[b]	1980.77[b]	126.90
Female kids (g)	3312.08[a]	2545.50[b]	1914.50[c]	130.15

[abc] Means on the same row having different superscripts are significantly different ($p<0.05$)

Table 18: Main effects of levels of Turmeric powder inclusions on weight distribution of kids based on sex and birth types

Parameters	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Birth Weight (g)	2375.48	2492.05	2655.00	91.53
Litter Weight (g)	3325.67	3655.67	3540.00	183.08
Birth Type				
Singleton (g)	2666.11	2765.63	3137.00	145.23
Twins (g)	2157.50	2335.71	2229.00	99.00
Kid's Sex at Birth				
Male kids (g)	2370.00	2243.18	2602.86	126.90
Female kids (g)	2384.38	2740.91	2701.54	130.15

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

Table 19: Interaction effects of breeds of goat kids and levels of Turmeric powder inclusions on weight distribution of kids based on sex and birth types

	Kalahari Red			KalaWAD			WAD			
Parameters	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Birth Weight (g)	2974.29^{bc}	3225.00^{ab}	3596.67^{a}	2109.29^{def}	2489.29^{cde}	2625.00^{cd}	2042.86^{ef}	1853.13^{f}	1971.25^{ef}	91.53
Litter Weight (g)	4164.00	4515.00	4316.00	2953.00	3486.00	3150.00	2860.00	2966.00	3154.00	183.08
Birth Type										
Singleton (g)	3323.33^{ab}	3141.67^{abc}	3770.00^{a}	2575.00^{bc}	2808.33^{abc}	3052.50^{abc}	2100.00^{c}	2137.50^{c}	2040.00^{c}	145.23
Twins (g)	2712.50^{b}	3287.50^{a}	3250.00^{a}	1760.00^{d}	2250.00^{c}	2050.00^{cd}	2000.00^{cd}	1758.33^{d}	1948.33^{cd}	99.00
Kid's Sex at Birth										
Male kids (g)	2850.00^{abc}	3175.00^{ab}	3740.00^{a}	2165.00^{bcd}	2331.25^{bcd}	2370.00^{bcd}	2150.00^{bcd}	1800.00^{d}	2000.00^{cd}	126.90
Female kids (g)	3140.00^{ab}	3245.00^{ab}	3525.00^{a}	2035.00^{cd}	2700.00^{bc}	2812.50^{ab}	1775.00^{d}	1941.67^{cd}	1954.00^{cd}	130.15

^{abcdef} Means on the same row having different superscripts are significantly different ($p<0.05$)

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.16 Main effect of breeds of lactating goats on post-natal weight change

Table 20 shows main effect of breeds of lactating goats on post-natal weight change. Kalahari Red (KR) Does recorded highest ($p<0.05$) values for grass intake (125.58g/day on dry matter basis (DMB)); concentrate intake (850.50g/day on DMB); total feed intake (1471.00g/day on DMB); metabolic weight change (13.67g/day/$W^{0.75}$); and metabolic initial weight (13.84g/day/$W^{0.75}$). WAD Does had the lowest values for these respective parameters with 97.10g/day on DMB; 757.20g/day on DMB; 1251.80g/day on DMB; 13.04g/day/$W^{0.75}$; and 13.61g/day/$W^{0.75}$.

Breeds of lactating goat had no significant effects ($p>0.05$) on the final weight, metabolic final weight, weight change and daily weight change of the goats.

4.17 Main effect of levels of Turmeric powder inclusions on post-natal weight change of lactating goats

Main effect of levels of Turmeric powder inclusions on post-natal weight change of lactating goats is presented in Table 21. Does fed TP-0 had highest significant ($p<0.05$) effects on grass intake (111.13g/day on dry matter basis (DMB)); 812.65g/day on DMB; and 1360.10g/day on DMB, whereas, Does fed TP-5g had least value (102.91g/day on DMB) for grass intake. Does fed TP-2g had lowest values for concentrate (780.75g/day) and total feed (1322.50g/day) intakes. Does fed TP-5g had highest significant ($p<0.05$) values for final weight (31.50kg); metabolic weight change (13.45g/day/$W^{0.75}$); metabolic final weight (13.11g/day/$W^{0.75}$); and weight change (2.00kg). Conversely. Does fed TP-0 recorded lowest values for final weight (30.02kg); metabolic weight change (13.16g/day/$W^{0.75}$); metabolic final weight (12.60g/day/$W^{0.75}$); and weight change (-3.47kg). Does fed TP-0 had highest significant ($p<0.05$) value for daily weight reduction (-38.58g/day), while Does fed TP-5g recorded the least value of -22.22g/day for daily weight reduction.

4.18 Interaction effects of breeds of lactating goats and levels of Turmeric powder inclusions on post-natal weight change

Table 22 shows interaction effects of breeds of lactating goats and levels of Turmeric powder inclusions on post-natal weight change. Kalahari Red (KR) Does fed TP-0 had highest ($p<0.05$) values for all the intakes. For grass intake (127.99g/day on dry matter basis (DMB)); concentrate intake (876.80g/day on DMB); and total feed intake (1498.60g/day on DMB). West African Dwarf (WAD) Does fed TP-5g had lowest for grass intake (88.87g/day on DMB), while WAD Does fed TP-2g had lowest values of 734.40 and 1204.40g/day on DMB for concentrate and total feed intakes respectively.

KR Does fed TP-5g recorded highest significant values for final weight (34.56kg); metabolic weight change (13.97g/day/$W^{0.75}$), metabolic final weight (14.08g/day/$W^{0.75}$); and weight change (1.06kg). KalaWAD Does fed TP-0 recorded lowest value (28.97kg) for final weight; WAD Does fed TP-0 had lowest value of 12.97g/day/$W^{0.75}$ for metabolic weight change; KalaWAD Does fed TP-0 recorded lowest values of 12.31g/day/$W^{0.75}$ and -4.52kg for metabolic final weight and weight change respectively.

KR Does fed TP-5g had highest ($p<0.05$) value of 11.80g/day for daily weight change, while KalaWAD Does fed TP-0 recorded highest daily weight reduction of -50.26g/day

Table 20: Main effects of breeds of lactating goats on post-natal weight change

Parameters	Kalahari Red	KalaWAD	WAD	SEM
Lactation duration (weeks)	12	12	12	
Grass Intake (g/day on DMB)	125.58[a]	97.24[b]	97.10[b]	4.51
Conc. Intake (g/day on DMB)	850.50[a]	779.44[b]	757.20[c]	12.30
Total Feed Intake (g/day on DMB)	1471.00[a]	1278.60[b]	1251.80[b]	17.31
Final Weight (kg)	32.55	29.77	29.94	0.81
Weight Change (g/day/$W^{0.75}$)	13.67[a]	13.20[ab]	13.04[b]	0.13
Initial Weight (g/day/$W^{0.75}$)	13.84[a]	13.79[a]	13.61[b]	0.07
Final Weight (g/day/$W^{0.75}$)	13.50	12.60	12.47	0.24
Weight Change (kg)	-0.95	-3.72	-3.56	0.81
Weight Change (g/day)	-10.50	-41.36	-39.55	9.67

[abc] Means on the same row having different superscripts are significantly different ($p<0.05$)

DMB is *Dry Matter Basis*

Table 21: Main effect of levels of Turmeric powder inclusions on post-natal weight change of lactating goats

Parameters	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Lactation duration (weeks)	12	12	12	
Grass Intake (g/day on DMB)	111.13^{a}	105.89^{ab}	102.91^{b}	2.57
Conc. Intake (g/day on DMB)	812.65^{a}	780.75^{b}	793.68^{ab}	6.87
Total Feed Intake (g/day on DMB)	1360.10^{a}	1318.81^{b}	1322.50^{b}	9.81
Final Weight (kg)	30.02^{b}	30.74^{ab}	31.50^{a}	0.47
Weight Change (g/day/$W^{0.75}$)	13.16^{b}	13.31^{ab}	13.45^{a}	0.07
Initial Weight (g/day/$W^{0.75}$)	13.71	13.74	13.78	0.04
Final Weight (g/day/$W^{0.75}$)	12.60^{b}	12.86^{ab}	13.11^{a}	0.14
Weight Change (kg)	-3.47^{b}	-2.76^{ab}	2.00^{a}	0.47
Weight Change (g/day)	-38.58^{b}	-30.63^{ab}	22.22^{a}	5.18

^{ab} Means on the same row having different superscripts are significantly different ($p<0.05$)

DMB is *Dry Matter Basis*

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

Table 22: Interaction effects of breeds of lactating goats and levels of Turmeric powder inclusions on post-natal weight change

	Kalahari Red			KalaWAD			West African Dwarf			
Parameters	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Lactation duration (weeks)	12	12	12	12	12	12	12	12	12	
Grass Intake (g/day on DMB)	127.99^{a}	123.26^{ab}	125.50^{a}	93.38^{cd}	103.96^{bc}	94.36^{cd}	112.00^{ab}	90.44^{d}	88.87^{d}	5.66
Conc. Intake (g/day on DMB)	876.80^{a}	837.50^{b}	837.00^{b}	793.60^{bc}	770.30^{c}	774.40^{c}	767.50^{cd}	734.40^{d}	769.60^{c}	16.60
Total Feed Intake (g/day on DMB)	1498.60^{a}	1452.80^{a}	1461.60^{a}	1270.00^{bc}	1299.20^{b}	1266.60^{bc}	1311.60^{b}	1204.40^{d}	1239.4^{cd}	21.7
Final Weight (kg)	31.07^{b}	32.02^{b}	34.56^{a}	28.97^{b}	30.09^{b}	30.26^{b}	30.03^{b}	30.11^{b}	29.67^{b}	0.99
Weight Change (g/day/$W^{0.75}$)	13.47^{b}	13.57^{b}	13.97^{a}	13.05^{b}	13.22^{b}	13.33^{b}	12.97^{b}	13.12^{b}	13.04^{b}	0.17
Initial Weight (g/day/$W^{0.75}$)	13.86^{a}	13.80^{a}	13.85^{a}	13.77^{a}	13.76^{a}	13.84^{a}	13.51^{b}	13.66^{a}	13.65^{a}	0.09
Final Weight (g/day/$W^{0.75}$)	13.08^{b}	13.34^{b}	14.08^{a}	12.31^{b}	12.68^{b}	12.81^{b}	12.41^{b}	12.58^{b}	12.43^{b}	0.33
Weight Change (kg)	-2.43^{b}	-1.48^{b}	1.06^{a}	-4.52^{b}	-3.41^{b}	-3.23^{b}	-3.47^{b}	-3.38^{b}	-3.83^{b}	0.99
Weight Change (g/day)	-27.00^{b}	-16.40^{b}	11.80^{a}	-50.26^{b}	-37.90^{b}	-35.94^{b}	-38.50^{b}	-37.60^{b}	-42.50^{b}	12.30

^{abcd} Means on the same row having different superscripts are significantly different ($p<0.05$)

DMB is *Dry Matter Basis*

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.19 Main effects of breeds of goat on prolactin and oxytocin concentrations at kidding and at 3 months of lactation

Table 23 shows main effects of breeds of goat on prolactin and oxytocin concentrations at kidding and at 3 months of lactation. KalaWAD Does had highest ($p<0.05$) values for prolactin and oxytocin concentrations within 24hrs of kidding. These values were 17.09ng/ml and 37.86pg/ml for Prolactin and oxytocin respectively. Kalahari Red (KR) Does recorded least value for prolactin (14.40ng/ml) and oxytocin (28.37ng/ml) within 24hrs of kidding. Prolactin and oxytocin concentrations taken after 3 months of lactation was significantly ($p<0.05$) influenced by breeds of goat where KR Does had highest values for prolactin (13.86ng/ml) and oxytocin (32.75pg/ml), while KalaWAD and WAD Does recorded least values of 10.49ng/ml and 27.93pg/ml for prolactin and oxytocin respectively. Difference in oxytocin at 3 months of lactation and within 24hrs of kidding was significantly ($p<0.05$) highest for KR Does where it recorded 1.42pg/ml, whereas lowest value of -6.54pg/ml was recorded for KalaWAD. Breeds of goat had no significant ($p<0.05$) influence on prolactin difference.

4.20 Main effects of levels of Turmeric powder inclusions on prolactin and oxytocin concentrations at kidding and at 3 months of lactation

Main effects of levels of Turmeric powder inclusions on prolactin and oxytocin concentrations at kidding and at 3 months of lactation is presented in Table 24. Does fed TP-0 had highest ($p<0.05$) value of 17.68ng/ml for prolactin within 24hrs of kidding, while Does fed TP-5g recorded the least value (14.24ng/ml). Turmeric powder inclusions had no significant ($p<0.05$) effect on oxytocin concentration within 24hrs of kidding. Prolactin and oxytocin concentrations at 3 months of lactation ranged between 10.55-14.60ng/ml and 29.14-33.11pg/ml. Does fed TP-5g had highest ($p<0.05$) values for prolactin and oxytocin concentrations at 3 months of lactation, while Does fed TP-0 had the least values for same parameters. Similarly, Does fed TP-5g had highest ($p<0.05$) values for prolactin and oxytocin difference, while Does fed TP-0 had least value.

4.21 Interaction effects of breeds of goat and levels of Turmeric powder inclusions on prolactin and oxytocin concentrations at kidding and at 3 months of lactation

Table 25 shows the interaction effects of breeds of goat and levels of Turmeric powder inclusions on prolactin and oxytocin concentrations at kidding and at 3 months of lactation. KalaWAD Does fed TP-0 had highest ($p<0.05$) value of 19.34ng/ml for prolactin concentration within 24hrs of kidding, the value which was least (11.70ng/ml) for WAD Does fed TP-5g. Oxytocin concentration within 24hrs of kidding ranged between 23.97-40.03ng/ml where KR Does fed TP-0 and TP-5g had highest and lowest ($p<0.05$) values respectively. Prolactin and oxytocin concentrations taken after 3 months of lactation was significantly ($p<0.05$) influenced where KR Does fed TP-5g recorded highest values for prolactin (17.70ng/ml) and oxytocin (32.05pg/ml), while KalaWAD Does fed TP-2g and WAD Does fed TP-0 had least values of 9.85ng/ml and 25.60pg/ml for prolactin and oxytocin respectively. Difference in prolactin at 3 months of lactation and within 24hrs of kidding was significantly ($p<0.05$) highest for WAD Does fed TP-5g where it recorded 3.66ng/ml, whereas lowest value of -8.45ng/ml was recorded for WAD Does fed TP-0. Difference in oxytocin at 3 months of lactation and within 24hrs of kidding was significantly ($p<0.05$) highest for KR Does fed TP-5g where it recorded 7.73Pg/ml, whereas lowest value of -10.40pg/ml was recorded for KalaWAD Does fed TP-2g.

Table 23: Main effects of breeds of goat on prolactin and oxytocin concentrations at kidding and at 3 months of lactation

Parameters	Kalahari Red	KalaWAD	WAD	SEM
Within 24hrs of Kidding				
Prolactin (ng/ml)	14.40^{b}	17.09^{a}	14.52^{b}	0.51
Oxytocin (pg/ml)	28.37^{b}	37.86^{a}	29.53^{b}	1.13
At 3 Months of Lactation				
Prolactin (ng/ml)	13.86^{a}	10.49^{b}	13.15^{a}	0.52
Oxytocin (pg/ml)	32.75^{a}	31.32^{a}	27.93^{b}	0.68
Difference				
Prolactin (ng/ml)	-3.14	-6.59	-2.07	0.97
Oxytocin (pg/ml)	1.42^{a}	-6.54^{b}	-2.33^{ab}	1.37

^{ab} Means on the same row having different superscripts are significantly different ($p<0.05$)

The difference is values at 3 months of lactation less values at kidding

Table 24: Main effects of levels of Turmeric powder inclusions on prolactin and oxytocin concentrations at kidding and at 3 months of lactation

Parameters	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Within 24hrs of Kidding				
Prolactin (ng/ml)	17.68^{a}	14.37^{b}	14.24^{b}	0.51
Oxytocin (pg/ml)	34.58	31.16	30.31	1.13
At 3 Months of Lactation				
Prolactin (ng/ml)	10.55^{b}	12.21^{b}	14.60^{a}	0.52
Oxytocin (pg/ml)	29.14^{b}	29.71^{b}	33.11^{a}	0.68
Difference				
Prolactin (ng/ml)	-7.89^{b}	-3.43^{a}	-0.86^{a}	0.97
Oxytocin (pg/ml)	-6.24^{b}	-2.54^{ab}	1.01^{a}	1.37

^{ab} Means on the same row having different superscripts are significantly different ($p<0.05$)

The difference *is values at 3 months of lactation less values at kidding*

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

Table 25: Interaction effects of breeds of goat and levels of Turmeric powder inclusions on prolactin and oxytocin concentrations at kidding and at 3 months of lactation

	Kalahari Red			**KalaWAD**			**West African Dwarf**			
Parameters	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Within 24hrs of Kidding										
Prolactin (ng/ml)	16.95^{abc}	13.55^{cd}	13.57^{cd}	19.34^{a}	14.47^{bcd}	17.47^{ab}	16.57^{abc}	15.30^{bcd}	11.70^{d}	0.51
Oxytocin (pg/ml)	40.03^{a}	24.89^{d}	23.97^{d}	36.56^{ab}	38.87^{a}	38.15^{a}	28.50^{cd}	31.29^{bc}	28.80^{cd}	1.13
At 3 Months of Lactation										
Prolactin (ng/ml)	10.55^{d}	12.77^{bcd}	17.70^{a}	10.90^{cd}	9.85^{d}	10.73^{cd}	10.20^{d}	13.88^{bc}	15.36^{ab}	0.52
Oxytocin (pg/ml)	31.66^{bc}	29.96^{c}	37.05^{a}	30.78^{bc}	28.47^{cd}	34.72^{ab}	25.60^{d}	30.65^{bc}	27.55^{cd}	0.68
Difference										
Prolactin (ng/ml)	-6.40^{bc}	-4.09^{bc}	0.48^{ab}	-8.44^{c}	-4.62^{bc}	-6.73^{bc}	-8.45^{c}	-1.42^{abc}	3.66^{a}	0.97
Oxytocin (pg/ml)	-8.36^{bc}	2.25^{ab}	7.73^{a}	-5.78^{bc}	-10.40^{c}	-3.43^{abc}	-5.09^{bc}	-0.64^{abc}	-1.25^{abc}	1.37

^{abcd}Means on the same row having different superscripts are significantly different ($p<0.05$).

The difference is *values at 3 months of lactation less values at kidding*

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.22 Main effects of breeds of goat on milk yield from 1st week of kidding to 12 weeks post-kidding

Table 26 shows main effects of breeds of goat on milk yield from 1st week of kidding to 12 weeks post-kidding. Kalahari Red Does had highest ($p<0.05$) values for milk yield in all the weeks except at week 11 where KalaWAD Does had highest significant value. WAD Does had the least values for milk yield in all the weeks. Milk yield per 24hours at weeks 1-4 for Kalahari Red Does was 949.33, 1182.22, 1204.44 and 1210.00ml respectively, while for WAD it was 537.45, 625.45, 546.36 and 464.64ml for respective week. Similarly, weeks 5-8 had milk yield of 960.00, 881.25, 803.75 and 980.00ml/24hrs respectively for Kalahari Red Does whereas WAD Does had 485.45, 526.72, 434.27 and 391.73ml/24hrs for respective weeks of milk collection. Kalahari Red Does had 667.50, 601.25 and 523.87ml/24hrs milk yield at weeks 9, 10 and 12 respectively. KalaWAD Does had highest milk yield of 555.00ml/24hrs at week 11. Lowest milk yield of 387.27, 402.36, 365.45 and 310.73ml/24hrs was recorded for WAD Does at weeks 9-12 respectively.

4.23 Main effects of levels of Turmeric powder inclusions on milk yield of goat from 1st week of kidding to 12 weeks post-kidding

Main effects of levels of Turmeric powder inclusions on milk yield of goat from 1st week of kidding to 12 weeks post-kidding is presented in Table 27. Turmeric powder inclusion at different levels had significant ($p<0.05$) effects on milk yield at weeks 2, 8, 10, 11 and 12. Does fed TP-2g had the highest values of 1060.00, 853.20, 599.00, 557.50 and 526.80ml of milk per 24hrs at weeks 2, 8, 10, 11 and 12 respectively. While Does fed TP-0 recorded the lowest values for milk yield in the respective weeks with 583.75, 388.25, 338.12, 348.75 and 278.12ml/24hrs.

Table 26: Main effects of breeds of goat on Milk yield from 1st week of kidding to 12 weeks post-kidding

Weeks	Kalahari Red	KalaWAD	WAD	SEM
1 (ml/24hrs)	949.33[a]	890.00[a]	537.45[b]	52.54
2 (ml/24hrs)	1182.22[a]	926.67[ab]	625.45[b]	78.90
3 (ml/24hrs)	1204.44[a]	716.67[b]	546.36[b]	92.00
4 (ml/24hrs)	1210.00[a]	850.00[a]	464.64[b]	90.78
5 (ml/24hrs)	960.00[a]	773.33[a]	485.45[b]	56.61
6 (ml/24hrs)	881.25[a]	765.00[a]	526.72[b]	45.57
7 (ml/24hrs)	803.75[a]	696.67[a]	434.27[b]	45.41
8 (ml/24hrs)	980.00[a]	619.33[b]	391.73[b]	80.50
9 (ml/24hrs)	667.50[a]	601.67[a]	387.27[b]	41.92
10 (ml/24hrs)	601.25[a]	581.67[a]	402.36[b]	35.51
11 (ml/24hrs)	555.00[a]	571.67[a]	365.45[b]	32.30
12 (ml/24hrs)	532.87[a]	508.33[a]	310.73[b]	33.82
Total Yield (ml/12 weeks)	74,036.38[a]	59,507.00[b]	38,345.36[c]	3,711.59

[ab] Means on the same row having different superscripts are significantly different ($p<0.05$)

Table 27: Main effects of levels of Turmeric powder inclusions on milk yield of goat from 1st week of kidding to 12 weeks post-kidding

Weeks	TP-0	TP-2g	TP-5g	SEM
1 (ml/24hrs)	711.25	764.36	836.80	52.54
2 (ml/24hrs)	583.75^{b}	1060.00^{a}	953.00^{a}	78.90
3 (ml/24hrs)	661.25	1060.91	634.00	92.00
4 (ml/24hrs)	718.75	936.00	733.10	90.78
5 (ml/24hrs)	673.75	746.00	713.00	56.61
6 (ml/24hrs)	565.50	792.50	728.00	45.57
7 (ml/24hrs)	479.62	695.00	669.00	45.41
8 (ml/24hrs)	388.25^{b}	853.20^{a}	608.50^{ab}	80.50
9 (ml/24hrs)	412.50	581.00	590.50	41.92
10 (ml/24hrs)	338.12^{b}	599.00^{a}	577.60^{a}	35.50
11 (ml/24hrs)	348.75^{b}	557.50^{a}	524.00^{a}	32.30
12 (ml/24hrs)	278.12^{b}	526.80^{a}	476.30^{a}	33.82
Total Yield (ml/12 weeks)	43,117.38^{b}	64,164.80^{a}	56,306.60^{ab}	3,711.59

^{ab} Means on the same row having different superscripts are significantly different ($p<0.05$)

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.24 Interaction effects of breeds of goat and levels of Turmeric powder inclusions on milk yield from 1st week of kidding to 12 weeks post-kidding

Table 28 shows the interaction effects of breeds of goat and levels of Turmeric powder inclusions on milk yield from 1st week of kidding to 12 weeks post-kidding. There was significant ($p<0.05$) interaction effect on milk yield of Does per 24hrs from weeks 1-12. Kalahari Red (KR) Does fed TP-0 had highest value of 1100ml/24hrs at the 1st week, while WAD fed TP-0 recorded the least value (373.33ml/24hrs). At week 2, KR Does fed TP-5g and WAD Does fed TP-0 had the highest and lowest values of 1386.67 and 400.00ml/24hrs respectively. KR Does fed TP-2g had highest values of 1500.00 and 1560.00ml/24hrs at weeks 3 and 4 respectively, while WAD fed TP-0 had the least values of 393.33 and 413.33ml/24hrs at the respective week. KR and WAD Does fed TP-0 recorded the highest and lowest values of 1160.00 and 453.33ml/24hrs at week 5 respectively. KR fed TP-2g recorded highest values for milk yield at weeks 6, 7, 8, 9, 11 and 12 with 1020.00, 923.33, 1536.67, 773.33, 720.00 and 701.33ml/24hrs respectively. KR fed TP-5g recorded the highest value of 726.67ml/24hrs at week 10. WAD Does fed TP-0 had least values for milk yield from weeks 6-12 with 464.67, 409.00, 388.67, 320.00, 266.67, 320.00 and 206.67ml/24hrs for respective week.

Table 28: Interaction effects of breeds of goat and levels of Turmeric powder inclusions on milk yield from 1st week of kidding to 12 weeks post-kidding

	Kalahari Red			KalaWAD			West African Dwarf			
Weeks	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
1 (ml/24hrs)	1100.00^{a}	882.00^{abc}	938.67^{abc}	790.00^{abc}	880.00^{abc}	1000.00^{abc}	373.33^{d}	560.00^{cd}	638.00^{bcd}	52.54
2 (ml/24hrs)	700.00^{bc}	1270.00^{ab}	1386.67^{a}	690.00^{bc}	1140.00^{ab}	950.00^{abc}	400.00^{c}	790.00^{abc}	630.00^{bc}	78.90
3 (ml/24hrs)	1140.00^{ab}	1500.00^{a}	853.33^{ab}	610.00^{b}	980.00^{ab}	560.00^{b}	393.33^{b}	682.50^{b}	525.00^{b}	92.00
4 (ml/24hrs)	1220.00^{ab}	1560.00^{a}	853.33^{bc}	690.00^{bc}	820.00^{bc}	1040.00^{abc}	413.33^{c}	555.00^{bc}	412.75^{c}	90.78
5 (ml/24hrs)	1160.00^{a}	920.00^{ab}	866.67^{abc}	570.00^{bc}	860.00^{abc}	890.00^{abc}	453.33^{c}	530.00^{bc}	465.00^{c}	56.61
6 (ml/24hrs)	620.00^{bcd}	1020.00^{a}	916.67^{ab}	630.00^{bcd}	835.00^{abc}	830.00^{abc}	464.67^{d}	590.00^{bcd}	510.00^{cd}	45.57
7 (ml/24hrs)	480.00^{cd}	923.33^{a}	900.00^{a}	550.00^{bcd}	740.00^{abc}	800.00^{ab}	409.00^{d}	490.00^{cd}	397.50^{d}	45.41
8 (ml/24hrs)	280.00^{c}	1536.67^{a}	890.00^{b}	460.00^{bc}	743.00^{bc}	655.00^{bc}	388.67^{c}	423.25^{bc}	362.50^{c}	80.50
9 (ml/24hrs)	360.00^{b}	773.33^{a}	766.67^{a}	540.00^{ab}	550.00^{ab}	715.00^{a}	320.00^{b}	460.00^{ab}	365.00^{b}	41.92
10 (ml/24hrs)	330.00^{b}	656.67^{a}	726.67^{a}	415.00^{b}	680.00^{a}	650.00^{a}	266.67^{b}	495.00^{ab}	411.50^{b}	35.50
11 (ml/24hrs)	240.00^{d}	720.00^{a}	600.00^{ab}	450.00^{bc}	615.00^{ab}	650.00^{a}	320.00^{d}	392.50^{cd}	372.50^{cd}	32.30
12 (ml/24hrs)	240.00^{de}	701.33^{a}	559.67^{ab}	375.00^{cd}	525.00^{bc}	625.00^{ab}	206.67^{e}	397.25^{cd}	302.25^{de}	33.82
Total Yield (ml/12 weeks)	55,090.00^{bcd}	88,895.33^{a}	71,808.33^{ab}	47,390.00^{cde}	65,576.00^{bc}	65,555.00^{bc}	30,863.00^{e}	44,558.50^{de}	37,744.00^{de}	3,711.59

^{abcde} Means on the same row having different superscripts are significantly different ($p<0.05$)

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.25 Main effects of breeds of goat on proximate composition and some physico-chemical properties of milk collected a week after kidding

Table 29 shows main effects of breeds of goat on proximate composition and some physico-chemical properties of milk collected a week after kidding. Breeds of goat had no significant (p>0.05) effect on proximate composition of the milk collected a week after kidding. Physico-chemical properties such as Titratable acidity (TTA) and milk temperature was significantly influenced (p<0.05) by breed. TTA ranged between 0.26-0.44, where milk from West African Dwarf (WAD) and KalaWAD Does had highest and lowest significant (p<0.05) values respectively. Milk temperature was significantly highest (p<0.05) for KalaWAD Does with 35.43^{o}C, whereas lowest value of 33.05^{o}C was recorded for WAD Does.

Breeds of goat had no significant (p>0.05) effect of pH of milk collected.

4.26 Main effects of Turmeric powder inclusions on proximate composition and some physico-chemical properties of milk collected a week after kidding

Main effects of Turmeric powder inclusions on proximate composition and some physico-chemical properties of milk collected a week after kidding is presented in Table 30. Turmeric powder inclusion had significant effects (p<0.05) on crude protein (CP) and ash contents of the milk collected. Does fed TP-2g had highest milk CP (4.46%), while lowest CP of 3.58% was recorded for Does fed TP-0. Similarly, Does fed TP-5g recorded highest value of 1.80% for milk ash, followed by Does fed TP-0 with 1.17%, while lowest value of 0.79% was recorded for Does fed TP-2g. Turmeric powder inclusion had no significant (p>0.5) on other proximate composition parameters such as total solid, fat, lactose and solid non-fat; and physico-chemical properties such as Titratable acidity, pH and temperature of milk collected.

Table 29: Main effects of breeds of goat on proximate composition and some physico-chemical properties of milk collected a week after kidding

Parameters	**Kalahari Red**	**KalaWAD**	**West African Dwarf**	**SEM**
Total Solid (%)	19.68	20.62	18.28	0.74
Crude Protein (%)	4.46	3.87	3.99	0.16
Fat (%)	9.29	10.94	8.43	0.54
Ash (%)	1.35	1.24	1.17	0.18
Lactose (%)	4.58	4.56	4.68	0.36
Solid Non-Fat (%)	10.39	9.67	9.85	0.43
Physico-Chemical Properties				
Titratable Acidity	0.36^{ab}	0.26^{b}	0.44^{a}	0.03
pH	6.11	6.25	6.20	0.03
Temperature (^{o}C)	35.30^{a}	35.43^{a}	33.05^{b}	0.32

^{ab} Means on the same row having different superscripts are significantly different ($p<0.05$)

Table 30: Main effects of Turmeric powder inclusions on proximate composition and some physico-chemical properties of milk collected a week after kidding

Parameters	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Total Solid (%)	18.88	18.04	21.36	0.74
Crude Protein (%)	3.58^{b}	4.46^{a}	4.35^{a}	0.16
Fat (%)	8.74	8.42	11.12	0.54
Ash (%)	1.17^{ab}	0.79^{b}	1.80^{a}	0.18
Lactose (%)	5.37	4.37	4.09	0.36
Solid Non-Fat (%)	10.13	9.61	10.24	0.43
Physico-Chemical Properties				
Titratable Acidity	0.42	0.31	0.36	0.03
pH	6.22	6.18	6.14	0.03
Temperature (^{o}C)	34.28	34.53	34.74	0.32

^{ab} Means on the same row having different superscripts are significantly different ($p<0.05$)

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.27 Interaction effects of breeds of goat and Turmeric powder inclusions on proximate composition and some physico-chemical properties of milk collected a week after kidding

Table 31 shows interaction effects of breeds of goat and Turmeric powder inclusions on proximate composition and some physico-chemical properties of milk collected a week after kidding. Milk from KalaWAD fed TP-0 had highest ($p<0.05$) value for total solid (23.27%), whereas West African Dwarf (WAD) Does fed TP-0 recorded lowest value of 14.48% for same parameter. For crude protein, Kalahari Red (KR) Does fed TP-5g and TP-0 had highest and lowest ($p<0.05$) values of 5.12% and 3.47% respectively. Fat was significantly ($p<0.05$) highest and lowest for KalaWAD and WAD Does fed TP-0 with 13.51% and 4.64% respectively. Milk fat was significantly ($p<0.05$) highest and lowest for milk from WAD fed TP-5g and TP-0 with 2.30% and 0.45% respectively. KalaWAD Does fed TP-2g and TP-5g had highest and lowest ($p<0.05$) lactose with 6.80 and 2.40% respectively. Conversely, KR Does fed TP-5g and TP-2g had highest and lowest ($p<0.05$) values of 12.64 and 7.83% respectively for solid non-fat content of milk collected.

Physico-chemical properties of milk collected such as titratable acidity (TTA), pH and temperature were significantly influenced ($p<0.05$) by breeds of goats and turmeric powder inclusion. WAD and KalaWAD Does fed TP-0 had highest and lowest values of 0.65 and 0.21 respectively for TTA. Milk pH was highest and lowest for KalaWAD Does fed TP-2g and KR Does fed TP-5g with 6.28 and 6.04 respectively. Milk from KR Does fed TP-2g had highest temperature of 36.40^0C, while that of WAD Does fed TP-0 had least value of 32.37^0C.

Table 31: Interaction effects of breeds of goat and Turmeric powder inclusions on proximate composition and some physico-chemical properties of milk collected a week after kidding

Parameters	Breeds of Goat									SEM
	Kalahari Red			KalaWAD			West African Dwarf			
	TP-0	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	
Total Solid (%)	19.98^{abc}	16.27^{bc}	22.80^{a}	23.27^{a}	20.91^{ab}	17.67^{abc}	14.48^{c}	17.66^{abc}	22.70^{a}	0.74
Crude Protein (%)	3.47^{b}	4.79^{ab}	5.12^{a}	3.70^{ab}	3.92^{ab}	4.00^{ab}	3.61^{b}	4.54^{ab}	3.83^{ab}	0.16
Fat (%)	9.28^{bc}	8.44^{c}	10.16^{abc}	13.51^{a}	9.09^{c}	10.23^{abc}	4.64^{d}	7.90^{c}	12.75^{ab}	0.54
Ash (%)	1.60^{ab}	0.58^{ab}	1.87^{ab}	1.56^{ab}	1.10^{ab}	1.04^{ab}	0.45^{b}	0.76^{ab}	2.30^{a}	0.18
Lactose (%)	5.64^{ab}	2.44^{c}	5.65^{ab}	4.49^{abc}	6.80^{a}	2.40^{c}	5.78^{ab}	4.45^{abc}	3.81^{bc}	0.36
Solid Non-Fat (%)	10.71^{ab}	7.83^{b}	12.64^{a}	9.75^{ab}	11.82^{a}	7.44^{b}	9.84^{ab}	9.75^{ab}	9.95^{ab}	0.43
Physico-Chemical Properties										
Titratable Acidity	0.34^{b}	0.28^{b}	0.46^{ab}	0.21^{b}	0.28^{b}	0.28^{b}	0.65^{a}	0.36^{b}	0.32^{b}	0.03
pH	6.22^{ab}	6.07^{ab}	6.04^{b}	6.13^{ab}	6.36^{a}	6.25^{ab}	6.28^{ab}	6.16^{ab}	6.16^{ab}	0.03
Temperature (^{o}C)	34.87^{ab}	36.40^{a}	34.63^{abc}	36.05^{a}	34.35^{abc}	35.90^{a}	32.37^{c}	32.80^{bc}	33.97^{abc}	0.32

^{abcd} Means on the same row having different superscripts are significantly different ($p<0.05$)

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.28 Main effects of breeds of goat on cholesterol, somatic cell count, coliform count, microbial population and identification of milk collected a week after kidding

Table 32 shows main effects of breeds of goat on cholesterol, somatic cell count, coliform count, microbial population and identification of milk collected a week after kidding. Kalahari Red (KR) goats had highest (p<0.0.05) value for somatic cell count, the value which was $3.84x10^6$ cell/ml, followed by WAD Does with 2.94 $x10^6$cell/ml, while KalaWAD Does had the least value ($1.68x10^6$cell/ml). KalaWAD and KR Does had highest and lowest ($p<0.05$) values of 0.40 and $0.08x10^6$ CFU/ml respectively for coliform count. Goat breeds had no significant ($p<0.05$) effects on milk cholesterol level and total bacteria count. Milk collected from KR and WAD goats had *Escherichia coli* in common, whereas it was not common to milk obtained from KalaWAD. Milk collected from KR and KalaWAD goats had *Staphylococcus saprophyticus* in common, whereas it was not common to milk obtained from WAD. *Staphylococcus aureus* was common only to milk obtained from WAD, while this was not common to milk collected from KR and KalaWAD Does. Milk obtained from KalaWAD and WAD Does had *Bacillus subtilis* in common, whereas it was not common in KR milk. It was only WAD milk that had *Micrococcus specie* in common, milk obtained from KR and KalaWAD had not *Micrococcus specie* in common.

4.29 Main effects of levels of Turmeric powder inclusions on cholesterol, somatic cell count, coliform count, microbial population and identification of milk collected from goats a week after kidding

Main effects of levels of Turmeric powder inclusions on cholesterol, somatic cell count, coliform count, microbial population and identification of milk collected from goats a week after kidding is presented in Table 33. Total bacteria count (TBC) of milk collected from goats was significantly ($p<0.05$) influenced by levels of Turmeric powder inclusion. Milk from Does fed TP-0 had highest TBC value of $1.69x10^6$ CFU/ml, while Does fed TP-2g recorded the least value ($0.57x10^6$ CFU/ml) for same parameter. Milk collected from Does fed TP-0 had *Escherichia coli*, *Staphylococcus saprophyticus* and *Micrococcus specie* in common, whereas milk obtained from Does fed TP-2g and TP-5g did not have them in common. For *Staphylococcus aureus*, milk collected from Does fed TP-0 and TP-5g had it in common, while this is not common to milk obtained from Does fed TP-2g. Conversely, only the milk collected from Does fed TP-2g had *Bacillus subtilis* in common, whereas that of Does fed TP-0 and TP-5g did not have it in common.

Table 32: Main effects of breeds of goat on cholesterol, somatic cell count, coliform count, microbial population and identification of milk collected a week after kidding

Parameter	Kalahari Red	KalaWAD	WAD	SEM
Cholesterol level (mg/dl)	44.04	44.23	52.66	2.95
Somatic cell count ($x10^6$ cell/ml)	3.84^a	1.68^b	2.94^{ab}	0.36
Coliform count ($x10^6$ CFU/ml)	0.08^b	0.40^a	0.39^a	0.06
TBC ($x10^6$ CFU/ml)	0.99	1.08	1.04	0.16
Bacteria Identification				
Escherichia coli	+	-	+	
Staphylococcus saprophyticus	+	+	-	
Staphylococcus aureus	-	-	+	
Bacillus subtilis	-	+	+	
Micrococcus specie	-	-	+	

[ab] Means on the same row having different superscripts are significantly different ($p<0.05$)

EPG- Egg per gram; TBC- Total bacteria count; CFU- Coliform forming unit

+ = Present

- = Absent

Table 33: Main effects of levels of Turmeric powder inclusions on cholesterol, somatic cell count, coliform count, microbial population and identification of milk collected from goats a week after kidding

Parameters	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Cholesterol level (mg/dl)	50.48	47.72	44.22	2.95
Somatic cell count ($x10^6$ cell/ml)	2.26	2.93	3.23	0.36
Coliform count ($x10^6$ CFU/ml)	0.29	0.16	0.43	0.06
TBC ($x10^6$ CFU/ml)	1.69^a	0.57^b	0.91^b	0.16
Bacteria Identification				
Escherichia coli	+	-	-	
Staphylococcus saprophyticus	+	-	-	
Staphylococcus aureus	+	-	+	
Bacillus subtilis	-	+	-	
Micrococcus specie	+	-	-	

^{ab} Means on the same row having different superscripts are significantly different ($p<0.05$)

EPG- Egg per gram; TBC- Total bacteria count; CFU- Coliform forming unit

+ = Present

- = Absent

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.30 Interaction effects of breeds of goat kids and levels of Turmeric powder inclusions on cholesterol, somatic cell count, coliform count, microbial population and identification of milk collected a week after kidding

Table 34 shows the interaction effects of breeds of goat kids and levels of Turmeric powder inclusions on cholesterol, somatic cell count, coliform count, microbial population and identification of milk collected a week after kidding. There was interaction effect on milk cholesterol level where WAD and KalaWAD Does fed TP-0 had highest and lowest ($p<0.05$) values of 68.50 and 36.15mg/ml respectively. Coliform count ranged between 0.00-0.65x10^6 CFU/ml. Milk collected from KalaWAD fed TP-5g had highest ($p<0.05$) value, whereas milk obtained from Kalahari Red (KR) and KalaWAD Does fed TP-2g had lowest value. Milk from KR Does fed TP-0 had highest ($p<0.05$) value of 2.20x10^6 CFU/ml for total bacteria count, the value which was lowest for milk obtained from KR Does fed TP-2g. There was no significant ($p<0.05$) interaction effect on somatic cell count of milk collected from goats fed diets with different levels of Turmeric powder inclusion.

For bacteria identification, *Escherichia coli* was present in all milk samples collected from KR Does fed TP-0, WAD Does fed TP-0 and TP-5g, milk collected from Does of other dietary treatments did not have *Escherichia coli* in common. Milk collected from KR Does fed TP-0, KalaWAD Does fed TP-0; TP-2g and TP-5g; and WAD Does fed TP-0 had *Staphylococcus saprophyticus* in common, while this was not common to milk collected from KR and WAD Does fed TP-2g and TP-5g. Milk collected from KR Does fed TP-5g and WAD Does fed TP-0 had *Staphylococcus aureus* in common, where milk from other dietary treatments did not have it in common. Milk collected from KalaWAD Does fed TP-0 and WAD Does fed TP-2g had *Bacillus subtilis* in common, whereas milk from other dietary treatments did not have it in common. *Micrococcus specie* was present in all milk samples collected from KalaWAD and WAD Does fed TP-0, whereas milk obtained from other dietary treatments did not have it in common.

Table 34: Interaction effects of breeds of goat and levels of Turmeric powder inclusions on cholesterol, somatic cell count, coliform count, microbial population and identification of milk collected a week after kidding

	Kalahari Red			KalaWAD			WAD			
Parameter	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Cholesterol level (mg/dl)	46.80^{ab}	45.37^{ab}	39.97^{ab}	36.15^{b}	55.75^{ab}	40.80^{ab}	68.50^{a}	43.47^{ab}	49.97^{ab}	2.95
Somatic cell count ($x10^6$ cell/ml)	3.30	3.47	4.77	1.50	1.80	1.75	2.00	3.37	3.20	0.36
Coliform count ($x10^6$ CFU/ml)	0.07^{b}	0.00^{b}	0.17^{ab}	0.55^{ab}	0.00^{b}	0.65^{a}	0.27^{ab}	0.40^{ab}	0.47^{ab}	0.06
TBC ($x10^6$ CFU/ml)	2.20^{a}	0.17^{b}	0.60^{b}	1.35^{ab}	0.70^{b}	1.20^{ab}	1.53^{ab}	0.77^{ab}	0.92^{ab}	0.16
Bacteria Identification										
Escherichia coli	+	-	-	-	-	-	+	-	+	
Staphylococcus saprophyticus	+	-	-	+	+	+	+	-	-	
Staphylococcus aureus	-	-	+	-	-	-	+	-	-	
Bacillus subtilis	-	-	-	+	-	-	-	+	-	
Micrococcus specie	-	-	-	+	-	-	+	-	-	

[ab] Means on the same row having different superscripts are significantly different ($p<0.05$)
EPG- Egg per gram; TBC- Total bacteria count; CFU- Colony forming unit
+ = Present
- = Absent

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.31 Main effect of breeds of goat on oxidative stress markers and cortisol concentrations from mating till kidding

Main effect of breeds of goat on oxidative stress markers and cortisol concentrations from mating till kidding is presented in Table 35. Kalahari Red (KR) Does had highest ($p<0.05$) value before mating, at day 100 of pregnancy, within 24hrs post-kidding and for difference in Thiobarbituric reactive substances (TBARS) with values ranging between 6.14-7.62u/ml; 8.03-9.68u/ml; 10.80-12.93u/ml; and 3.57-6.79 respectively. KalaWAD Does had highest value before mating, while KR Does had the least. KR Does had highest values at day 100 of pregnancy, within 24hrs post-kidding and for TBARS difference. WAD Does had lowest values for TBARS at the respective periods. For superoxide dismutase (SOD), KR Does had highest ($p<0.09$) values for all periods of measurement except for SOD difference where it had the lowest ($p<0.05$) value of -6.44u/ml, while KalaWAD Does had highest value (0.50u/ml). SOD values for KR before mating; at 1st and 2nd trimesters; and within 24hrs post-kidding were 42.10, 40.08, 41.43 and 35.65u/ml respectively, whereas KalaWAD recorded least values of 27.60, 30.97, 33.17 and 28.10u/ml for respective periods. WAD Does had the highest ($p<0.05$) values of 49.29 and 47.54u/ml respectively for glutathione peroxidase (GSH-Px) at 1st and 2nd trimesters. KR Does had the lowest values of 40.49 and 40.63u/ml at the respective periods. KalaWAD Does recorded highest ($p<0.05$) value of 6.98ng/ml for cortisol before mating of the Does was done, while WAD Does had the lowest value (5.82ng/ml). WAD Does had highest significant ($p<0.05$) values of 9.39, 6.42 and 0.60ng/ml for cortisol levels at 1st trimester, within 24hrs post-kidding and for difference respectively. Least values of 8.00, 5.02 and -1.78 was recorded for KR in the respective period.

Breeds of goat had no significant ($p>0.05$) effect on glutathione (GSH) at any of the periods for which other oxidative stress markers were evaluated.

Table 35: Main effect of breeds of goat on oxidative stress markers and cortisol concentrations from mating till kidding

Parameters	Kalahari Red	KalaWAD	WAD	SEM
Thiobarbituric Acid Reactive Substance (TBARS, u/ml)				
Before mating	6.14^{b}	7.62^{a}	7.23^{a}	0.33
1^{st} Trimester (day 50)	8.35	8.36	7.63	0.16
2^{nd} Trimester (day 100)	9.68^{a}	9.32^{a}	8.03^{b}	0.24
Within 24hrs post-kidding	12.93^{a}	12.57^{a}	10.80^{b}	0.48
Difference	6.79^{a}	4.95^{b}	3.57^{b}	0.41
Superoxide Dismutase (SOD, u/ml)				
Before mating	42.10^{a}	27.60^{c}	33.36^{b}	1.34
1^{st} Trimester (day 50)	40.08^{a}	30.97^{b}	38.76^{a}	1.06
2^{nd} Trimester (day 100)	41.43^{a}	33.17^{b}	36.82^{b}	1.03
Within 24hrs post-kidding	35.65^{a}	28.10^{b}	29.35^{b}	0.93
Difference	-6.44^{b}	0.50^{a}	-4.01^{b}	0.97
Glutathione Peroxidase (GSH-Px, u/ml)				
Before mating	40.79	43.71	43.90	0.82
1^{st} Trimester (day 50)	40.49^{b}	47.35^{a}	49.29^{a}	1.18
2^{nd} Trimester (day 100)	40.63^{b}	46.26^{a}	47.54^{a}	1.05
Within 24hrs post-kidding	39.24	41.19	37.83	0.91
Difference	-1.56	-2.52	-6.07	1.14
Glutathione (GSH, u/ml)				
Before mating	25.21	21.23	22.93	0.80
1^{st} Trimester (day 50)	26.50	23.58	28.08	0.97
2^{nd} Trimester (day 100)	27.71	24.99	28.16	0.88
Within 24hrs post-kidding	24.58	20.83	23.61	0.77
Difference	-0.63	-0.40	-0.68	0.81
Cortisol (ng/ml)				
Before mating	6.80^{a}	6.98^{a}	5.82^{b}	0.17
1^{st} Trimester (day 50)	8.00^{b}	8.29^{b}	9.39^{a}	0.21
2^{nd} Trimester (day 100)	10.02	10.24	10.78	0.21
Within 24hrs post-kidding	5.02^{b}	5.54^{b}	6.42^{a}	0.16
Difference	-1.78^{b}	-1.45^{b}	0.60^{a}	0.28

[abc]Means on the same row having different superscripts are significantly different ($p<0.05$)
Difference= Values within 24hrs post-kidding less Before mating

4.32 Main effect of levels of Turmeric powder inclusions on oxidative stress markers and cortisol concentrations of goat from mating till kidding

Table 36 shows main effect of levels of Turmeric powder inclusions on oxidative stress markers and cortisol concentrations of goat from mating till kidding. Level of Turmeric powder inclusion had significant ($p<0.05$) effect on some oxidative stress markers such SOD, GSH-Px and GSH whereas it had no significant effect on TBARS and Cortisol levels of the goats. SOD difference in values within 24hrs post-kidding and before mating was highest for Does fed TP-2g with -1.21u/ml, while Does fed TP-0 recorded the lowest value (-6.99u/ml). GSH-Px value recorded within 24hrs post-kidding was significantly ($p<0.05$) influenced where Does fed TP-5g had highest value of 41.48u/ml, while Does fed TP-0 had lowest value (36.48u/ml). GSH-Px difference was significantly ($p<0.05$) highest and lowest for Does fed TP-2g and TP-0 with -0.85 and -8.06u/ml respectively. GSH was highest before mating for Does fed TP-2g with 24.96u/ml, while Does fed TP-0 had the lowest value of 20.25u/ml. Similarly, Does fed TP-2g had highest values for GSH at 1st and 2nd trimesters; and for the difference with 29.37, 29.76 and 26.18u/ml respectively. Does fed TP-5g recorded lowest value at 1st trimester (22.37u/ml) and 2nd trimester (23.26u/ml), while lowest value of 20.31u/ml was recorded for Does fed TP-0. GSH difference ranged between -3.85 to 2.28u/ml, where Does fed TP-5g and TP-0 had highest and lowest ($p<0.05$) values respectively.

Table 36: Main effect of levels of Turmeric powder inclusions on oxidative stress markers and cortisol concentrations of goat from mating till kidding

Parameters	TP-0	TP-2g	TP-5g	SEM
Thiobarbituric Acid Reactive Substance (TBARS, u/ml)				
Before mating	6.71	7.12	7.17	0.19
1st Trimester (day 50)	8.38	7.91	8.05	0.16
2nd Trimester (day 100)	8.35	9.18	9.50	0.24
Within 24hrs post-kidding	12.63	11.18	12.48	0.33
Difference	5.92	4.07	5.32	0.41
Superoxide Dismutase (SOD, u/ml)				
Before mating	36.62	33.47	32.97	1.35
1st Trimester (day 50)	34.63	39.47	35.72	1.06
2nd Trimester (day 100)	38.52	37.22	35.68	1.03
Within 24hrs post-kidding	29.63	32.26	31.22	0.92
Difference	-6.99^{b}	-1.21^{a}	-1.76^{a}	0.97
Glutathione Peroxidase (GSH-Px, u/ml)				
Before mating	44.54	41.14	42.72	0.82
1st Trimester (day 50)	45.53	43.90	47.71	1.18
2nd Trimester (day 100)	45.37	42.73	46.32	1.05
Within 24hrs post-kidding	36.48^{b}	40.29^{ab}	41.48^{a}	0.91
Difference	-8.06^{b}	-0.85^{a}	-1.24^{a}	1.14
Glutathione (GSH, u/ml)				
Before mating	24.16^{a}	24.96^{a}	20.25^{b}	0.80
1st Trimester (day 50)	26.43^{ab}	29.37^{a}	22.37^{b}	0.97
2nd Trimester (day 100)	27.83^{a}	29.76^{a}	23.26^{b}	0.88
Within 24hrs post-kidding	20.31^{b}	26.18^{a}	22.53^{b}	0.77
Difference	-3.85^{b}	1.22^{a}	2.28^{a}	0.81
Cortisol (ng/ml)				
Before mating	6.25	6.55	6.80	0.15
1st Trimester (day 50)	8.91	8.64	8.13	0.21
2nd Trimester (day 100)	10.50	10.68	9.85	0.22
Within 24hrs post-kidding	6.00	5.40	5.57	0.17
Difference	-0.25	-1.15	-1.23	0.20

^{ab} Means on the same row having different superscripts are significantly different ($p<0.05$)

Difference= Values within 24hrs post-kidding less Before mating

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.33 Interaction effects of breeds of goat and levels of Turmeric powder inclusions on oxidative stress markers and cortisol from mating till kidding

Interaction effects of breeds of goat and levels of Turmeric powder inclusions on oxidative stress markers and cortisol from mating till kidding is presented in Table 37. KalaWAD and Kalahari Red (KR) Does placed under TP-2g had highest and lowest ($p<0.05$) values of 8.15u/ml and 5.55u/ml respectively for TBARS before mating was done. KalaWAD Does fed TP-2g had highest ($p<0.05$) value of 9.00u/ml for TBARS in 1st trimester, while WAD Does fed TP-2g had least value (6.95u/ml) for same parameter. TBARS range of 7.65-10.60u/ml was recorded at 2nd trimester where KR Does fed TP-5g and WAD Does fed TP-2g had highest and lowest ($p<0.05$) values respectively. KalaWAD Does fed TP-0 had highest significant ($p<0.05$) value of 13.80u/ml for TBARS taken within 24hrs post-kidding, the value (10.55u/ml) which was least for WAD Does fed TP-2g. Difference in TBARS within 24hrs post-kidding and before mating ranged between 2.70-7.17u/ml where KR Does fed TP-0 and KalaWAD Does fed TP-2g had highest and lowest ($p<0.05$) values respectively.

SOD values before mating; at 1st and 2nd trimesters; within 24hrs post-kidding; and the difference ranged between 27.31-44.58u/ml, 27-52-44.56u/ml, 32.02-45.55u/ml, 27.06-39.73u/ml and -13.15 to 1.91u/ml respectively. KR Does fed TP-2g had highest ($p<0.05$) values for SOD before mating, 1st and 2nd trimesters, and within 24hrs post-kidding. KalaWAD Does fed TP-5g had lowest values before mating and at 2nd trimester, whereas KalaWAD Does fed TP-0 had lowest values at 1st trimester and within 24hrs post-kidding. KalaWAD Does fed TP-5g had highest ($p<0.05$) value for SOD difference, while KR Does fed TP-0 recorded the least value for same parameter.

WAD Does fed TP-0 had highest ($p<0.05$) values for GSH-Px at 1st and 2nd trimesters with 53.29 and 51.20u/ml respectively, while KR Does fed TP-0 had least value of 36.90 and

37.07u/ml for respective period of pregnancy. GSH-Px determined within 24hrs post-kidding was significantly ($p<0.05$) influenced, where KR Does fed TP-2g had highest value (43.59u/ml), while KR Does fed TP-0 had the lowest value of 32.13u/ml for same parameter. GSH-Px difference ranged between -11.91 to 5.41u/ml, where KR Does fed TP-2g and TP-0 had highest and lowest ($p<0.05$) values respectively. Interaction had no significant ($p<0.05$) effect on GSH-Px value before mating of the Does was done.

GSH was significantly ($p<0.05$) influenced by interaction of breeds of goat and levels of Turmeric powder inclusion where values ranging from 19.40-30.36u/ml, 20.79-31.67u/ml, 22.52-33.49u/ml, 18.78-31.21u/ml and -5.92 to 3.67u/ml were recorded before mating; at 1st and 2nd trimesters; within 24hrs post-kidding; and for the difference respectively. KR Does placed under TP-2g and KalaWAD Does placed under TP-5g had highest and lowest values respectively. KR Does fed TP-2g had highest values at 1st trimester and within 24hrs post-kidding, while KR Does fed TP-5g and KalaWAD fed TP-0 had the least value at the respective period for same parameters. WAD Does fed TP-0 and KalaWAD Does fed TP-5g had highest and lowest values at 2nd trimester respectively. For GSH difference, WAD Does fed TP-5g had highest value, while KR Does fed TP-0 recorded least value.

KR Does placed under TP-5g had highest ($p<0.05$) value of 7.50ng/ml for cortisol before mating, whereas WAD Does placed under TP-0 had had the least value (5.40ng/ml). WAD Does fed TP-0 had highest ($p<0.05$) values of 10.00, 6.65 and 1.25ng/ml for cortisol at 1st trimester, within 24hrs post-kidding and cortisol difference respectively. KalaWAD Does fed TP-5g had least value at 1st trimester (7.19ng/ml), KR Does fed TP-5g recorded least values within 24hrs post-kidding (4.57ng/ml) and for cortisol difference (-2.93ng/ml).

There was no significant ($p>0.05$) influence of interaction on cortisol level at 2nd trimester.

Table 37: Interaction effects of breeds of goat and levels of Turmeric powder inclusions on oxidative stress markers and cortisol from mating till kidding

	Kalahari Red			KalaWAD			West African Dwarf			
Parameters	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Thiobarbituric Acid Reactive Substance (TBARS, u/ml)										
Before mating	5.93^{bc}	5.55^{e}	6.95^{ab}	7.15^{ab}	8.15^{a}	7.55^{a}	7.05^{ab}	7.65^{a}	7.00^{ab}	0.19
1st Trimester (day 50)	8.30^{abc}	7.76^{bcd}	8.99^{a}	8.20^{abc}	9.00^{a}	7.86^{bcd}	8.65^{ab}	6.95^{d}	7.30^{cd}	0.16
2nd Trimester (day 100)	8.75^{abc}	9.70^{ab}	10.60^{a}	8.55^{bc}	10.20^{ab}	9.20^{abc}	7.75^{c}	7.65^{c}	8.70^{bc}	0.24
Within 24hrs PK	13.10^{abc}	12.15^{abc}	13.55^{ab}	13.80^{a}	10.85^{c}	13.05^{abc}	11.00^{bc}	10.55^{c}	10.85^{c}	0.33
Difference	7.17^{a}	6.60^{ab}	6.60^{ab}	6.65^{ab}	2.70^{c}	5.50^{abc}	3.95^{bc}	2.90^{c}	3.85^{bc}	0.41
Superoxide Dismutase (SOD, u/ml)										
Before mating	44.58^{a}	44.05^{a}	37.65^{b}	27.81^{c}	27.68^{c}	27.31^{c}	37.46^{b}	28.67^{c}	33.96^{b}	1.35
1st Trimester (day 50)	37.46^{b}	44.56^{a}	38.24^{b}	27.52^{d}	35.03^{bc}	30.35^{cd}	38.91^{b}	38.82^{b}	38.56^{b}	1.06
2nd Trimester (day 100)	39.68^{abc}	45.55^{a}	39.05^{bc}	33.57^{cd}	32.02^{d}	33.93^{cd}	42.32^{ab}	34.08^{cd}	34.06^{cd}	1.03
Within 24hrs PK	31.43^{bc}	39.73^{a}	35.79^{ab}	27.06^{c}	28.02^{c}	29.22^{c}	30.39^{bc}	29.03^{c}	28.63^{c}	0.93
Difference	-13.15^{e}	-4.32^{bcd}	-1.85^{abc}	-0.75^{abc}	0.33^{ab}	1.91^{a}	-7.07^{d}	0.36^{ab}	-5.33^{cd}	0.97
Glutathione Peroxidase (GSH-Px, u/ml)										
Before mating	44.04	38.18	40.15	44.85	42.40	43.88	44.71	42.84	44.13	0.82
1st Trimester (day 50)	36.90^{e}	38.86^{de}	45.72^{bcd}	46.41^{abc}	49.68^{abc}	45.95^{bcd}	53.29^{a}	43.15^{cde}	51.44^{ab}	1.18
2nd Trimester (day 100)	37.07^{c}	40.09^{bc}	44.72^{abc}	47.84^{ab}	45.02^{abc}	45.91^{ab}	51.20^{a}	43.08^{abc}	48.34^{ab}	1.05
Within 24hrs PK	32.13^{b}	43.59^{a}	41.98^{a}	40.73^{a}	41.09^{a}	41.76^{a}	36.57^{ab}	36.20^{ab}	40.70^{a}	0.91
Difference	-11.91^{d}	5.41^{a}	-1.83^{ab}	-4.12^{bc}	-1.31^{abc}	-2.12^{bc}	-8.14^{cd}	-6.64^{cd}	-3.43^{bc}	1.14
Glutathione (GSH, u/ml)										
Before mating	25.43^{ab}	30.36^{a}	19.85^{b}	22.39^{b}	21.89^{b}	19.40^{b}	24.66^{ab}	22.62^{b}	21.50^{b}	0.80
1st Trimester (day 50)	27.03^{abc}	31.67^{a}	20.79^{c}	22.61^{bc}	26.95^{abc}	21.18^{c}	29.64^{ab}	29.47^{ab}	25.13^{abc}	0.97
2nd Trimester (day 100)	26.70^{bc}	33.36^{a}	23.05^{c}	23.30^{c}	29.14^{ab}	22.52^{c}	33.49^{a}	26.78^{bc}	24.20^{c}	0.88
Within 24hrs PK	19.51^{cd}	31.21^{a}	23.02^{bc}	18.78^{d}	24.32^{b}	19.38^{ed}	22.66^{bc}	23.00^{bc}	25.18^{b}	0.77
Difference	-5.92^{c}	0.85^{ab}	3.17^{a}	-3.61^{bc}	2.43^{ab}	-0.02^{abc}	-2.00^{abc}	0.38^{abc}	3.67^{a}	0.81
Cortisol (ng/ml)										
Before mating0	6.45^{abc}	6.45^{abc}	7.50^{a}	6.90^{ab}	6.85^{ab}	7.20^{a}	5.40^{c}	6.35^{abc}	5.70^{bc}	0.17
1st Trimester (day 50)	8.00^{bc}	8.20^{bc}	7.80^{bc}	8.74^{abc}	8.95^{ab}	7.19^{c}	10.00^{a}	8.77^{abc}	9.39^{ab}	0.21
2nd Trimester (day 100)	10.15	9.90	10.00	10.66	10.35	9.70	10.70	11.80	9.85	0.22
Within 24hrs PK	5.60^{abc}	4.90^{bc}	4.57^{c}	5.75^{abc}	5.26^{bc}	5.60^{abc}	6.65^{a}	6.05^{ab}	6.55^{a}	0.17
Difference	-0.85^{b}	-1.55^{bc}	-2.93^{c}	-1.15^{b}	-1.59^{bc}	-1.60^{bc}	1.25^{a}	-0.30^{ab}	0.85^{a}	0.87

^{abcdef}Means on the same row having different superscripts are significantly different (p<0.05). Difference= Values within 24hrs post-kidding less Before mating PK is Post-Kidding

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.34 Main effects of breeds of goat on haematological parameters

Table 38 shows the main effects of breeds of goat on haematological parameters. Breeds of goat had significant ($p<0.05$) effects on some haematological parameters such haemoglobin (Hb), Red blood cells (RBC), White blood cells (WBC), Eosinophil (Eos), Basophils (Bas), Monocytes (Mo), Packed cell volume (PCV), Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Volume (MCV) and Mean Corpuscular haemoglobin Concentration (MCHC). Hb at the final stage of the study revealed that KalaWAD and West African Dwarf (WAD) Does had higher statistically similar ($p<0.05$) values of 11.37 and 10.95g/l respectively. The value which was least (8.68g/l) for Kalahari Red (KR) Does. The difference between the Hb at the final and initial stages of the study revealed that KalaWAD Does had highest significant ($p<0.05$) value, where they gained additional 1.29g/l, whereas KR Does lost 1.58g/l of Hb. The initial RBC of the goats was significant ($p<0.05$), where KalaWAD and KR had highest (16.44×10^{12}/l) and least (10.92×10^{12}/l) respectively. WAD Does had the highest significant ($p<0.05$) final RBC of 8.14×10^{12}/l, followed by KalaWAD (7.77×10^{12}/l), while KR had the least value (6.34×10^{12}/l). The difference in the RBC values of the goats at the final and initial stages of the study indicated that all the goat breeds had significant ($p<0.05$) reduction in their RBC. WAD Does had the least ($p<0.05$) reduction of 2.99×10^{12}/l, followed by KR (4.41×10^{12}/l) and KalaWAD with the highest reduction value (8.67×10^{12}/l).

Similarly, the WBC of the goats was significant ($p<0.05$) at the start of the study where KalaWAD and WAD Does had highest (11.15×10^{9}/l) and least (7.86×10^{9}/l) values respectively. KR Does had highest ($p<0.05$) value of 11.38×10^{9}/l for WBC at the end of the study, while WAD Does had the least value (9.43×10^{9}/l). The goats' breed also had significant ($p<0.05$) effect on WBC difference at the final and initial stages of the study. There was an increase in WBC of KR at the final stage by 4.35×10^{9}/l, whereas KalaWAD had a reduction by 1.30×10^{9}/l. Final Eos ranged between 0.22-0.92%, where KalaWAD had highest value, followed by KR (0.71%) and least for WAD Does. The difference in Eos at the final and initial stages of the study revealed that KalaWAD had significant ($p<0.05$) increase in the value of Eos of 0.36%, while WAD had the highest reduction of 0.61%. Final Bas value ranged between 0.25-0.79%. KR and KalaWAD Does had the highest and least values respectively. KR had significant ($p<0.05$) increase in the value (0.48%) of Bas compared with KalaWAD that had reduction of 0.19% at the end of the study. KalaWAD had highest significant ($p<0.05$) Mo value (1.71%), followed by KR (1.22%) and WAD Does with the least value (0.78%). For difference in the Mo values at the final and initial stages of the study, KalaWAD had significant ($p<0.05$) increase of 0.15%, while WAD recorded the highest reduction (0.97%)

PCV taken at the final stage of the study was significantly influenced by the breeds of goats, where KalaWAD and KR Does had significant ($p<0.05$) highest and lowest values of 33.92% and 27.25% respectively. The difference in the PCV values at the final and initial stages of the study was also significantly ($p<0.05$) influenced by goats' breeds. KalaWAD had increase in PCV value with 3.81%, while KR had reduced value with 7.04%. Percent MCH taken at the beginning of the study was significantly influenced ($p<0.05$) by breeds of goat. The value was highest and lowest for KR and KalaWAD with 10.12g/mg and 6.20g/mg respectively. There was a significant increase ($p<0.05$) in MCH at the end of the study, KalaWAD had highest value of 9.20g/mg, while WAD recorded the least value with 4.03g/mg. KalaWAD had highest MCHC at the final stage with 33.51pg, while KR had the least value (31.82pg) for same parameter. MCV ranged between 18.53-30.43fl at the beginning of the study. KR and KalaWAD Does had the highest and lowest ($p<0.05$) values respectively. On the other hand, the difference in the MCV at the final and initial stages was significantly influenced ($p<0.05$) by goats' breeds, where KalaWAD had the highest value (27.38fl) with WAD recording the least (13.55fl).

Table 38: Main effects of breeds of goat on haematological parameters

Parameters	Kalahari Red	KalaWAD	WAD	SEM
Haemoglobin (g/l)				
Initial	11.04	10.08	10.89	0.23
Final	8.68^{b}	11.37^{a}	10.95^{a}	0.25
Difference	**-1.58^{b}**	**1.29^{a}**	**0.06^{a}**	**0.34**
Red Blood Cells ($\times 10^{12}$/l)				
Initial	10.92^{b}	16.44^{a}	11.13^{b}	0.57
Final	6.34^{b}	7.77^{a}	8.14^{a}	0.31
Difference	**-4.41^{a}**	**-8.67^{b}**	**-2.99^{a}**	**0.57**
White blood cells ($\times 10^{9}$/l)				
Initial	8.18^{b}	11.15^{a}	7.86^{b}	0.41
Final	11.38^{a}	9.86^{ab}	9.43^{b}	0.40
Difference	**4.35^{a}**	**-1.30^{c}**	**1.57^{b}**	**0.62**
Neutrophil (%)				
Initial	32.79	31.55	31.75	0.61
Final	32.38	31.67	32.22	0.84
Difference	**-1.58**	**0.11**	**0.47**	**0.95**
Lymphocytes (%)				
Initial	64.04	65.78	65.17	0.62
Final	64.90	63.33	66.56	0.81
Difference	**1.79**	**-2.44**	**1.39**	**1.05**
Eosinophil (%)				
Initial	0.79	0.55	0.83	0.10
Final	0.71^{a}	0.92^{a}	0.22^{b}	0.11
Difference	**-0.08^{a}**	**0.36^{a}**	**-0.61^{b}**	**0.12**
Basophils (%)				
Initial	0.33	0.44	0.50	0.10
Final	0.79^{a}	0.25^{b}	0.67^{ab}	0.10
Difference	**0.48^{a}**	**-0.19^{b}**	**0.17^{ab}**	**0.15**
Monocytes (%)				
Initial	2.04	1.55	1.75	0.14
Final	1.22^{ab}	1.71^{a}	0.78^{b}	0.15
Difference	**-0.71^{ab}**	**0.15^{a}**	**-0.97^{b}**	**0.21**
Packed Cell Volume (%)				
Initial	33.25	30.11	32.58	0.74
Final	27.25^{b}	33.92^{a}	33.89^{a}	0.72
Difference	**-7.04^{b}**	**3.81^{a}**	**1.31^{a}**	**1.42**
MCH (g/mg)				
Initial	10.12^{a}	6.20^{b}	9.89^{a}	0.36
Final	14.39	15.41	13.93	0.58
Difference	**5.33^{b}**	**9.20^{a}**	**4.03^{b}**	**0.71**
MCHC (pg)				
Initial	33.25	33.53	33.47	0.15
Final	31.82^{b}	33.51^{a}	32.34^{b}	0.22
Difference	**-1.18**	**-0.02**	**-1.13**	**0.24**
MCV (fl)				
Initial	30.43^{a}	18.53^{b}	29.54^{a}	1.09
Final	44.94	45.91	43.09	1.66
Difference	**17.36^{b}**	**27.38^{a}**	**13.55^{b}**	**2.00**

[ab] Means on the same row having different superscripts are significantly different ($p<0.05$)

MCH= Mean Corpuscular Haemoglobin: MCV= Mean Corpuscular Volume
MCHC= Mean Corpuscular haemoglobin Concentration

4.35 Main effect of levels of Turmeric powder inclusions on haematological parameters of goats

Table 39 shows main effect of levels of Turmeric powder inclusions on haematological parameters of goats. The inclusion of Turmeric powder in the concentrate diets of goats had significant ($p<0.05$) effects on some haematological parameters such as Red blood cell (RBC), White blood cells (WBC), Neutrophils, Mean corpuscular haemoglobin (MCH) and Mean corpuscular volume (MCV). The RBC at the final stage was significantly influenced ($p<0.05$) by goats' breeds where Turmeric powder included at 2g/kg concentrate (TP-2g) recorded the highest value of 8.38×10^{12}/l, whereas Turmeric powder included at 5g/kg concentrate (TP-5g) had the least value (6.83×10^{12}/l). Similarly, WBC was significantly ($p<0.05$) influenced. TP-0 and TP-2g had the highest and least values of 11.04×10^{9}/l and 8.92×10^{9}/l respectively. The neutrophil at the initial stage ranged between 30.03-33.07%, where concentrate diet without Turmeric powder (TP-0) and TP-5g recorded highest and lowest values respectively. For difference in percent neutrophils at the final and initial stages, TP-5g had the highest significant ($p<0.05$) value of 3.16%, while TP-2g had reduction in same parameter with 2.23%. Mean corpuscular haemoglobin (MCH) was significantly ($p<0.05$) influenced at the final stage, where TP-5g had the highest value (15.89g/mg) and TP-2g had the least value of 12.56g/mg. The Mean corpuscular volume (MCV) was significantly influenced ($p<0.05$) by goats' breeds at the final stage and the difference between the final and initial stages of the study. Final MCV ranged between 39.03-48.96fl, while the difference ranged between 13.70-24.06fl. TP-5g and TP-2g recorded the highest and lowest values for MCV and its difference.

Table 39: Main effect of levels of Turmeric powder inclusions on haematological parameters of goats

Parameters	TP-0	TP-2g	TP-5g	SEM
Haemoglobin (g/l)				
Initial	10.72	10.92	10.35	0.21
Final	10.34	10.13	10.56	0.25
Difference	**-0.38**	**-0.41**	**0.56**	**0.34**
Red Blood Cells ($\times 10^{12}$/l)				
Initial	13.39	12.67	12.51	0.53
Final	6.92^{b}	8.38^{a}	6.83^{b}	0.29
Difference	**-6.46**	**-4.08**	**-5.72**	**0.57**
White blood cells ($\times 10^{9}$/l)				
Initial	9.37	8.76	9.11	0.37
Final	11.04^{a}	8.92^{b}	10.89^{a}	0.38
Difference	**1.66**	**0.80**	**2.24**	**0.62**
Neutrophil (%)				
Initial	33.07^{a}	33.00^{a}	30.03^{b}	0.60
Final	31.17	31.29	33.80	0.79
Difference	**-1.91^{b}**	**-2.23^{b}**	**3.16^{a}**	**0.95**
Lymphocytes (%)				
Initial	64.17	64.28	66.53	0.60
Final	66.61	65.06	63.25	0.77
Difference	**2.44**	**1.02**	**-2.61**	**1.05**
Eosinophil (%)				
Initial	0.76	0.55	0.89	0.10
Final	0.54	0.52	0.78	0.10
Difference	**-0.21**	**0.05**	**-0.19**	**0.12**
Basophils (%)				
Initial	0.44	0.42	0.42	0.09
Final	0.65	0.40	0.68	0.09
Difference	**0.21**	**0.09**	**0.26**	**0.15**
Monocytes (%)				
Initial	1.56	1.74	2.03	0.13
Final	1.15	1.23	1.32	0.15
Difference	**-0.41**	**-0.43**	**-0.68**	**0.21**
Packed Cell Volume (%)				
Initial	32.01	32.70	31.17	0.68
Final	31.11	31.45	32.57	0.70
Difference	**-0.90**	**-0.26**	**2.51**	**0.97**
MCH (g/mg)				
Initial	8.50	8.80	8.89	0.34
Final	15.52^{a}	12.56^{b}	15.89^{a}	0.55
Difference	**7.02**	**4.15**	**7.63**	**0.71**
MCHC (pg)				
Initial	33.60	33.41	33.25	0.14
Final	33.25	32.19	32.31	0.21
Difference	**-0.35**	**-1.06**	**-0.85**	**0.24**
MCV (fl)				
Initial	25.43	26.33	26.67	1.02

Final	46.58^a	39.03^b	48.96^a	1.57
Difference	**21.15^{ab}**	**13.70^b**	**24.06^a**	**2.00**

^{ab} Means on the same row having different superscripts are significantly different ($p<0.05$)
MCH= Mean Corpuscular Haemoglobin: MCV= Mean Corpuscular Volume (MCV):
MCHC= Mean Corpuscular haemoglobin Concentration (MCHC)

4.36 Interaction effects of breeds of goat and levels of Turmeric powder inclusions on haematological parameters

Interaction effects of breeds of goat and levels of Turmeric powder inclusions on haematological parameters are presented in Table 40. The interaction effects had significant influence ($p<0.05$) on all the haematological parameters determined. KalaWAD Does fed TP-5g had highest ($p<0.05$) value (12.17g/l) and increase (2.31g/l) for final and difference in Haemoglobin respectively, while least value of 8.47g/l was recorded for Kalahari Red (KR) fed TP-5g with KR fed TP-0 having the highest reduction (2.25g/l) in the Hb difference. Interaction effects had significant effects ($p<0.05$) on Red blood cells (RBC) at the initial and final stages of the study and their difference. RBC at the initial stage ranged between 10.02-17.20×10^{12}/l, 4.95-9.89×10^{12}/l at the final stage, while the range for the difference was -10.61 to -2.88×10^{12}/l. KalaWAD under TP-0 had the highest value at the initial stage, while WAD under TP-5g had the least value. At the final stage, KalaWAD fed TP-2g and KR fed TP-0 had the highest and lowest values respectively. RBC difference was highest for WAD fed TP-2g, while KalaWAD fed TP-0 recorded the lowest difference. KalaWAD placed under TP-5g had highest (11.93×10^9/l) significant ($p<0.05$) value for white blood cells (WBC) at the initial stage, while WAD placed under TP-5g had the lowest value of 7.05×10^9/l. Conversely, KR fed TP-0 and KalaWAD fed TP-2g had highest (14.40×10^9/l and 7.15×10^9/l) and lowest (7.51×10^9/l and -2.55×10^9/l) values for WBC at the final stage and the difference respectively.

Interaction effects are also noted for neutrophils at the initial and final stages including their difference. KR placed under TP-2g and TP-5g had highest and lowest significant ($p<0.05$) values of 37% and 28.50% at initial stage respectively. Whereas, KalaWAD fed TP-5g recorded highest significant ($p<0.05$) values at the final stage (38.75%) and neutrophils difference (7.41%). KalaWAD and KR fed TP-2g had lowest ($p<0.05$) values at final stage

(25.50%) and difference (-4.60%) respectively. Lymphocytes at the initial and final stages with their difference ranged between 60-68.67%, 57.75-68.67% and -7.58-5.40% respectively. KalaWAD and KR placed under TP-2g recorded highest and lowest ($p<0.05$) values at initial stage respectively. WAD fed TP-0 and KalaWAD fed TP-2g had highest and lowest ($p<0.05$) values at final stage respectively. For lymphocytes difference, KR fed TP-2g had highest ($p<0.05$) value, while KalaWAD fed TP-5g had least value. KR fed TP-0 had highest ($p<0.05$) value of 1.50% for eosinophil at the final stage, while KR fed TP-2g and WAD fed TP-0 had 0% for same parameter. KalaWAD fed TP-2g and WAD fed TP-0 recorded highest and lowest ($p<0.05$) values of 0.71% and -1.00% respectively for eosinophil difference. Basophils at the initial and final stages and their difference had values ranged between 0-1%, 0-1% and -0.62-1% respectively. KalaWAD placed under TP-5g recorded highest ($p<0.05$) value at the initial stage, while KR placed under TP-5g and KalaWAD placed under TP-2g had lowest value for same parameter. At the final stage KR fed TP-0 and TP-5g recorded highest ($p<0.05$) value, while KalaWAD fed TP-2g had the lowest value. KR fed TP-5g had highest ($p<0.05$) value for basophils difference, while KalaWAD fed TP-5g had the least value.

Packed cell volume (PCV) was significantly ($p<0.05$) influenced at the final stage and difference between final and initial stages. KalaWAD fed TP-5g had highest values at the final stage (36.37%) and the difference (6.37%). KR fed TP-0.g recorded least value at the final stage and PCV difference with 25.50% and -7% respectively. Mean corpuscular haemoglobin (MCH) ranged between 5.75-10.49g/mg, 10.87-17.96g/mg and 2.35-12.07g/mg at the initial stage, final stage and their difference respectively. KalaWAD placed under TP-0 and KR placed under TP-5g recorded lowest and highest ($p<0.05$) values respectively. KalaWAD fed TP-5g had highest ($p<0.05$) values at the final stage and MCH difference. KalaWAD fed TP-2g and WAD fed TP-0 had least ($p<0.05$) values for MCH at final stage and its difference respectively. KalaWAD placed under TP-0 and KR placed under TP-5g had highest (34.50pg) and lowest (32.82pg) significant values ($p<0.05$) for mean corpuscular haemoglobin concentration (MCHC) at the beginning of the study. Similarly, KalaWAD fed TP-0 had highest ($p<0.05$) value of 34.14pg for MCHC at final stage, while KR fed TP-2g had the least value (31.06pg). MCHC difference ranged between -2.21-0.55pg, where KR fed TP-2g and KalaWAD fed TP-5g recorded highest and lowest ($p<0.05$) values respectively. The mean corpuscular volume (MCV) at the initial stage ranged between 16.67-31.95fl, KR placed under TP-5g and KalaWAD placed under TP-0 had highest and lowest values respectively. KalaWAD fed TP-5g had highest ($p<0.05$) values at the final stage (53.67fl) and MCV difference (35.79fl). KalaWAD fed TP-2g and WAD fed TP-0 had lowest ($p<0.05$) values MCV at final stage (33.04fl) and the difference (7.98fl).

Table 40: Interaction effects of breeds of goat and levels of Turmeric powder inclusions on haematological parameters

	Kalahari Red			**KalaWAD**			**West African Dwarf**			
Parameters	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Haemoglobin (g/l)										
Initial	10.75	11.25	11.00	9.87	10.50	9.87	11.55	10.92	10.20	0.21
Final	8.50^{b}	8.97^{b}	8.47^{b}	11.18^{a}	10.75^{a}	12.17^{a}	10.87^{a}	10.97^{a}	11.03^{a}	0.25
Difference	**-2.25^{c}**	**-1.29^{bc}**	**-1.45^{bc}**	**1.32^{ab}**	**0.25^{abc}**	**2.31^{a}**	**-0.68^{bc}**	**0.04^{abc}**	**0.83^{ab}**	**0.34**
Red Blood Cells ($\times10^{12}$/l)										
Initial	10.65^{b}	11.40^{b}	10.55^{b}	17.20^{a}	15.17^{a}	16.97^{a}	11.62^{b}	11.75^{b}	10.02^{b}	0.53
Final	4.95^{c}	6.77^{bc}	6.83^{bc}	6.59^{c}	9.89^{a}	6.84^{bc}	8.73^{ab}	8.87^{a}	6.83^{bc}	0.29
Difference	**-5.70^{a}**	**-4.08^{a}**	**-3.85^{a}**	**-10.61^{b}**	**-5.28^{a}**	**-10.13^{b}**	**-2.89^{a}**	**-2.88^{a}**	**-3.19^{a}**	**0.57**
White blood cells ($\times10^{9}$/l)										
Initial	7.25^{d}	8.60^{cd}	8.35^{cd}	11.47^{ab}	10.07^{abc}	11.93^{a}	8.87^{bcd}	7.65^{cd}	7.05^{d}	0.37
Final	14.40^{a}	9.75^{bc}	11.17^{b}	10.99^{b}	7.51^{c}	11.07^{b}	8.57^{bc}	9.30^{bc}	10.43^{b}	0.38
Difference	**7.15^{a}**	**2.80^{abc}**	**4.20^{ab}**	**-0.48^{bcd}**	**-2.55^{d}**	**-0.86^{cd}**	**-0.31^{bcd}**	**1.65^{bcd}**	**3.38^{abc}**	**0.62**
Neutrophil (%)										
Initial	31.50^{bc}	37.00^{a}	28.50^{c}	34.33^{ab}	29.00^{c}	31.33^{bc}	33.00^{abc}	32.00^{bc}	30.25^{bc}	0.60
Final	31.50^{bc}	33.75^{ab}	31.33^{bc}	30.75^{bc}	25.50^{c}	38.75^{a}	31.33^{bc}	34.00^{ab}	31.33^{bc}	0.79
Difference	**0.00^{ab}**	**-4.60^{b}**	**1.00^{ab}**	**-3.58^{b}**	**-3.50^{b}**	**7.41^{a}**	**-1.67^{b}**	**2.00^{ab}**	**1.08^{ab}**	**0.95**
Lymphocytes (%)										
Initial	65.50^{ab}	60.00^{c}	68.00^{ab}	63.33^{bc}	68.67^{a}	65.33^{ab}	64.00^{abc}	65.25^{ab}	66.25^{ab}	0.60
Final	65.00^{a}	64.75^{a}	65.00^{a}	65.75^{a}	66.50^{a}	57.75^{b}	68.67^{a}	64.00^{a}	67.00^{a}	0.77
Difference	**-0.50^{ab}**	**5.40^{a}**	**-1.00^{ab}**	**2.42^{a}**	**-2.17^{ab}**	**-7.58^{b}**	**4.67^{a}**	**-1.25^{ab}**	**0.75^{ab}**	**1.05**
Eosinophil (%)										
Initial	1.00	0.50	1.00	0.33	0.67	0.67	1.00	0.50	1.00	0.10
Final	1.50^{a}	0.00^{b}	1.00^{a}	0.37^{b}	1.37^{a}	1.00^{a}	0.00^{b}	0.33^{b}	0.33^{b}	0.10
Difference	**0.50^{ab}**	**-0.30^{bcd}**	**-0.25^{abcd}**	**0.04^{abc}**	**0.71^{a}**	**0.33^{ab}**	**-1.00^{d}**	**-0.17^{abcd}**	**-0.67^{cd}**	**0.12**
Basophils (%)										
Initial	0.50^{ab}	0.50^{ab}	0.00^{b}	0.33^{ab}	0.00^{b}	1.00^{a}	0.50^{ab}	0.75^{ab}	0.25^{ab}	0.09
Final	1.00^{a}	0.50^{ab}	1.00^{a}	0.37^{ab}	0.00^{b}	0.37^{ab}	0.67^{ab}	0.67^{ab}	0.67^{ab}	0.09
Difference	**0.50^{ab}**	**0.30^{ab}**	**1.00^{a}**	**0.04^{ab}**	**0.00^{ab}**	**-0.62^{b}**	**0.11^{ab}**	**-0.08^{ab}**	**0.42^{ab}**	**0.15**
Monocytes (%)										
Initial	1.50	2.00	2.50	1.67	1.67	1.33	1.50	1.50	2.25	0.13
Final	1.00	1.00	1.67	1.75	1.75	1.62	0.67	1.00	0.67	0.14
Difference	**-0.50**	**-0.80**	**-0.75**	**0.08**	**0.08**	**0.29**	**-0.83**	**-0.50**	**-1.58**	**0.21**

Packed Cell Volume (%)									
Initial	32.50	33.50	33.50	28.67	31.67	30.00	35.00	32.75	30.00	0.68
Final	25.50^{c}	29.00^{bc}	26.67^{c}	32.75^{ab}	32.62^{ab}	36.37^{a}	33.67^{a}	33.33^{ab}	34.67^{a}	0.70
Difference	**-7.00^{d}**	**-1.90^{bcd}**	**-3.50^{cd}**	**4.08^{abc}**	**0.96^{abcd}**	**6.37^{a}**	**-1.33^{abcd}**	**0.58^{abcd}**	**4.67^{ab}**	**0.97**
MCH (g/mg)									
Initial	10.06^{a}	9.84^{a}	10.49^{a}	5.75^{b}	6.97^{b}	5.89^{b}	10.07^{a}	9.34^{a}	10.28^{a}	0.34
Final	17.16^{ab}	13.60^{bcd}	13.30^{bcd}	17.39^{ab}	10.87^{d}	17.96^{a}	12.42^{dc}	12.94^{cd}	16.41^{abc}	0.55
Difference	**7.09^{b}**	**4.78^{b}**	**4.68^{b}**	**11.64^{a}**	**3.90^{b}**	**12.07^{a}**	**2.35^{b}**	**3.61^{b}**	**6.13^{b}**	**0.71**
MCHC (pg)									
Initial	33.14^{b}	33.66^{ab}	32.82^{b}	34.50^{a}	33.16^{b}	32.92^{b}	33.05^{b}	33.34^{ab}	34.01^{ab}	0.14
Final	33.35^{abc}	31.06^{e}	31.61^{de}	34.14^{a}	32.92^{abcd}	33.47^{ab}	32.29^{bcde}	32.88^{abcd}	31.85^{cde}	0.21
Difference	**0.20^{a}**	**-2.21^{b}**	**-0.93^{ab}**	**-0.36^{ab}**	**-0.23^{ab}**	**0.55^{a}**	**-0.76^{ab}**	**-0.46^{ab}**	**-2.16^{b}**	**0.24**
MCV (fl)									
Initial	30.37^{a}	29.25^{a}	31.95^{a}	16.67^{c}	21.05^{b}	17.88^{b}	30.49^{a}	27.95^{a}	30.16^{a}	1.02
Final	51.47^{ab}	43.54^{abc}	41.78^{abc}	51.03^{ab}	33.04^{c}	53.67^{a}	38.47^{c}	39.38^{c}	51.41^{ab}	1.57
Difference	**21.10^{b}**	**16.89^{b}**	**15.16^{b}**	**34.37^{a}**	**11.98^{b}**	**35.79^{a}**	**7.98^{b}**	**11.43^{b}**	**21.25^{b}**	**2.00**

^{abcd} Means on the same row having different superscripts are significantly different ($p<0.05$)

MCH= Mean Corpuscular Haemoglobin: MCV= Mean Corpuscular Volume (MCV): MCHC= Mean Corpuscular Haemoglobin Concentration (MCHC)

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.37 Main effects of breeds of goat on serum biochemistry concentrations

Table 41 shows the main effects of breeds of goat on serum biochemistry concentrations. Breeds of goat had significant ($p<0.09$) effects on Total protein (TP), Albumin, Globulin, Glucose, Urea, Aspartate transaminase (AST), Alanine transaminase (ALT), Alkaline phosphatase (ALP) and Bilirubin. Breed had significant effect ($p<0.05$) on TP at the final stage and its difference with ranges between 6.53-7.57g/dl and -1.80 to -6.2g/dl respectively. KalaWAD and WAD had the lowest and highest TP at the initial stage respectively, while KalaWAD and Kalahari Red (KR) had highest and lowest TP difference respectively. The albumin concentration was significantly influenced ($p<0.05$) at the initial and final stages and their difference. KR had highest value (3.79g/dl), while KalaWAD had the lowest value of 3.18g/dl at the initial stage. KalaWAD had highest values for albumin at the final stage and difference with 3.64g/dl and 0.46g/dl respectively. In the same vein, KR recorded the lowest values for same parameters with 3.08g/dl and -0.63g/dl respectively. Globulin was significantly influenced ($p<0.05$) at the initial and final stages where WAD and KalaWAD recorded highest (4.15g/dl and 2.83g/dl) and lowest (3.35g/dl and 2.27g/dl) values respectively. KR and KalaWAD had significantly ($p<0.05$) highest (67.87mg/dl) and lowest (52.89mg/dl) initial glucose level. Glucose difference was significantly influenced by the breed with value ranging between 2.80 to -12.75mg/dl where KalaWAD and KR recorded the highest and lowest values respectively.

Urea was significantly influenced ($p<0.05$) by breed at the initial stage and urea difference. KalaWAD had highest value for urea at initial stage with 17.14mg/dl, while KR recorded least value (13.75mg/dl). Urea difference was highest (1.57mg/dl) and lowest (-3.23mg/dl) for KR and KalaWAD respectively. ALT at the final stage and its difference was significantly influenced ($p<0.05$) where KR recorded highest (39.71u/l) value, while WAD had the least value (29.17u/l). For ALT difference, WAD and KR had highest (0.72u/l) and lowest (-9.33u/l) values respectively. ALP values ranged between 51.80-61.44mg/dl at the final stage, WAD had highest ($p<0.05$) value, while KalaWAD had the least value. KalaWAD had highest value ($p<0.05$) of 0.21mg/dl, while WAD had least (0.11mg/dl) value for bilirubin at the initial stage. Difference of bilirubin at the final and initial stages ranged between -0.01 to -0.14mg/dl, where WAD and KalaWAD had highest and lowest ($p<0.05$) values respectively.

4.38 Main effects of levels of Turmeric powder inclusions on serum biochemistry concentrations of goat

Main effects of levels of Turmeric powder inclusions on serum biochemistry concentrations of goat is presented in Table 42. Blood cholesterol level ranged between 87.93-114.01mg/dl, Does placed under TP-5g and TP-2g had the highest and lowest values respectively at the initial stage. Does fed TP-2g had the highest ($p<0.05$) value for blood cholesterol difference with 1.95mg/dl, while TP-5g had the least (-29.63mg/dl) difference. Does fed TP-0 had highest ($p<0.05$) glucose level of 60.32mg/dl at the final stage, while Does fed TP-2g had lowest value (53.55mg/dl).

Table 41: Main effects of breeds of goat on serum biochemistry concentrations

Parameter	Kalahari Red	KalaWAD	WAD	SEM
Total Protein (g/dl)				
Initial	7.22^{a}	6.53^{b}	7.57^{a}	0.14
Final	5.57	5.91	6.14	0.13
Difference	**-1.80^{b}**	**-0.62^{a}**	**-1.42^{b}**	**0.16**
Albumin (g/dl)				
Initial	3.79^{a}	3.18^{b}	3.41^{b}	0.08
Final	3.08^{b}	3.64^{a}	3.31^{ab}	0.07
Difference	**-0.63^{c}**	**0.46^{a}**	**-0.10^{b}**	**0.10**
Globulin (g/dl)				
Initial	3.43^{b}	3.35^{b}	4.15^{a}	0.14
Final	2.48^{ab}	2.27^{b}	2.83^{a}	0.08
Difference	**-1.17**	**-1.08**	**-1.32**	**0.14**
Cholesterol (mg/dl)				
Initial	96.90	93.96	106.94	3.17
Final	90.45	84.66	88.07	1.34
Difference	**-6.54**	**-9.30**	**-18.87**	**3.70**
Glucose (mg/dl)				
Initial	67.87^{a}	52.89^{b}	56.50^{b}	1.68
Final	54.28	55.69	57.11	0.99
Difference	**-12.75^{b}**	**2.80^{a}**	**0.61^{a}**	**1.97**
Urea (mg/dl)				
Initial	13.75^{b}	17.14^{a}	15.36^{ab}	0.48
Final	14.57	13.91	14.29	0.33
Difference	**1.57^{a}**	**-3.23^{b}**	**-1.07^{b}**	**0.60**
Creatinine (mg/dl)				
Initial	1.94	1.72	1.71	0.06
Final	1.87	1.57	1.90	0.07
Difference	**0.08**	**-0.15**	**0.19**	**0.09**
Aspartate Transaminase (u/l)				
Initial	56.02	54.22	57.75	1.34
Final	51.69	50.47	54.00	0.97
Difference	**-5.46**	**-3.75**	**-3.75**	**1.42**
Alanine Transaminase (u/l)				
Initial	39.71^{a}	30.00^{b}	29.17^{b}	1.16
Final	31.99	28.55	29.89	0.91
Difference	**-9.33^{b}**	**-1.44^{a}**	**0.72^{a}**	**1.49**
Alkaline phosphate (mg/dl)				
Initial	69.33	69.11	73.33	1.95
Final	60.09^{a}	51.80^{b}	61.44^{a}	1.12
Difference	**-6.83**	**-17.30**	**-11.89**	**2.22**
Bilirubin (mg/dl)				
Initial	0.12^{b}	0.21^{a}	0.11^{b}	0.01
Final	0.07	0.08	0.10	0.01
Difference	**-0.06^{a}**	**-0.14^{b}**	**-0.01^{a}**	**0.02**

^{ab} Means on the same row having different superscripts are significantly different ($p<0.05$)

Table 42: Main effects of levels of Turmeric powder inclusions on serum biochemistry concentrations of goat

Parameter	TP-0	TP-2g	TP-5g	SEM
Total Protein (g/dl)				
Initial	7.04	7.15	7.11	0.14
Final	5.72	5.74	6.15	0.13
Difference	**-1.32**	**-1.32**	**-1.20**	**0.16**
Albumin (g/dl)				
Initial	3.12	3.62	3.61	0.07
Final	3.22	3.40	3.40	0.08
Difference	**0.09**	**-0.16**	**-0.19**	**0.10**
Globulin (g/dl)				
Initial	3.92	3.54	3.50	0.14
Final	2.50	2.34	2.76	0.08
Difference	**-1.42**	**-1.16**	**-1.00**	**0.14**
Cholesterol (mg/dl)				
Initial	96.57[b]	87.93[b]	114.01[a]	3.17
Final	88.72	90.28	84.04	1.34
Difference	**-7.85[a]**	**1.95[a]**	**-29.63[b]**	**3.70**
Glucose (mg/dl)				
Initial	57.47	59.56	60.05	1.80
Final	60.32[a]	53.55[b]	53.78[b]	0.99
Difference	**2.85**	**-5.82**	**-5.64**	**1.97**
Urea (mg/dl)				
Initial	14.77	15.33	16.10	0.48
Final	14.52	13.73	14.58	0.33
Difference	**-0.25**	**-1.17**	**-1.24**	**0.60**
Creatinine (mg/dl)				
Initial	1.73	1.72	1.92	0.06
Final	1.67	1.83	1.82	0.07
Difference	**-0.06**	**0.18**	**-0.02**	**0.09**
Aspartate Transaminase (u/l)				
Initial	53.30	58.95	55.33	1.34
Final	49.38	53.54	52.89	0.97
Difference	**-3.92**	**-5.46**	**-3.44**	**1.42**
Alanine Transaminase (u/l)				
Initial	33.18	34.06	31.55	1.16
Final	30.74	31.82	27.78	0.91
Difference	**-2.44**	**-2.47**	**-5.14**	**1.49**
Alkaline Phosphate (mg/dl)				
Initial	68.35	69.50	73.83	1.95
Final	58.21	57.31	57.89	1.12
Difference	**-10.14**	**-11.78**	**-13.97**	**2.22**
Bilirubin (mg/dl)				
Initial	0.15	0.17	0.13	0.01
Final	0.07	0.07	0.11	0.01
Difference	**-0.07**	**-0.10**	**-0.03**	**0.02**

[ab] Means on the same row having different superscripts are significantly different ($p<0.05$)

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.39 Interaction effects of breeds of goat and levels of Turmeric powder inclusions on serum biochemistry concentrations

Table 43 shows the interaction effects of breeds of goat and levels of Turmeric powder inclusions on serum biochemistry concentrations. KalaWAD placed under TP-2g had highest ($p<0.05$) value of 7.90g/dl for total protein (TP) at the initial stage, while KalaWAD fed TP-0 had the lowest value (6.36g/dl). KalaWAD fed TP-0 had least values ($p<0.05$) for TP at the final stage (4.50g/dl) and difference (-2.45g/dl). WAD fed TP-0 and KalaWAD fed TP-2g had significantly ($p<0.05$) highest values for TP at the final stage (6.73g/dl) and difference (-0.43g/dl) respectively. Albumin range of 2.97-4.25g/dl was recorded at the initial stage where KR placed under TP-5g had highest ($p<0.05$) value, while KalaWAD placed under TP-0 had the least value. KalaWAD fed TP-2g had highest ($p<0.05$) value of 3.90g/dl for albumin at the final stage, while KR fed TP-0 had the least value (2.55g/dl). The difference in albumin at the final and initial stages ranged between -0.80 to 0.51g/dl, where KalaWAD fed TP-0 and KR fed TP-5g had highest and lowest ($p<0.05$) values respectively. Globulin range of 2.35-4.50g/dl was recorded at the initial stage where WAD placed under TP-0 and KR placed under TP-5g recorded highest and lowest ($p<0.05$) values respectively. WAD fed TP-0 had highest ($p<0.05$) value of 3.27g/dl for globulin at the final stage, while least value (1.95g/dl) was recorded for KR Does fed TP-0. Globulin difference ranged between -1.90 to -0.22g/dl. KR Does fed TP-5g and TP-0 had highest and lowest ($p<0.05$) values respectively.

Cholesterol level was significantly ($p<0.05$) highest (129.87mg/dl) for WAD Does placed under TP-5g at the initial stage, while KalaWAD Does placed under TP-2g had the least value (76.33mg/dl). KalaWAD fed TP-5g and KR fed TP-2g had the lowest (77.47mg/dl) and the highest value (96.37mg/dl) for cholesterol at the final stage respectively. Cholesterol difference ranged between -42.97-8.63mg/dl, where KalaWAD fed TP-2g and WAD fed TP-5g recorded the highest and lowest ($p<0.0.5$) values respectively. Blood glucose level ranged between 48.67-75.50mg/dl, 51.50-66.00mg/dl and -15.25-13.25mg/dl at the initial and final stages and their difference. KR and KalaWAD placed under TP-0 had the highest and lowest ($p<0.05$) values at the initial stage respectively. WAD fed TP-0 had highest ($p<0.05$) values at the final stage and for difference, while KR fed TP-2g and TP-5g had the lowest ($p<0.05$) values at the final stage and for difference. KalaWAD placed under TP-5g and KR placed under TP-0 had highest and lowest ($p<0.05$) values of 19.00mg/dl and 11.35mg/dl of Urea at the initial stage respectively. Urea level at the final stage ranged between 12.50-16.00mg/dl, where KalaWAD and KR fed TP-0 had the lowest and highest ($p<0.05$) values respectively. Difference in urea was significantly (p<0.0.5) highest and lowest for KR and KalaWAD fed TP-0 where they recorded 4.65mg/dl and -4.13mg/dl respectively. Creatinine level at the initial stage ranged between 1.50-2.20mg/dl. KR placed under TP-5g and KalaWAD placed under TP-2g had significantly ($p<0.05$) highest and lowest values respectively. WAD and KalaWAD fed TP-2g had highest (2.47mg/dl) and lowest (1.33mg/dl) values ($p<0.05$) for urea at the final stage respectively.

AST was significantly ($p<0.05$) influenced at the final stage where KalaWAD fed TP-2g had the highest value (57.66u/l), while KR fed TP-0 had lowest value (44.50u/l). ALT values ranged between 27.50-42.50u/l, 25.00-34.50u/l and -12.10-5.67u/l at the initial and final stages and their difference respectively. KR placed under TP-2g and WAD placed TP-5g had highest and lowest ($p<0.05$) values at the initial stage respectively, while KR and KalaWAD fed TP-0 had the highest and lowest ($p<0.05$) values at the final stage respectively. KalaWAD and KR Does fed TP-2g had highest and lowest ($p<0.05$) values for ALT difference respectively. ALP was significantly ($p<0.05$) influenced at the final stage where KR fed TP-0 had the highest value of 64.00mg/dl, while KalaWAD fed TP-0 had the lowest value (48.75mg/dl). Bilirubin level ranged between 0.07-0.23mg/dl, 0.02-0.13mg/dl and -0.17-0.01mg/dl at the initial and final stages and their difference. KalaWAD fed TP-0 and KR fed

TP-0 and TP-5g had the highest and lowest ($p<0.05$) values at the initial stage respectively. WAD and KR Does fed TP-0 had the highest and lowest ($p<0.05$) values at the final stage respectively. For bilirubin difference, KR fed TP-5g and KalaWAD fed TP-0 had the highest and lowest ($p<0.05$) values respectively.

Table 43: Interaction effects of breeds of goat and levels of Turmeric powder inclusions on serum biochemistry concentrations

	Kalahari Red			KalaWAD			West African Dwarf			
Parameter	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Total Protein (g/dl)										
Initial	6.95^{ab}	7.90^{a}	6.60^{b}	6.36^{b}	6.37^{b}	6.87^{ab}	7.80^{a}	7.02^{ab}	7.87^{a}	0.14
Final	4.50^{c}	5.62^{b}	6.30^{ab}	5.64^{b}	5.93^{ab}	6.17^{ab}	6.73^{a}	5.70^{ab}	6.00^{ab}	0.13
Difference	**-2.45^{c}**	**-2.04^{bc}**	**-1.02^{ab}**	**-0.73^{ab}**	**-0.43^{a}**	**-0.70^{ab}**	**-1.07^{ab}**	**-1.32^{abc}**	**-1.87^{bc}**	**0.16**
Albumin (g/dl)										
Initial	3.10^{c}	3.85^{ab}	4.25^{a}	2.97^{c}	3.46^{bc}	3.10^{c}	3.30^{bc}	3.47^{bc}	3.47^{bc}	0.08
Final	2.55^{c}	3.15^{b}	3.40^{ab}	3.47^{ab}	3.90^{a}	3.53^{ab}	3.47^{ab}	3.20^{b}	3.27^{b}	0.07
Difference	**-0.55^{d}**	**-0.55^{d}**	**-0.80^{d}**	**0.51^{a}**	**0.43^{ab}**	**0.43^{ab}**	**0.17^{abc}**	**-0.27^{cd}**	**-0.21^{bcd}**	**0.10**
Globulin (g/dl)										
Initial	3.85^{abc}	4.05^{ab}	2.35^{d}	3.40^{bc}	2.90^{cd}	3.77^{abc}	4.50^{a}	3.55^{abc}	4.40^{a}	0.14
Final	1.95^{d}	2.47^{bcd}	2.90^{ab}	2.14^{cd}	2.03^{d}	2.65^{bc}	3.27^{a}	2.50^{bcd}	2.73^{ab}	0.08
Difference	**-1.90^{b}**	**-1.49^{ab}**	**-0.22^{a}**	**-1.26^{ab}**	**-0.87^{ab}**	**-1.12^{ab}**	**-1.23^{ab}**	**-1.05^{ab}**	**-1.67^{b}**	**0.14**
Cholesterol (mg/dl)										
Initial	96.90^{bc}	94.50^{bc}	99.90^{bc}	93.27^{bc}	76.33^{c}	112.27^{ab}	99.62^{bc}	91.32^{bc}	129.87^{a}	3.18
Final	84.15^{bc}	96.37^{a}	87.77^{abc}	91.53^{ab}	84.97^{abc}	77.47^{c}	89.33^{ab}	87.97^{abc}	86.90^{abc}	1.33
Difference	**-12.75^{ab}**	**0.84^{a}**	**-11.12^{ab}**	**-1.73^{a}**	**8.63^{a}**	**-34.80^{bc}**	**-10.29^{ab}**	**-3.36^{a}**	**-42.97^{c}**	**3.70**
Glucose (mg/dl)										
Initial	75.50^{a}	62.00^{bc}	69.50^{ab}	48.67^{d}	54.33^{cd}	55.67^{cd}	52.75^{cd}	61.75^{bc}	55.00^{cd}	1.67
Final	61.50^{ab}	51.50^{c}	52.33^{c}	53.75^{c}	56.33^{bc}	57.00^{bc}	66.00^{a}	53.33^{c}	52.00^{c}	1.00
Difference	**-14.00^{d}**	**-10.00^{cd}**	**-15.25^{d}**	**5.08^{ab}**	**2.00^{abc}**	**1.33^{abc}**	**13.25^{a}**	**-8.42^{bcd}**	**-3.00^{bcd}**	**1.97**
Urea (mg/dl)										
Initial	11.35^{c}	15.15^{abc}	13.80b^{c}	16.63ab	15.80^{ab}	19.00^{a}	15.47^{ab}	15.10^{abc}	15.50^{ab}	0.48
Final	16.00^{a}	14.40^{ab}	13.70^{ab}	12.50^{b}	13.33^{ab}	15.90^{a}	15.43^{ab}	13.30^{ab}	14.13^{ab}	0.33
Difference	**4.65^{a}**	**0.37^{ab}**	**0.75^{ab}**	**-4.13^{b}**	**-2.47^{b}**	**-3.10^{b}**	**-0.04^{ab}**	**-1.80^{b}**	**-1.37^{b}**	**0.60**
Creatinine (mg/dl)										
Initial	1.65^{ab}	1.90^{ab}	2.20^{a}	1.87^{ab}	1.50^{b}	1.80^{ab}	1.65^{ab}	1.72^{ab}	1.75^{ab}	0.06
Final	1.90^{b}	1.72^{bcd}	2.03^{b}	1.40^{cd}	1.33^{d}	1.97^{b}	1.77^{bc}	2.47^{a}	1.47^{cd}	0.07
Difference	**0.25^{ab}**	**0.00^{ab}**	**0.05^{ab}**	**-0.47^{b}**	**-0.17^{b}**	**-0.17^{ab}**	**0.12^{ab}**	**0.74^{a}**	**-0.28^{b}**	**0.09**
Aspartate Transaminase (u/l)										
Initial	56.00	55.00	57.50	51.33	60.33	51.00	53.25	62.50	57.50	1.34
Final	44.50^{c}	51.75^{ab}	57.00^{a}	47.75^{bc}	57.66^{a}	46.00^{bc}	54.67^{a}	51.67^{ab}	55.67^{a}	0.97
Difference	**-11.5**	**-3.40**	**-3.50**	**-3.58**	**-2.67**	**-5.00**	**1.42**	**-10.83**	**-1.83**	**1.42**

Alanine Transaminase (u/l)		``								
Initial	42.00^{a}	42.50^{a}	34.50^{b}	29.00^{b}	28.33^{b}	32.67^{b}	30.75^{b}	29.25^{b}	27.50^{b}	1.16
Final	34.50^{a}	31.00^{ab}	31.33^{ab}	25.00^{b}	34.00^{a}	26.67^{ab}	33.67^{a}	30.67^{ab}	25.33^{b}	0.91
Difference	**-7.50^{ab}**	**-12.10^{b}**	**-7.25^{ab}**	**-4.00^{ab}**	**5.67^{a}**	**-6.00^{ab}**	**2.92^{a}**	**1.42^{a}**	**-2.17^{ab}**	**1.49**
Alkaline Phosphate (mg/dl)										
Initial	70.50	68.50	69.50	61.33	74.00	72.00	73.75	66.25	80.00	1.95
Final	64.00^{a}	60.75^{a}	56.33^{ab}	48.75^{c}	49.67^{bc}	57.00^{ab}	63.33^{a}	60.67^{a}	60.33^{a}	1.12
Difference	**-6.50**	**-6.70**	**-7.25**	**-12.58**	**-24.33**	**-15.00**	**-10.42**	**-5.58**	**-19.67**	**2.22**
Bilirubin (mg/dl)										
Initial	0.07^{b}	0.18^{ab}	0.07^{b}	0.23^{a}	0.22^{a}	0.20^{ab}	0.12^{ab}	0.11^{ab}	0.11^{ab}	0.01
Final	0.02^{d}	0.05^{cd}	0.12^{ab}	0.05^{cd}	0.06^{bcd}	0.12^{abc}	0.13^{a}	0.10^{abc}	0.08^{abcd}	0.01
Difference	**-0.05^{abcd}**	**-0.13^{bcd}**	**0.01^{a}**	**-0.17^{d}**	**-0.16^{cd}**	**-0.08^{abcd}**	**0.01^{ab}**	**-0.01^{ab}**	**-0.03^{abc}**	**0.02**

^{abcde} Means on the same row having different superscripts are significantly different ($p<0.05$)

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.40 Main effects of breeds of goat kids on performance and mortality from birth to 4 weeks post-weaning

Table 44 shows main effects of breeds of goat kids on performance and mortality from birth to 4 weeks post-weaning. Kalahari Red (KR) Does produced kids with highest significant ($p<0.05$) value for birth weight of 3.25kg, followed by kids produced by KalaWAD (2.40kg), while West African Dwarf (WAD) goats kids had the least weight (1.95kg) for same parameter. Kids produced by KR Does recorded highest ($p<0.05$) values for weights taken from weeks 2 to 12 when weaning was done, while WAD kids had the least weight from weeks 2 to 12. Similarly, KR kids had highest ($p<0.05$) values for weight gain (11.25kg) and daily weight gain (133.98g/day), while WAD kids recorded lowest values of 5.83kg and 69.40g/day for respective parameter. KalaWAD Does recorded highest kid mortality at pre-weaning period with 20%, followed by KR kids with 5% kid mortality. No mortality was recorded for kids produced by WAD Does.

For post-weaning performance, concentrate and total feed intakes on dry matter basis (DMB) were significantly ($p<0.05$) influenced by breeds of goat kids. Concentrate intake ranged between 257.80-299.90g/day, while Total feed intake ranged between 313.30-361.80g/day. KR and WAD kids recorded highest and lowest ($p<0.05$) values respectively for the intakes. Final weight of the kids was also significantly influenced ($p<0.05$) by the breeds of the dams. KR kids recorded highest final weight of 12.07kg, followed by KalaWAD kids with 11.88kg while WAD kids recorded lowest value of 11.82kg for same parameter. Post-weaning kid mortality was highest for KR kids with 10% mortality, while KalaWAD and WAD kids had no mortality.

Breeds of goat kids had no significant ($p>0.05$) effects on post-weaning grass intake, weight gains, feed conversion ratio and protein efficiency ratio.

Table 44: Main effects of breeds of goat kids on performance and mortality from birth to 4 weeks post-weaning

Parameters	KR kids	KalaWAD kids	WAD kids	SEM
Pre-Weaning Performance				
Weight at Birth (kg)	3.25^{a}	2.40^{b}	1.95^{c}	0.91
Weight at Week 2 (kg)	5.24^{a}	4.17^{b}	3.08^{c}	0.19
Weight at Week 4 (kg)	7.08^{a}	5.42^{b}	4.20^{c}	0.26
Weight at Week 6 (kg)	8.7^{a}	7.14^{b}	5.34^{c}	0.32
Weight at Week 8 (kg)	10.47^{a}	8.47^{b}	6.12^{c}	0.41
Weight at Week 10 (kg)	12.25^{a}	9.85^{b}	6.87^{c}	0.50
Weight at Week 12 (kg)	14.54^{a}	11.21^{b}	7.78^{c}	0.59
Weight Gain (kg)	11.25^{a}	8.68^{b}	5.83^{c}	0.50
Daily Weight Gain (g/day)	133.98^{a}	103.33^{b}	69.40^{c}	6.00
Mortality (%)	5.00	20.00	0.00	
Post-Weaning Performance				
Grass Intake (g/day on DMB)	61.83	55.52	68.05	6.48
Conc. Intake (g/day on DMB)	299.90^{a}	257.80^{b}	292.20^{a}	11.40
Total FI (g/day on DMB)	361.80^{a}	313.30^{b}	360.30^{a}	14.30
Final Weight (kg)	12.07^{a}	11.88^{b}	11.82^{c}	0.18
Weight Gain (g)	1.55	1.33	1.26	0.02
Daily Weight Gain (g/day)	54.11	47.35	45.12	0.56
Feed Conversion Ratio	7.43	7.67	10.45	1.53
Protein Efficiency Ratio	1.06	1.07	0.87	0.12
Mortality (%)	10.00	0.00	0.00	

^{abc} Means on the same row having different superscripts are significantly different ($p<0.05$)

KR is *Kalahari Red*; **WAD** is *West African Dwarf*; **DMB** is *Dry matter basis*; **FI** is *Feed intake*

4.41 Main effects of levels of Turmeric powder inclusions on performance and mortality of goat kids from birth to 4 weeks post-weaning

Main effects of levels of Turmeric powder inclusions on performance and mortality of goat kids from birth to 4 weeks post-weaning is presented in Table 45. Turmeric powder inclusion had no significant ($p>0.05$) effects on all pre-weaning parameters taken on the kids. Birth weight was highest and lowest for kids produced by Does fed TP-5g (2.65kg) and TP-0 (2.37kg) respectively. Kids produced by Does fed TP-2g had marginally highest values for weights taken from weeks 2 to 12 when weaning was done and the weight gains, while kids produced by Does fed TP-0 recorded lowest values for these parameters

Kids' mortality rate was highest for kids of Does fed TP-0 (14.28%), followed by kids of Does fed TP-5g with 5%, while lowest mortality rate of 4.54% was recorded for kids of Does fed TP-2g at the pre-weaning phase.

For post-weaning performance, kids fed TP-0 had highest ($p<0.05$) value for grass intake (73.24g/day on dry matter basis (DMB)), while kids fed TP-2g had lowest grass intake of 54.26g/day DMB. Highest ($p<0.05$) final post-weaning weight, weight gain and daily weight gain of 12.19kg, 1.64kg and 58.62g/day respectively were recorded for kids fed TP-2g, while kids fed TP-0 had lowest value for respective parameter. Feed conversion ratio was significantly ($p<0.05$) highest for kids fed TP-0 (12.29), while lowest value of 6.21 was recorded for kids fed TP-2g. Conversely, kids fed TP-5g had highest ($p<0.05$) value of 1.36 for protein efficiency ratio, while kids fed TP-0 had the least value (0.65) for same parameter. Turmeric powder inclusion had no significant ($p>0.05$) effect on the concentrate and total feed intakes of the kids.

Kids' mortality rate was highest for kids fed TP-0 (4.76%), followed by kids fed TP-2g with 4.54%, while no mortality was recorded for kids fed TP-5g at the post-weaning phase.

Table 45: Main effects of levels of Turmeric powder inclusions on performance and mortality of goat kids from birth to 4 weeks post-weaning

Parameters	TP-0	TP-2g	TP-5g	SEM
Pre-Weaning Performance				
Weight at Birth (kg)	2.37	2.49	2.65	0.91
Weight at Week 2 (kg)	3.93	3.98	3.97	0.19
Weight at Week 4 (kg)	5.02	5.57	5.32	0.26
Weight at Week 6 (kg)	6.33	7.07	6.56	0.32
Weight at Week 8 (kg)	7.37	8.27	7.87	0.41
Weight at Week 10 (kg)	8.64	9.53	8.86	0.50
Weight at Week 12 (kg)	9.65	11.53	9.90	0.59
Weight Gain (kg)	7.20	9.09	7.43	0.50
Daily Weight Gain (g/day)	85.71	108.18	88.46	6.00
Mortality (%)	14.28	4.54	5.00	
Post-Weaning Performance				
Grass Intake (g/day on DMB)	73.24[a]	54.26[b]	57.90[ab]	5.61
Conc. Intake (g/day on DMB)	277.40	294.30	278.24	9.66
Total Feed Intake (g/day on DMB)	350.60	348.50	336.10	12.40
Final Weight (kg)	11.49[b]	12.19[a]	12.08[a]	0.16
Weight Gain (kg)	0.94[b]	1.64[a]	1.53[a]	0.02
Daily Weight Gain (g/day)	33.43[b]	58.62[a]	54.54[a]	0.56
Feed Conversion Ratio	12.29[a]	6.21[b]	7.05[b]	1.33
Protein Efficiency Ratio	0.65[c]	1.00[b]	1.36[a]	0.10
Mortality (%)	4.76	4.54	0.00	

[abc]Means on the same row having different superscripts are significantly different ($p<0.05$)

DMB is *Dry matter basis*

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.42 Interaction effects of breeds of goat kids and levels of Turmeric powder inclusions on performance and mortality from birth to 4 weeks post-weaning of the kids

Table 46 shows interaction effects of breeds of goat kids and levels of Turmeric powder inclusions on performance and mortality from birth to 4 weeks post-weaning of the kids. Kids kidded by Kalahari Red (KR) Does fed TP-5g recorded highest ($p<0.05$) values for birth weight (3.60kg) and kids' weights taken at weeks 2 to 10 after birth. Kids kidded by West African Dwarf (WAD) Does fed TP-5g recorded least values for birth weight (1.85kg) and weights of the kids at weeks 2, 4.and 8, while kids of WAD Does fed TP-5g had lowest body weights at weeks 6, 10 and 12. Kids of KR Does fed TP-2g recorded highest significant ($p<0.05$) weight gains of 12.51kg and 148.93g/day, while kids of WAD Does fed TP-5g had the least weight gains of 5.37kg and 64g/day. Pre-weaning mortality was highest for kids of KalaWAD Does fed TP-0 with 28.57%, while kids of KR Does fed TP-2g and TP-5g; and kids of WAD Does fed TP-0, TP-2g and TP-5g had no mortality.

Post-weaning performance parameters of the kids taken were all significantly influenced ($p<0.05$) by breeds of goat kids and turmeric powder inclusion. WAD kids fed TP-0 recorded highest grass and total feed intakes on dry matter basis (DMB) with 82.18 and 370.50g/day respectively. KR kids fed TP-2 recorded highest value of 307g/day for concentrate intake on DMB. KalaWAD kids fed TP-5g recorded least values for all intakes with 47.10, 243.34 and 290.40g/day for grass, concentrate and total feed intakes respectively. KR kids fed TP-2g and TP-5g had the highest value of 12.35kg for final post-weaning weight, while KalaWAD kids fed TP-0 recorded least value (11.27kg) for same parameter. Weight gains were highest (1.80kg and 64.40g/day) and lowest (0.72kg and 25.70g/day) for KR kids fed TP-5g and KalaWAD kids fed TP-0 respectively. WAD kids fed TP-0 had highest feed conversion ratio of 13.18, while KalaWAD kids fed TP-2g and TP-5g had lowest value (5.38) for same parameter. KalaWAD kids fed TP-5g and TP-0 recorded highest and lowest ($p<0.05$) values of 1.57 and 0.55 respectively for Protein efficiency ratio.

KR kids fed TP-0 and TP-2g had highest value of 14.28 for post-weaning mortality, while no mortality was recorded for other kids fed the dietary treatments.

Table 46: Interaction effects of breeds of goat kids and levels of Turmeric powder inclusions on performance and mortality from birth to post-weaning

	Kalahari Red kids			KalaWAD kids			WAD kids			
Parameters	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Pre-Weaning Performance										
Weight at Birth (kg)	2.97^{bc}	3.22^{ab}	3.60^{a}	2.11^{def}	2.49^{cde}	2.62^{cd}	2.04^{ef}	1.85^{f}	1.97^{ef}	0.91
Weight at Week 2 (kg)	4.64^{bc}	5.31^{ab}	5.90^{a}	3.95^{cde}	4.53^{bc}	4.07^{bcd}	3.46^{cde}	2.78^{e}	3.09^{ed}	0.19
Weight at Week 4 (kg)	5.99^{bcd}	7.50^{ab}	7.72^{a}	5.13^{cde}	6.40^{abc}	4.90^{cde}	4.32^{de}	3.81^{e}	4.53^{de}	0.26
Weight at Week 6 (kg)	7.18^{bc}	8.93^{ab}	10.33^{a}	6.67^{c}	8.83^{ab}	5.93^{c}	5.60^{c}	5.25^{c}	5.21^{c}	0.32
Weight at Week 8 (kg)	8.82^{bc}	10.68^{ab}	12.33^{a}	7.50^{cd}	10.47^{ab}	7.45^{cd}	6.33^{cd}	5.95^{d}	6.14^{cd}	0.41
Weight at Week 10 (kg)	10.82^{abc}	12.28^{ab}	14.10^{a}	9.00^{bcd}	11.40^{ab}	9.17^{bcd}	7.01^{cd}	7.11^{cd}	6.48^{d}	0.50
Weight at Week 12 (kg)	12.15^{ab}	15.74^{a}	15.73^{a}	9.98^{bc}	13.60^{ab}	10.05^{bc}	7.82^{c}	8.12^{c}	7.34^{c}	0.59
Weight Gain (kg)	9.02^{bc}	12.51^{a}	12.14^{ab}	7.63^{cd}	10.89^{ab}	7.52^{cd}	5.77^{cd}	6.27^{cd}	5.37^{d}	0.50
Daily Weight Gain (g/day)	107.38^{bc}	148.93^{a}	144.52^{ab}	90.83^{cd}	129.66^{ab}	89.48^{cd}	68.70^{cd}	74.66^{cd}	64.00^{d}	0.60
Mortality (%)	14.28	0.00	0.00	28.57	14.28	16.67	0.00	0.00	0.00	
Post-Weaning Performance										
Grass Intake (g/day on DMB)	79.74^{ab}	43.30^{c}	62.40^{ab}	57.80^{bc}	61.70^{ab}	47.10^{c}	82.18^{a}	57.82^{bc}	64.15^{ab}	1.10
Conc. Intake (g/day on DMB)	286.90^{ab}	307.00^{a}	306.00^{a}	257.14^{ab}	273.00^{ab}	243.34^{b}	288.30^{ab}	302.90^{a}	285.50^{ab}	15.30
Total FI (g/day on DMB)	366.60^{a}	350.30^{ab}	368.40^{a}	314.90^{ab}	334.60^{ab}	290.40^{b}	370.50^{a}	360.70^{a}	349.60^{ab}	21.80
Final Weight (kg)	11.50^{bc}	12.35^{a}	12.35^{a}	11.27^{c}	12.28^{ab}	12.08^{abc}	11.69^{abc}	11.94^{abc}	11.81^{abc}	0.28
Weight Gain (kg)	0.95^{bc}	1.79^{a}	1.80^{a}	0.72^{c}	1.73^{ab}	1.53^{abc}	1.14^{abc}	1.39^{abc}	1.26^{abc}	0.28
Daily Weight Gain (g/day)	33.90^{bc}	64.10^{a}	64.40^{a}	25.70^{c}	61.90^{ab}	54.40^{ab}	40.68^{abc}	49.79^{abc}	44.90^{abc}	1.10
Feed Conversion Ratio	11.44^{ab}	5.20^{b}	5.64^{b}	12.23^{ab}	5.38^{b}	5.38^{b}	13.18^{a}	8.05^{b}	10.12^{ab}	2.34
Protein Efficiency Ratio	0.64^{cd}	1.11^{bc}	1.44^{ab}	0.55^{d}	1.10^{bc}	1.57^{a}	0.75^{cd}	0.79^{cd}	1.06^{abc}	0.20
Mortality (%)	14.28	14.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

^{abcdef}Means on the same row having different superscripts are significantly different ($p<0.05$)

WAD is *West African Dwarf*; **DMB** is *Dry matter basis*; **FI** is *Feed intake*

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.43 Main effects of breeds of goat on faecal egg count and identification of 4 months old kids

Main effects of breeds of goat on faecal egg count and identification of 4 months old kids is presented in Table 47. Kalahari Red goat kids at 4 months old had highest ($p<0.05$) value of $0.23x10^3$ egg per gram, this was followed by WAD kids with $0.15x10^3$ egg per gram, while KalaWAD kids recorded lowest faecal egg count of $0.09x10^3$ egg per gram. KR kids with the highest value for faecal egg count had *Haemonchus contortus* and *Trichostrongylus specie* in common for all the kids, whereas *Stronglyloides species, Trichuris blobulosa* and *Nematodius specie* were not common to all KR kids. Eggs of *Haemonchus contortus, Trichostrongylus specie*, *Stronglyloides species*, *Trichuris blobulosa* and *Nematodius specie* were not common to all KalaWAD and WAD goat kids at 4 months of age.

4.44 Main effects of levels of Turmeric powder inclusions on faecal egg count and identification of 4 months old goat kids

Table 48 shows main effects of levels of Turmeric powder inclusions on faecal egg count and identification of 4 months old goat kids. Turmeric powder inclusion had significant ($p<0.05$) effects on faecal egg count and identification of goat kids that were 4 months old. Kids fed TP-0 had highest value of $0.26x10^3$ egg per gram, followed by kids fed TP-2g with $0.13x10^3$ egg per gram, while least value of $0.09\ x10^3$egg per gram was recorded for kids that were fed TP-5g. Kids fed TP-0 had *Haemonchus contortus* and *Stronglyloides species* in common, whereas eggs of *Trichostrongylus specie*, *Trichuris blobulosa* and *Nematodius specie* were not common to same kids. Kids fed TP-2g and TP-5g had not in common eggs of *Haemonchus contortus*, *Stronglyloides species*, *Trichostrongylus specie*, *Trichuris blobulosa* and *Nematodius specie*.

Table 47: Main effects of breeds of goat on faecal egg count and identification of 4 months old kids

Parameter	**KR kids**	**KalaWAD kids**	**WAD kids**	**SEM**
Faecal egg count (x10^3 EPG)	0.23^{a}	0.09^{b}	0.15^{ab}	0.02
Identification				
Haemonchus contortus	+	-	-	
Trichostrongylus specie	+	-	-	
Stronglyloides species	-	-	-	
Trichuris blobulosa	-	-	-	
Nematodius specie	-	-	-	

[ab] Means on the same row having different superscripts are significantly different ($p<0.05$)

KR- Kalahari Red; EPG- Egg per gram

+ = Present

- = Absent

Table 48: Main effects of levels of Turmeric powder inclusions on faecal egg count and identification of 4 months old goat kids

Parameters	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Faecal egg count (x10^3 EPG)	0.26^a	0.13^b	0.09^b	0.02
Identification				
Haemonchus contortus	+	-	-	
Trichostrongylus specie	-	-	-	
Stronglyloides species	+	-	-	
Trichuris blobulosa	-	-	-	
Nematodius specie	-	-	-	

[ab] Means on the same row having different superscripts are significantly different ($p<0.05$)

EPG- Egg per gram

+ = Present

- = Absent

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.45 Interaction effects of breeds of goat kids and levels of Turmeric powder inclusion on faecal egg count and identification of 4 months old kids

Interaction effects of breeds of goat kids and levels of Turmeric powder inclusion on faecal egg count and identification of 4 months old kids is presented in Table 49. Faecal egg count range of 0.00-0.40x10^3 eggs per gram was obtained for 4 months old goat kids fed diets containing different inclusion levels of Turmeric powder. Kalahari Red goat kids fed TP-0 had the highest ($p<0.05$) value for faecal egg count, while KalaWAD kids fed TP-2g recorded the lowest value for same parameter. For faecal eggs identification, KR kids fed TP-0 and TP-2g; KalaWAD kids fed TP-0 and WAD kids fed TP-0 had *Haemonchus contortus* is common for their kids. Whiles kids in other dietary treatments had not *Haemonchus contortus* in common. For *Trichostrongylus specie*, it was only the kids of KR fed TP-0 and TP-2g that had it in common. *Trichostrongylus specie* was not common to kids of other dietary treatments. Eggs of *Stronglyloides species* and *Nematodius specie* were common to only the kids of KR goats fed TP-0, whereas they were not common to kids of other dietary treatments.

Goats' kids in each dietary treatments had not *Trichuris blobulosa* in common.

Table 49: Interaction effects of breeds of goat kids and levels of Turmeric powder inclusions on faecal egg count and identification of 4 months old kids

	Kalahari Red kids			KalaWAD kids			WAD kids			
Parameter	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Faecal egg count ($x10^3$ EPG)	0.40^{a}	0.20^{b}	0.10^{bc}	0.20^{b}	0.00^{c}	0.07^{bc}	0.22^{b}	0.15^{bc}	0.10^{bc}	0.02
Identification										
Haemonchus contortus	+	+	-	+	-	-	+	-	-	
Trichostrongylus specie	+	+	-	-	-	-	-	-	-	
Stronglyloides species	+	-	-	-	-	-	-	-	-	
Trichuris blobulosa	-	-	-	-	-	-	-	-	-	
Nematodius specie	+	-	-	-	-	-	-	-	-	

[ab] Means on the same row having different superscripts are significantly different ($p<0.05$)

EPG- Egg per gram
+ = Present
- = Absent

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.46 Main effects of breeds of goat kids on haematological parameters and serum biochemistry concentration at 4 months old

Table 50 shows main effects of breeds of goat kids on haematological parameters and serum biochemistry concentration at 4 months old. Breeds of goat kids had significant ($p<0.05$) effects on some haematological parameters such as Haemoglobin (Hb), Red blood cells (RBC), White blood cells (WBC), Neutrophils, Lymphocytes, Packed cell volume (PCV) and Mean corpuscular haemoglobin concentration (MCHC); and serum biochemistry like Total protein (TP), Albumin. Globulin, Urea, Alanine transaminase (ALT) and Alkaline Phosphatase (ALP). Kids from KalaWAD had the highest significant ($p<0.05$) values for Hb (11.12g/l), RBC (6.75×10^{12}/l), WBC (12.45×10^{9}/l) and PCV (34.22%), while kids produced by Kalahari Red (KR) had the least value for the respective parameter with 6.95g/l, 3.67×10^{12}/l, 5.50×10^{9}/l and 20.50%. Percent neutrophils ranged between 27.83-37.71% where WAD and KR kids had the highest and lowest ($p<0.05$) values respectively. Conversely, KR kids had highest ($p<0.05$) value for lymphocytes which was 70.83%, while WAD kids had least value (60.24%) for same parameter. MCHC ranged between 32.51-33.84pg where KR and KalaWAD kids had the highest and lowest ($p<0.05$) values respectively.

For serum biochemistry concentration, KalaWAD kids had the highest ($p<0.05$) values for TP, Albumin, Globulin and Urea with 5.79g/dl, 3.48g/dl, 2.31g/dl and 13.40mg/dl respectively. KR kids had the least ($p<0.05$) values for respective parameter with 3.98g/dl, 2.65g/dl, 1.33g/dl and 10.88mg/dl. WAD kids had the highest ($p<0.05$) value for ALT, the value which was 20.86u/l, while KalaWAD kids recorded the least value (16.22u/l) for same parameter. ALP ranged between 38.19-42.33mg/dl, where KR and WAD kids had the highest and lowest ($p<0.05$) values respectively.

Table 50: Main effects of breeds of goat kids on haematological parameters and serum biochemistry concentration at 4 months old

Parameters	KR kids	KalaWAD kids	WAD kids	SEM
Haematology				
Haemoglobin (g/l)	6.95^{b}	11.12^{a}	10.82^{a}	0.38
Red Blood Cells ($\times 10^{12}$/l)	3.67^{b}	6.75^{a}	6.03^{a}	0.31
White blood cells ($\times 10^{9}$/l)	5.50^{b}	12.45^{a}	9.88^{a}	0.67
Neutrophils (%)	27.83^{b}	33.22^{ab}	37.71^{a}	1.78
Lymphocytes (%)	70.83^{a}	65.44^{ab}	60.24^{b}	1.72
Eosinophil (%)	0.33	0.22	0.57	0.10
Basophils (%)	0.08	0.22	0.38	0.07
Monocytes (%)	0.92	0.89	1.05	0.13
Packed Cell Volume (%)	20.50^{b}	34.22^{a}	32.95^{a}	1.21
MCH (g/mg)	19.03	16.88	18.60	0.40
MCHC (pg)	33.84^{a}	32.51^{b}	32.91^{ab}	0.19
MCV (fl)	56.25	52.06	56.43	1.15
Serum Biochemistry Concentration				
Total Protein (g/dl)	3.98^{b}	5.79^{a}	5.25^{a}	0.17
Albumin (g/dl)	2.65^{b}	3.48^{a}	2.98^{ab}	0.12
Globulin (g/dl)	1.33^{b}	2.31^{a}	2.26^{a}	0.10
Cholesterol (mg/dl)	54.83	54.87	56.00	0.92
Glucose (mg/dl)	45.50	45.44	49.62	1.12
Urea (mg/dl)	10.88^{b}	13.40^{a}	10.98^{b}	0.40
Creatinine (mg/dl)	0.88	0.87	1.04	0.05
Aspartate Transaminase (u/l)	32.50	34.33	31.86	0.82
Alanine Transaminase (u/l)	18.83^{ab}	16.22^{b}	20.86^{a}	0.82
Alkaline Phosphatase (mg/dl)	42.33^{a}	39.22^{ab}	38.19^{b}	0.66
Bilirubin (mg/dl)	0.08	0.07	0.08	0.01
Cortisol (ng/ml)	5.38	4.78	5.64	0.19

[ab] Means on the same row having different superscripts are significantly different ($p<0.05$)

KR= Kalahari Red: MCH= Mean Corpuscular Haemoglobin: MCV= Mean Corpuscular Volume:

MCHC= Mean Corpuscular haemoglobin Concentration

4.47 Main effects of levels of Turmeric powder inclusions on haematological parameters and serum biochemistry concentration of goat kids at 4 months old

Table 51 shows the main effects of levels of Turmeric powder inclusions on haematological parameters and serum biochemistry concentration of goat kids at 4 months old. Levels of Turmeric powder inclusion had significant effects on haematological parameters such as Eosinophil and Monocytes; and serum biochemistry concentration of goats' kids on parameters such as Albumin, Alanine transaminase (ALT), Alkaline phosphatase (ALP) and Bilirubin. For haematological parameters, kids fed TP-0 had highest significant values ($p<0.05$) for eosinophil and monocytes with 0.75% and 1.44% respectively, while kids fed TP-5g had least values for respective parameter with 0.38% and 0.69%.

For serum biochemistry, Kids fed TP-2g had highest ($p<0.05$) values for Albumin (3.33g/dl) and ALT (21.53u/l), while kids fed TP-0 and TP-5g had least values for Albumin (2.72g/dl) and ALT (16.61g/dl) respectively. Kids fed TP-5g had highest ($p<0.05$) value for ALP which was 40.65mg/dl, while kids fed TP-0 had the least value (37.00mg/dl). Conversely, Kids fed TP-0 and TP-2g had the highest and lowest ($p<0.05$) values for bilirubin with 0.09mg/dl and 0.06mg/dl respectively.

Table 51: Main effects of levels of Turmeric powder inclusions on haematological parameters and serum biochemistry concentration of goat kids at 4 months old

Parameters	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Haematology				
Haemoglobin (g/l)	8.99	10.51	10.38	0.38
Red Blood Cells ($\times10^{12}$/l)	5.25	6.06	5.58	0.31
White blood cells ($\times10^{9}$/l)	9.19	9.69	9.46	0.67
Neutrophil (%)	32.75	37.82	32.23	1.78
Lymphocytes (%)	64.67	60.82	66.46	1.72
Eosinophil (%)	0.75^{a}	0.21^{ab}	0.38^{b}	0.10
Basophils (%)	0.31	0.28	0.23	0.07
Monocytes (%)	1.44^{a}	0.86^{ab}	0.69^{b}	0.13
Packed Cell Volume (%)	27.54	31.82	31.42	1.21
MCH (g/mg)	17.72	18.14	19.01	0.40
MCHC (pg)	32.74	33.25	33.06	0.19
MCV (fl)	54.20	54.46	57.45	1.15
Serum Biochemistry Concentration				
Total Protein (g/dl)	4.77	5.38	5.04	0.17
Albumin (g/dl)	2.72^{b}	3.33^{a}	2.96^{ab}	0.12
Globulin (g/dl)	2.04	2.05	2.08	0.10
Cholesterol (mg/dl)	55.25	55.50	55.65	0.92
Glucose (mg/dl)	45.83	49.28	47.73	1.12
Urea (mg/dl)	12.03	11.58	10.97	0.40
Creatinine (mg/dl)	0.92	0.97	1.00	0.05
Aspartate Transaminase (u/l)	31.46	31.61	34.65	0.82
Alanine Transaminase (u/l)	19.67^{ab}	21.53^{a}	16.61^{b}	0.82
Alkaline Phosphatase (mg/dl)	37.00^{b}	40.25^{a}	40.65^{a}	0.66
Bilirubin (mg/dl)	0.09^{a}	0.06^{b}	0.08^{ab}	0.01
Cortisol (ng/ml)	5.02	5.57	5.52	0.19

[ab] Means on the same row having different superscripts are significantly different ($p<0.05$)

MCH= Mean Corpuscular Haemoglobin: MCV= Mean Corpuscular Volume:

MCHC= Mean Corpuscular haemoglobin Concentration

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.48 Interaction effects of breeds of goat kids and levels of Turmeric powder inclusions on haematological parameters and serum biochemistry concentration at 4 months old

Interaction effects of breeds of goat kids and levels of Turmeric powder inclusions on haematological parameters and serum biochemistry concentration at 4 months old is presented in Table 52. Interaction had significant ($p<0.05$) influence on haematological parameters such as haemoglobin (Hb), Red blood cells (RBC), White blood cells (WBC), Neutrophil, Lymphocytes, Monocytes, Packed cell volume (PCV) and Mean corpuscular haemoglobin concentration (MCHC); and Serum biochemistry concentration like Total protein (TP), Albumin, Globulin, Glucose, Urea, Creatinine, Aspartate transaminase (AST), Alanine Transaminase, Alkaline phosphatase (ALP) and Bilirubin.

For interaction effects on breeds of goats' kids and levels of Turmeric powder inclusion on haematology, KalaWAD kids fed TP-5g had the highest ($p<0.05$) value of 11.90g/dl for Hb. Kalahari Red (KR) kids fed TP-0 had the least value of 5.15g/dl for Hb. RBC values ranged between 2.85-7.13×10^{12}/l, where KalaWAD fed TP-5g and KR kids fed TP-0 had the highest and lowest ($p<0.05$) values respectively. KalaWAD kids fed TP-0 had highest ($p<0.05$) values for WBC, the value which was 13.30x10^{9}/l, while KR kids fed TP-2g had least value of 4.10x10^{9}/l. For percent neutrophil, WAD and KalaWAD kids fed TP-2g had the highest and lowest ($p<0.05$) values of 44.62% and 25.50% respectively. Lymphocytes range of 54.12-73.50% was obtained, where KR and WAD kids fed TP-2g had the highest and lowest ($p<0.05$) values respectively. KR kids fed TP-5g had no monocytes (0%), while KR kids fed TP-0 had the highest ($p<0.05$) value of 1.75%. Percent PCV ranged between 15.50-36.00%, where KalaWAD kids fed TP-5g and KR kids fed TP-0 had highest and lowest ($p<0.05$) values respectively. KR kids fed TP-2g had the highest ($p<0.05$) value of 34.90pg for MCHC, while KalaWAD kids fed TP-0 had the least value (31.82pg).

For serum biochemistry concentration, KalaWAD kids fed TP-2g had the highest ($p<0.05$) values for TP (6.10g/dl), Albumin (3.53g/dl) and Globulin (2.57g/dl). KR kids fed TP-0 had least values of

3.50g/dl and 2.15g/dl for TP and Albumin respectively. KR kids fed TP-2g had least value of 1.10g/dl for Globulin. Blood glucose level ranged between 39.00-52.00mg/dl, where KR kids fed TP-2g and TP-0 had the highest and lowest ($p<0.05$) values respectively. For blood urea level, KalaWAD kids fed TP-0 had highest ($p<0.05$) value of 14.97mg/dl, while KR kids fed TP-5g had the least value (10.15mg/dl). Creatinine was significantly ($p<0.05$) highest for KR kids fed TP-5g, the value which was 1.15mg/dl, while KR kids fed TP-0 had the least value (0.65mg/dl). AST ranged between 28.50-38.50u/l, where KR kids fed TP-5g and TP-0 had the highest and lowest ($p<0.05$) values respectively. ALT, ALP and Bilirubin had ranges between 14.67 to 23u/l; 35.00 to 46.50mg/dl; and 0.04 to 0.12mg/dl respectively. WAD and KalaWAD kids fed TP-0 had the highest and lowest ($p<0.05$) values for ALT respectively. KR kids fed TP-2g and KalaWAD kids fed TP-0 had the highest and lowest ($p<0.05$) values for ALP respectively. For Bilirubin, KR kids fed TP-0 and KalaWAD kids fed TP-2g had the highest and lowest ($p<0.05$) values respectively.

Table 52: Interaction effects of breeds of goat kids and levels of Turmeric powder inclusions on haematological parameters and serum biochemistry concentration at 4 months old

	Kalahari Red kids			KalaWAD kids			WAD kids			
Parameters	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**SEM**
Haematology										
Haemoglobin (g/l)	5.15^{c}	7.85^{b}	7.85^{b}	10.27^{ab}	11.20^{a}	11.90^{a}	10.27^{ab}	11.25^{a}	10.81^{a}	0.38
Red Blood Cells ($\times 10^{12}$/l)	2.85^{c}	4.15^{bc}	4.00^{bc}	6.57^{ab}	6.57^{ab}	7.13^{a}	5.80^{ab}	6.59^{ab}	5.58^{abc}	0.31
White blood cells ($\times 10^{9}$/l)	6.85^{bcd}	4.10^{d}	5.55^{cd}	13.30^{a}	12.13^{ab}	11.93^{ab}	8.30^{abcd}	10.87^{abc}	10.08^{abcd}	0.67
Neutrophil (%)	28.00^{ab}	25.50^{b}	30.00^{ab}	38.33^{ab}	32.00^{ab}	29.33^{ab}	32.33^{ab}	44.62^{a}	34.43^{ab}	1.78
Lymphocytes (%)	69.00^{ab}	73.50^{a}	70.00^{ab}	60.00^{ab}	66.00^{ab}	70.33^{ab}	64.83^{ab}	54.12^{b}	63.28^{ab}	1.72
Eosinophil (%)	1.00	0.00	0.00	0.33	0.33	0.00	0.83	0.25	0.71	0.10
Basophils (%)	0.25	0.00	0.00	0.33	0.33	0.00	0.33	0.37	0.43	0.07
Monocytes (%)	1.75^{a}	1.00^{abc}	0.00^{c}	1.00^{abc}	1.33^{ab}	0.33^{bc}	1.50^{ab}	0.62^{abc}	1.14^{abc}	0.13
Packed Cell Volume (%)	15.50^{c}	22.50^{c}	23.50^{bc}	32.33^{a}	34.33^{a}	36.00^{a}	31.17^{ab}	34.37^{a}	32.86^{a}	1.21
MCH (g/mg)	18.09	19.30	19.70	16.18	17.11	17.35	18.31	18.08	19.43	0.40
MCHC (pg)	33.23^{ab}	34.90^{a}	33.39^{ab}	31.82^{b}	32.64^{b}	33.08^{ab}	32.97^{b}	32.86^{b}	32.92^{b}	0.19
MCV (fl)	54.44	55.30	59.00	51.49	52.43	52.25	55.42	54.91	59.02	1.15
Serum Biochemistry Concentration										
Total Protein (g/dl)	3.50^{d}	4.50^{bcd}	3.95^{cd}	5.73^{ab}	6.10^{a}	5.53^{ab}	4.91^{abcd}	5.45^{ab}	5.30^{abc}	0.17
Albumin (g/dl)	2.15^{b}	3.40^{a}	2.40^{ab}	3.43^{a}	3.53^{a}	3.47^{a}	2.65^{ab}	3.23^{ab}	2.98^{ab}	0.12
Globulin (g/dl)	1.35^{cd}	1.10^{d}	1.55^{bcd}	2.30^{ab}	2.57^{a}	2.07^{abc}	2.27^{abc}	2.21^{abc}	2.31^{ab}	0.10
Cholesterol (mg/dl)	55.00	52.00	57.50	55.67	58.33	50.67	55.17	55.75	57.00	0.92
Glucose (mg/dl)	39.00^{b}	52.00^{a}	45.50^{ab}	45.33^{ab}	41.67^{ab}	49.33^{ab}	49.50^{ab}	51.12^{a}	48.00^{ab}	1.12
Urea (mg/dl)	11.50^{ab}	11.00^{ab}	10.15^{b}	14.97^{a}	13.27^{ab}	11.97^{ab}	10.83^{ab}	11.17^{ab}	10.90^{ab}	0.40
Creatinine (mg/dl)	0.65^{b}	0.85^{ab}	1.15^{a}	0.77^{ab}	0.75^{ab}	1.09^{ab}	1.14^{a}	1.09^{ab}	0.90^{ab}	0.05
Aspartate Transaminase (u/l)	28.50^{b}	30.50^{ab}	38.50^{a}	34.00^{ab}	33.33^{ab}	35.67^{ab}	31.67^{ab}	31.37^{ab}	32.57^{ab}	0.82
Alanine Transaminase (u/l)	18.00^{ab}	22.50^{a}	16.00^{ab}	14.67^{b}	17.33^{ab}	16.67^{ab}	23.00^{a}	22.75^{a}	16.86^{ab}	0.82
Alkaline Phosphatase (mg/dl)	37.00^{d}	46.50^{a}	43.50^{ab}	35.00^{d}	42.67^{abc}	40.00^{bcd}	38.00^{cd}	37.00^{d}	39.71^{bcd}	0.66
Bilirubin (mg/dl)	0.12^{a}	0.05^{b}	0.06^{ab}	0.07^{ab}	0.04^{b}	0.10^{ab}	0.09^{ab}	0.07^{ab}	0.08^{ab}	0.01
Cortisol (ng/ml)	5.45	4.85	5.85	4.77	4.67	4.90	4.93	6.17	5.64	0.19

^{abcd}Means on the same row having different superscripts are significantly different ($p<0.05$)

MCH= Mean Corpuscular Haemoglobin: MCV= Mean Corpuscular Volume: MCHC= Mean Corpuscular haemoglobin Concentration

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.49 Proximate compositions of feed samples used for *in vitro* studies

Table 53 shows the proximate compositions of feed samples used for *in vitro* studies. Mixture of 75% concentrate and 25% *Brachiaria ruziziensis* (MCB) supplemented with TP-2g had highest dry matter content of 92.14%, while concentrate supplemented with TP-5g had least value of 86.55% for same parameter. Crude protein ranged between 7.73% and 18.47% where MCB supplemented with TP-5g and concentrate containing TP-2g had highest and lowest values respectively. Ether extract ranged between 1.82 and 2.94% where concentrate containing TP-5g and MCB without turmeric powder had highest and lowest values respectively. Highest crude fibre of 27.50% was obtained for concentrate without turmeric powder, while 24.85% was obtained for MCB containing TP-2g as the least value. Ash content ranged between 6.51 and 10.98% where concentrate containing TP-5g and without turmeric powder had highest and lowest values respectively. For nitrogen free extract, *Brachiaria ruziziensis* (BR) supplemented with TP-2g had highest value of 56.04%, whereas lowest value of 40.48% was obtained for concentrate containing TP-2g. Organic matter content ranged between 89.02 and 93.50% where concentrate without turmeric powder and the one supplemented with TP-5g had highest and lowest values respectively. Metabolisable energy of 12.82 MJ/kg DM was obtained for MCB containing TP-2g, while least value of 12.15 MJ/kg DM was obtained for concentrate containing TP-5g

Table 53: Proximate compositions of feed samples used for *in vitro* studies

Parameters (%)	Feed Types								
	Concentrate			**#*Brachiaria ruziziensis***			**75% Concentrate + #25% *Brachiaria ruziziensis***		
	TP-0	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**
Dry Matter	88.19	86.60	86.55	89.12	90.53	87.19	88.65	92.14	88.09
Crude Protein	16.49	18.47	12.68	8.01	6.87	12.55	7.80	12.34	7.73
Ether Extract	2.48	2.51	1.82	2.41	2.43	2.57	2.94	2.88	2.48
Crude Fibre	27.50	25.16	24.64	24.54	25.20	25.34	26.17	24.85	25.51
Ash	10.98	9.35	6.51	7.78	7.51	9.43	10.12	7.83	9.61
NFE	41.74	40.48	47.43	54.17	56.04	46.74	51.75	52.09	52.38
Organic Matter	89.02	90.65	93.50	92.22	92.49	90.57	89.89	92.18	90.39
ME (MJ/kg DM)	12.27	12.27	12.15	12.21	12.81	12.78	12.78	12.82	12.78

#oven dried before measurement
NFE is *Nitrogen free extract*
ME is *Metabolisable energy*

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.50 Main effects of feed types i.e. concentrate, *Brachiaria ruziziensis* and 75% Concentrate + 25% *Brachiaria ruziziensis* on *in vitro* gas production (ml/200mg DM) for 48hours of incubation

Table 54 shows the main effects of feed types i.e. concentrate, *Brachiaria ruziziensis* and 75% Concentrate + 25% *Brachiaria ruziziensis* on *in vitro* gas production (ml/200mg DM) for 48hours of incubation. Feed types had significant ($p<0.05$) effects on *in vitro* gas production from 3hours of incubation till 48hours when the incubation was terminated. Concentrate diet had highest gas production (from 0.89 to 14.11ml/200mg DM), followed by 75% Concentrate + 25% *Brachiaria ruziziensis* (from 0.11 to 14.00ml/200mg DM), while *Brachiaria ruziziensis* recorded the least value (from 0.00 to 8.89ml/200mg DM) during these hours of incubation.

4.51 Main effects of Turmeric powder inclusions on *in vitro* gas production (ml/200mg DM) for 48hours of incubation

Main effects of Turmeric powder inclusions on *in vitro* gas production (ml/200mg DM) for 48hours of incubation is presented in Table 55. Turmeric powder inclusion had no significant ($p>0.05$) effects on *in vitro* gas production from 3hours of incubation till 48hours when the incubation was terminated. Feed containing TP-0 had marginally highest ($p>0.05$) gas production (from 0.44 to 13.44ml/200mg DM), followed by feed containing TP-5g (from 0.44 to 12.67ml/200mg DM), while feed containing TP-2g recorded the least value (from 0.11 to 10.89ml/200mg DM) during these hours of incubation.

Table 54: Main effects of feed types on *in vitro* gas production (ml/200mg DM)

Hours of Incubation	**Feed Types**			**SEM**
	Concentrate	#*Brachiaria ruziziensis*	75% Concentrate + #25% *Brachiaria ruziziensis*	
3	0.89^{a}	0.00^{b}	0.11^{ab}	0.17
6	2.33^{a}	0.44^{b}	1.89^{a}	0.24
9	4.33^{a}	0.89^{b}	3.44^{a}	0.35
12	6.89^{a}	1.55^{b}	5.78^{a}	0.52
15	9.22^{a}	2.11^{b}	7.67^{a}	0.68
18	10.55^{a}	3.22^{b}	9.11^{a}	0.72
21	11.67^{a}	4.11^{b}	10.22^{a}	0.76
24	12.22^{a}	5.33^{b}	11.33^{a}	0.76
27	12.89^{a}	5.78^{b}	11.89^{a}	0.81
30	13.11^{a}	6.55^{b}	12.66^{a}	0.79
33	13.55^{a}	6.78^{b}	12.89^{a}	0.82
36	13.67^{a}	7.11^{b}	12.88^{a}	0.79
39	13.89^{a}	7.44^{b}	13.22^{a}	0.80
42	13.89^{a}	7.67^{b}	13.67^{a}	0.80
45	14.11^{a}	8.44^{b}	13.78^{a}	0.78
48	14.11^{a}	8.89^{b}	14.00^{a}	0.76

[ab] Means on the same row having different superscripts are significantly different ($p<0.05$)

#oven dried before measurement

Table 55: Main effects of Turmeric powder inclusions on *in vitro* gas production (ml/200mg DM)

Hours of Incubation	Turmeric Powder Inclusion			SEM
	TP-0	TP-2g	TP-5g	
3	0.44	0.11	0.44	0.17
6	1.78	1.11	1.78	0.24
9	3.44	2.22	3.00	0.35
12	5.44	3.89	4.89	0.52
15	7.00	5.33	6.67	0.68
18	8.44	6.55	7.89	0.72
21	9.55	7.44	9.00	0.76
24	10.67	8.33	9.89	0.76
27	11.22	8.67	10.67	0.81
30	11.67	9.33	11.33	0.79
33	12.33	9.44	11.44	0.82
36	12.33	9.78	11.55	0.79
39	12.55	10.11	11.89	0.80
42	12.78	10.22	12.22	0.80
45	13.11	10.67	12.55	0.78
48	13.44	10.89	12.67	0.76

Means on the same row having same superscripts are not significantly different ($p>0.05$)

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.52 Interaction effects of feed types and Turmeric powder inclusions on *in vitro* gas production (ml/200mg DM) for 48hours of incubation

Table 56 shows interaction effects of feed types and Turmeric powder inclusions on *in vitro* gas production (ml/200mg DM) for 48hours of incubation. Feed types and Turmeric powder inclusion had significant ($p<0.05$) effects on *in vitro* gas production from 6hours of incubation till 48hours when the incubation was terminated. Concentrate diet containing TP-5g had highest gas production from 6th hour of incubation (3.33ml/200mg DM) to 39th hour of incubation (16.66ml/200mg DM), while *Brachiaria ruziziensis* containing TP-2g and TP-5g recorded lowest values from 6th hour of incubation (0.33ml/200mg DM) to 24th hour of incubation (4.33ml/200mg DM). *Brachiaria ruziziensis* containing TP-2g recorded lowest values for *in vitro* gas production from 27th hour of incubation (4.67ml/200mg DM) till 48th hour of incubation (7.33ml/200mg DM) when the incubation was terminated. Feed type (i.e. 75% Concentrate + 25%) containing TP-0 highest gas production from 42nd hour of incubation with 16.67ml/200mg DM till 48th hour of incubation (17.33ml/200mg DM) when the incubation was terminated.

Table 56: Interaction effects of feed types and Turmeric powder inclusions on *in vitro* gas production (ml/200mg DM)

Hours of Incubation	Feed Types									SEM
	Concentrate			#*Brachiaria ruziziensis*			75% Concentrate + #25% *Brachiaria ruziziensis*			
	TP-0	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	
3	1.00	0.33	1.33	0.00	0.00	0.00	0.33	0.00	0.00	0.17
6	1.67^{bcd}	2.00^{abc}	3.33^{a}	0.67^{cd}	0.33^{d}	0.33^{d}	3.00^{ab}	1.00^{cd}	1.67^{bcd}	0.24
9	4.00^{abc}	3.67^{dcd}	5.33^{a}	1.33^{ef}	0.67^{f}	0.67^{f}	5.00^{ab}	2.33^{de}	3.00^{cd}	0.35
12	6.00^{bcd}	6.33^{bc}	8.33^{a}	2.67^{e}	1.00^{e}	1.00^{e}	7.67^{ab}	4.33^{d}	5.33^{cd}	0.52
15	8.00^{bcd}	8.33^{bc}	11.33^{a}	3.00^{e}	1.67^{e}	1.67^{e}	10.00^{ab}	6.00^{d}	7.00^{cd}	0.68
18	9.00^{cd}	10.00^{bc}	12.67^{a}	4.67^{e}	2.33^{e}	2.67^{e}	11.66^{ab}	7.33^{d}	8.33^{cd}	0.72
21	10.00^{bc}	11.00^{bc}	14.00^{a}	6.00^{de}	3.00^{f}	3.33^{ef}	12.67^{ab}	8.33^{cd}	9.67^{c}	0.76
24	10.33^{bc}	11.67^{ab}	14.67^{a}	7.33^{cd}	4.33^{d}	4.33^{d}	14.33^{a}	9.00^{bc}	10.67^{bc}	0.76
27	10.67^{bc}	12.33^{ab}	15.67^{a}	7.67^{cd}	4.67^{d}	5.00^{d}	15.33^{a}	9.00^{bc}	11.33^{bc}	0.81
30	10.67^{c}	12.67^{abc}	16.00^{a}	8.67^{cd}	5.00^{d}	6.00^{d}	15.67^{ab}	10.33^{c}	12.00^{bc}	0.79
33	11.33^{b}	13.00^{ab}	16.33^{a}	9.33^{bc}	5.00^{d}	6.00^{cd}	16.33^{a}	10.33^{b}	12.00^{b}	0.82
36	11.33^{b}	13.33^{ab}	16.33^{a}	9.33^{bcd}	5.67^{d}	6.33^{cd}	16.33^{a}	10.33^{bc}	12.00^{b}	0.79
39	11.67^{b}	13.33^{ab}	16.66^{a}	9.67^{bcd}	6.00^{d}	6.67^{cd}	16.33^{a}	11.00^{bc}	12.33^{ab}	0.80
42	11.67^{b}	13.33^{ab}	16.66^{a}	10.00^{bcd}	6.00^{d}	7.00^{cd}	16.67^{a}	11.33^{bc}	13.00^{ab}	0.80
45	11.67^{bc}	13.66^{ab}	17.00^{a}	10.67^{bc}	7.00^{c}	7.67^{c}	17.03^{a}	11.33^{bc}	13.00^{ab}	0.78
48	11.67^{bcd}	13.66^{ab}	17.00^{a}	11.33^{bcd}	7.33^{d}	8.00^{cd}	17.33^{a}	11.67^{bcd}	13.00^{abc}	0.76

^{abcdef}Means on the same row having different superscripts are significantly different ($p<0.05$); #oven dried before measurement

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.53 Main effects of feed types on *in vitro* post-incubation parameters and gas production kinetics

Table 57 shows main effects of feed types on *in vitro* post-incubation parameters and gas production kinetics. Feed types i.e. concentrate, *Brachiaria ruziziensis* and 75% Concentrate + 25% *Brachiaria ruziziensis* had significant ($p<0.05$) effects on *in vitro* post-incubation and gas production kinetics. Concentrate had highest value of 38.71% for organic matter digestibility, followed by 75% Concentrate + 25% *Brachiaria ruziziensis* (35.11%), while *Brachiaria ruziziensis* recorded lowest value of 29.10% for same parameter. Similarly, Concentrate had highest value of 46.67% for dry matter digestibility, while *Brachiaria ruziziensis* recorded lowest value of 32.44% for same parameter. Concentrate had highest value of 4.92MJ/kg DM for metabolisable energy, followed by 75% Concentrate + 25% *Brachiaria ruziziensis* (4.49MJ/kg DM), while *Brachiaria ruziziensis* recorded lowest value of 3.62MJ/kg DM for same parameter. Short chain fatty acid ranged between 0.07-0.23µmol, where *Brachiaria ruziziensis* and concentrate had the lowest and highest values respectively. Carbon IV Oxide production was highest for 75% Concentrate + 25% *Brachiaria ruziziensis* with 5ml/200mg DM, followed by concentrate (3.72ml/200mg DM), while *Brachiaria ruziziensis* recorded lowest value of 1.72ml/200mg DM for same parameter. Methane gas production ranged between 7.17-11.33ml/200mg DM, where concentrate and *Brachiaria ruziziensis* recorded highest and lowest values respectively.

In vitro gas production kinetics such as fractional rate of gas production and lag time ranged between 0.03-0.08ml/hour and 3.31-4.82hours respectively. Concentrate and *Brachiaria ruziziensis* recorded highest and lowest values for fractional rate of gas production respectively. Conversely, *Brachiaria ruziziensis* and concentrate recorded highest and lowest values for lag time respectively.

Feed types had no significant ($p>0.05$) effect on volume of gas produced.

Table 57: Main effects of feed types on *in vitro* post-incubation parameters and gas production kinetics

Parameters	Feed Types			SEM
	Concentrate	[#]*Brachiaria ruziziensis*	75% Concentrate + [#]25% *Brachiaria ruziziensis*	
Post-Incubation				
OMD (%)	38.71[a]	29.10[c]	35.11[b]	0.872
DMD (%)	46.67[a]	32.44[b]	45.22[a]	2.254
ME (MJ/kg DM)	4.92[a]	3.62[c]	4.49[b]	0.120
SCFA (µmol)	0.23[a]	0.07[b]	0.21[a]	0.018
CO_2 (ml/200mg DM)	3.72[ab]	1.72[b]	5.00[a]	0.507
Methane (ml/200mg DM)	11.33[a]	7.17[b]	8.22[ab]	0.529
Gas Production Kinetics				
b (ml/200mg DM)	14.62	16.06	15.22	0.639
c (ml/hour)	0.08[a]	0.03[c]	0.06[b]	0.004
Lag time (hour)	3.31[b]	4.82[a]	3.67[b]	0.247

[abc] Means on the same row having different superscripts are significantly different ($p<0.05$)

OMD is *Organic matter digestibility;*
DMD is *Dry matter digestibility*
ME is *Metabolisable energy*
SCFA is *Short chain fatty acid*
SEM is *Standard Error of Mean*
b is *Volume of gas produced in time (t)*

[#]oven dried before measurement
CO_2 is *Carbon IV Oxide*
c is *Fractional rate of gas production*

4.54 Main effects of Turmeric powder inclusions on *in vitro* post-incubation parameters and gas production kinetics

Main effects of Turmeric powder inclusions on *in vitro* post-incubation parameters and gas production kinetics is presented in Table 58. Turmeric powder inclusion had no significant ($p>0.05$) effects on *in vitro* post-incubation and gas production kinetics. Feed containing TP-0 had highest ($p>0.05$) values for Organic matter digestibility (OMD) with 35.47%, Metabolisable energy (ME) with 4.46MJ/kg DM, Short chain fatty acid (SCFA) with 0.19µmol, Carbon IV oxide (CO_2) with 3.94ml/200mg DM, Methane gas (10.61ml/200mg DM) and fractional rate of gas production (c) with 0.06ml/hour. Feed containing TP-2g had highest ($p>0.05$) dry matter digesstibility (DMD). Values for volume of gas produced (b) and lag time were highest ($p>0.05$) for feed containing TP-5g with 16.16ml/200mg DM and 4.19hours respectively. Feed containing TP-2g had lowest values for OMD (33.29%), ME (4.25MJ/kg DM), SCFA (0.13µmol), CO_2 (2.67ml/200mg DM), Methane gas (8.00ml/200mg DM), b (14.54ml/200mg DM) and c (0.05ml/hour). Feed containing TP-0 recorded lowest values DMD (36.66%) and lag time 3.54hours.

Table 58: Main effects of Turmeric powder inclusions on *in vitro* post-incubation parameters and gas production kinetics

Parameters	Turmeric Powder Inclusion			SEM
	TP-0	TP-2g	TP-5g	
Post-Incubation				
OMD (%)	35.47	33.29	34.15	0.872
DMD (%)	36.66	46.11	41.55	2.254
ME (MJ/kg DM)	4.46	4.25	4.32	0.120
SCFA (µmol)	0.19	0.13	0.17	0.018
CO_2 (ml/200mg DM)	3.94	2.67	3.83	0.507
Methane (ml/200mg DM)	10.61	8.00	8.17	0.529
Gas Production Kinetics				
b (ml/200mg DM)	15.21	14.54	16.16	0.639
c (ml/hour)	0.06	0.05	0.06	0.005
Lag time (hour)	3.54	4.07	4.19	0.247

Means on the same row having same superscripts are not significantly different ($p>0.05$)

OMD is *Organic matter digestibility*
ME is *Metabolisable energy*
CO_2 is *Carbon IV Oxide*
b is *Volume of gas produced in time (t)*
DMD is *Dry matter digestibility*
SCFA is *Short chain fatty acid*
SEM is *Standard Error of Mean*
c is *Fractional rate of gas production*

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

4.55 Interaction effects of feed types and Turmeric powder inclusions on *in vitro* post-incubation parameters and gas production kinetics

Table 59 shows the interaction effects of feed types and Turmeric powder inclusions on *in vitro* post-incubation parameters and gas production kinetics. Organic matter digestibility was significantly ($p<0.05$) highest for concentrate containing TP-2g with 39.65%, while lowest value of 30.07% was recorded for *Brachiaria ruziziensis* containing TP-2g for same parameter. Concentrate containing TP-2g and TP-5g recorded highest significant values of 55% for dry matter digestibility, the value was lowest (27.33%) for *Brachiaria ruziziensis* containing TP-5g. Metabolisable energy ranged between 3.35-5.02MJ/kg DM, where concentrate and *Brachiaria ruziziensis* containing TP-2g recorded highest and lowest significant ($p<0.05$) values respectively. Concentrate containing TP-5g had highest ($p<0.05$) value of 0.29µmol for short chain fatty acid, while *Brachiaria ruziziensis* containing TP-2g and TP-5g had the least value of 0.04µmol. 75% Concentrate + 25% *Brachiaria ruziziensis* containing TP-0 had highest ($p<0.05$) value of 8ml/200mg DM for Carbon IV Oxide production, while *Brachiaria ruziziensis* containing TP-0 recorded the least value (1.33ml/200mg DM) for same parameter. Methane gas production ranged between 5.00-12.50ml/200mg DM, where concentrate containing TP-0 and *Brachiaria ruziziensis* containing TP-2g had the highest and lowest ($p<0.05$) values respectively.

For *in vitro* gas production kinetics, concentrate containing TP-0 and TP-5g had highest ($p<0.05$) value of 0.08ml/hour for fractional rate of gas production, while *Brachiaria ruziziensis* containing TP-2g had the least value (0.02ml/hour) for same parameter.

No interaction effect ($p>0.05$) was observed for volume of gas produced and lag time.

Table 59: Interaction effects of feed types and Turmeric powder inclusions on *in vitro* post-incubation parameters and gas production kinetics

Parameters	Feed Types									SEM
	Concentrate			#*Brachiaria ruziziensis*			75% Concentrate + #25% *Brachiaria ruziziensis*			
	TP-0	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	**TP-0**	**TP-2g**	**TP-5g**	
Post-Incubation										
OMD (%)	38.63[a]	39.65[a]	37.86[a]	30.07[c]	26.71[d]	30.52[c]	37.71[a]	33.52[b]	34.10[b]	0.872
DMD (%)	30.00[cd]	55.00[a]	55.00[a]	30.00[cd]	40.00[bcd]	27.33[d]	50.00[ab]	43.33[ab]	42.33[abc]	2.254
ME (MJ/kg DM)	4.72[ab]	5.02[a]	5.01[a]	3.82[d]	3.35[e]	3.69[de]	4.84[a]	4.37[bc]	4.27[c]	0.120
SCFA (µmol)	0.19[bc]	0.22[ab]	0.29[a]	0.11[cd]	0.04[d]	0.04[d]	0.28[a]	0.15[bc]	0.19[bc]	0.018
CO_2 (ml/200mg DM)	2.50[c]	2.16[c]	6.50[ab]	1.33[c]	2.33[c]	1.50[c]	8.00[a]	3.50[bc]	3.50[bc]	0.507
Methane (ml/200mg DM)	12.50[a]	11.50[a]	10.00[ab]	10.00[ab]	5.00[d]	6.50[cd]	9.33[abc]	7.50[bcd]	8.00[bcd]	0.529
Gas Production Kinetics										
b (ml/200mg DM)	12.32	14.61	16.93	14.83	16.14	17.23	18.47	12.87	14.32	0.639
c (ml/hour)	0.08[a]	0.07[a]	0.08[a]	0.03[c]	0.02[c]	0.03[bc]	0.07[a]	0.05[ab]	0.06[ab]	0.005
Lag time (hour)	2.78	3.46	3.69	4.56	4.79	5.11	3.27	3.97	3.77	0.247

[abcde] Means on the same row having different superscripts are significantly different ($p<0.05$); #oven dried before measurement

OMD is *Organic matter digestibility*; **DMD** is *Dry matter digestibility*; **ME** is *Metabolisable energy*; **SCFA** is *Short chain fatty acid*
CO_2 is *Carbon IV Oxide*; **SEM** is *Standard Error of Mean*; **b** is *Volume of gas produced in time (t)*; **c** is *Fractional rate of gas production*

TP-0 *is without Turmeric*; **TP-2g** *is 2g/kg Turmeric Powder Inclusion*; **TP-5g** *is 5g/kg Turmeric Powder Inclusion*

CHAPTER FIVE

5.0 DISCUSSION

Dry matter (DM) contents of the dietary concentrates were 88.19% for concentrate supplemented with 0g/kg turmeric powder (TP-0), 86.60% for concentrate supplemented with 2g/kg turmeric powder (TP-2g) and 86.55% for concentrate supplemented with 5g/kg turmeric powder (TP-5g). The crude protein (CP) content of the dietary treatments ranged between 12.68 to 18.47%. This shows that the concentrate diets supplied sufficient amount of CP to meet the nutrient requirement of the pregnant goats in terms of CP. This is in line with the report of NRC (2007) that recommended CP of 9-10% and 13-14% for early and late gestations respectively for goats. TP-2g had the highest CP content, followed by TP-0 (16.49%) while TP-5g recorded the least value (12.68%). The metabolisable energy obtained for the study ranged between 12.15 to 12.27 MJ/kg DM, the value with was in line with 11.01 MJ/kg DM recommended for goats by NRC (2007).

The results obtained for proximate composition of turmeric powder revealed that the dry matter (DM) was 86.36%. The value is close to that of Feedipedia (2018) which reported DM content of turmeric to be 89.50%. The values reported by other researchers were higher than what was obtained for the study. Youssef *et al.* (2014) reported DM content of 93.40%, while 91.00% was reported by Ahamefula *et al.* (2014). Crude protein (CP) of 13.27% was obtained for turmeric, whereas lower CP content ranging from 4.6 to 9.40% was reported in other studies (Ahamefula *et al.,* 2014; Youssef *et al.,* 2014; Feedipedia, 2018). Variations in the values for CP might be due to processing methods, soil nutrient composition and effect of location. Crude fibre content obtained for the study was 24.21% which is close to 38.40% reported by Feedipedia (2018), whereas lower values of 4.02% and 4.60% were reported by Youssef *et al.* (2014) and Ahamefula *et al.* (2014) respectively. Values obtained for Ash content, ether extract and nitrogen free extract were 5.07%, 2.74% and 46.15% respectively. Neutral detergent fibre was 66.67%, Acid detergent fibre (38.67%), Acid detergent lignin (8.00%), Hemicellulose (28%) and Cellulose (30.67%). The values obtained for these are similar to what was reported by Feeedipedia (2018). Energy content of 12.44 MJ/kg DM was obtained, the value which was lower than 18.00 MJ/kg DM reported by Feedipedia (2018). The variation might be due to procedures employed in estimating the energy content.

Dry matter percentage (89.12) of the *Brachaiaria* used for the study was similar to that reported by Feedipedia (2018). Crude protein (CP) obtained was 8.01% which was higher than 4.60% that was reported by Feedipedia (2018). The variation in the CP content might be due to various factors ranging from soil nutrients, part(s) of the plant used for analysis, season of harvest and geographical location. The values of Ether extract (EE), Crude fibre (CF), Ash, Nitrogen free extract (NFE) and Organic matter (OM) were 2.41, 24.54, 7.78, 54.17 and 92.22 percent respectively. These values contradicts the results obtained by other authors (Maia *et al.*, 2014; Feedipedia, 2018). These variations might be due to part(s) of the plant used for analysis, season of harvest and geographical location. Fibre analysis for *Brachiaria* revealed that Neutral detergent fibre was 65.33%, Acid detergent fibre (45.33%), Acid detergent lignin (13.33%), Hemicellulose (20%), cellulose (32%).

Kalahari Red Does (KRD) had highest values for all the intakes which included grass and concentrate for the study at the prenatal period. This was followed by KalaWAD Does (KWD), while least intakes were recorded for West African Dwarf (WAD). Since KRD is physically heaviest, then they have capacity to consume more feed than KWD and WAD with the least size in terms of body weight. Similarly, KRD had the highest values for all the weight gains (gross, net and daily) compared to others.

Turmeric Powder Inclusion (TPI) exerted effects on the overall prenatal growth performance for the study. Total feed intake was highest for TP-0, while TP-5g had the least value for same parameter. Does supplemented with TP-2g had the best weight gains (gross, net and daily), followed by Does fed TP-5g while the least gains were recorded for those without TPI. The result is in line with Dinfa *et al.* (2015) who reported that Wenchang broilers fed diets supplemented with turmeric powder at 100 and 200g had improved daily weight gain compared to control. The result contradicts Karami *et al.* (2010) who reported highest weight gain for male goats fed diet supplemented with 500g/100kg of feed. The improvement in body weight gains at different levels of turmeric powder inclusion could be attributed to the fact that herbal plants may provide some compounds that enhance the digestion and absorption of some nutrients in the diet fed, thus leading to improvement in the growth of the goats. On the other hand, there were reports which showed that turmeric had the ability to stimulate the digestive system, such as stimulating the intestinal lipase, sucrose and maltase activities (Platel and Srinivasan, 1996) as well as the secretion of pancreatic lipase, amylase, trypsin and chymotrypsin enzymes (Platel and Srinivasan, 2000).

Does fed TP-2g had most improved feed conversion ratio (FCR), which was followed by TP-5g. The result agreed with the findings of Emadi and Kermanshahi (2007), who reported that *Curcuma longa* improved FCR in broilers and their beneficial effects might be due to enhanced secretions of amylase, trypsin, chymotrypsin and lipase enzymes (Platel and Srinivasan, 2000). Protein efficiency ratio was highest for Does fed TP-5g while those without TPI had least value.

The interaction effects of breeds of goat and levels of turmeric powder inclusion on prenatal growth performance revealed that KRD fed TP-2g had lowest total feed intake of 982.10g/day on DMB, whereas lowest value of 624.30g/day on DMB was recorded for TP-

5g. Gross weight gains of 17.65kg and 119.40g/day were recorded for KRD fed TP-2g, while 9.51kg and 65.57g/day were recorded for WAD fed TP-2g. This is an indication that KRD fed TP-2g had highest weight gain together with foetus and foetal materials during pregnancy compared to WAD fed TP-2g with the lowest gross weight gain. Similarly, highest net weight gains of 11.62kg and 78.50g/day were recorded for KRD fed TP-2g which implies that the Does added 11.62kg to their weights at mating after weights accrued to foetus and foetal materials during pregnancy have been excluded. WAD fed TP-0 recorded least values for same parameter. KWD fed TP-2g recorded least value of 7.82 for FCR which is an indication of better feed utilisation by the Does, while 11.92 was recorded for KRD fed TP-0. Protein efficiency ratio (PER) was highest for KWD fed TP-5g (0.97), whereas KRD fed TP-0 had 0.52 for same parameter. This shows that KWD fed TP-5g had the best protein utilization for feed offered compared to KRD fed TP-0.

Breeds of goat had no effect on abortion, whereas KRD and KWD had 5% and 6.67% for stillbirth and dystocia respectively. WAD had highest values for fecundity and kidding rate which showed that WAD have the ability to produce more offsprings than other breeds. KWD had prolonged gestation length of 152.58 days (with maximum of 162 days) compared to others. The reason for the extended number of days could not be ascertained. WAD had highest values for product of pregnancy within 24hrs before kidding and foetal growth rate, while highest afterbirth weight was recorded for KRD.

Turmeric powder inclusion (TPI) had no effect on abortion rate, whereas it had effects on all other reproductive performance indices and pregnancy variables of goats. Prolificacy, fecundity and kidding rate were highest for Does fed TP-2g. These showed that TPI at 2g/kg will improve the number of offsprings to be produced. Does fed TP-2g had reduced values for product of pregnancy within 24hrs before kidding and foetal growth rate compared to others. This is an indication that there was a nutrient balance for maternal body development and products of pregnancy by the goats fed TP-2g. Does supplemented with TP-0 with the highest values for same parameters mobilised most nutrients for development of products of pregnancy at the expense of maternal body development (Oderinwale *et al*., 2017a).

Interaction effects of breeds of goat and levels of Turmeric powder inclusion on some reproductive performance and pregnancy variables showed that KRD fed TP-0 had 14.28% for stillbirth which was the only one recorded for the study. In the same vein, KWD fed TP-0 had 20% dystocia which was aided by intramuscular injection of oxytocin. No other dietary treatments had any case of dystocia. Prolificacy, fecundity and kidding rates of 1.60, 160% and 160% respectively were obtained for WAD fed TP-2g and TP-5g. Whereas, lowest values of 1.20, 120% and 120% were recorded for KRD and KWD fed TP-5g for respective parameter. These implied that WAD fed TP-2g and TP-5g had ability to produce more offsprings, most especially twins than others. Highest gestation length of 156.80days was obtained for KWD fed TP-5g. Whereas, WAD fed TP-0 recorded gestation length of 144.20days which was the least. WAD fed TP-0 had 11.69kg and 98.75g/day for product of pregnancy taken within 24hrs before kidding and foetal growth rate respectively which account for least value for net weight gain recorded for the Does. Whereas, KRD fed TP-2g with the highest value for net weight gain had the least values for same parameters.

Effects of breeds of goats on birth types and sex of kids produced revealed that both KRD and KWD produced highest number of singleton (66.67%), while WAD produced highest number of twins (53.33%). WAD and KRD produced highest (65%) and lowest (40%) number of male kids respectively, while in contrary, KRD and WAD produced highest (60%) and lowest (35%) number of female kids respectively.

For effects of TPI for goats on birth types and sex of kids produced, highest number of singleton was produced by Does fed TP-5g with 66.67%, whereas, Does that received TP-2g had the highest (46.67%) number of twins. Does fed diet without TPI had highest number of male kids (61.90%), whereas Does fed TP-5g had the highest value for female kids (65%).

Interaction effects of breeds of goat kids and levels of Turmeric powder inclusion on weight distribution of kids based on sex and birth types revealed that kids kidded by KRD fed TP-5g recorded highest values for birth weight; weights for single births; weights for male and female kids compared to kids of other breeds fed the dietary treatments.

Breeds of goats exerted effects on the on weight distribution of kids based on sex and birth types. It was observed that kids produced by KRD had the highest values for the parameters taken, while least values was recorded for same parameters for kids produced by WAD. Kids produced by KRD had highest birth weight (3248.75g); litter weight (4331.70g); singleton (3447.50g); twins (3050g); male kids (3153.75g); and female kids (3312.08g). The reason for these could be attributed to the fact that KRD Does are heavy breed of goat and thus influencing the size of the kids produced.

TPI had no effect on the on weight distribution of kids based on sex and birth types. The results of the study revealed that the kids produced by Does fed diets containing turmeric powder are marginally heavier than the control group, though not in a particular order. This is corroborated by Sameh *et al.* (2018) who reported significant effect of antioxidant on Baladi, Damascus and Zaraibi goats where improved birth weight was reported compared to control group.

Most studies on reproduction do not take into consideration the post-natal growth performance of ruminant animals. The post-natal growth performance will enable pastoralists and/or animal productionists/breeders to know how the dams are faring as the offsprings are adding to their weights from time to time from birth. The results obtained revealed that KRD had the highest values for all the intakes, while least values were obtained for WAD for same parameters. This suggests that KRD consume much feed due to their big size compared to other breeds of goats used. KRD had the least reduction in weight (-0.95kg and -10.50g/day) after nursing their kids for 12 weeks after birth, while KWD had the highest reduction in the values of same parameters (-3.72kg and -41.36g/day).

Results obtained for the effect of levels of Turmeric powder inclusion on post-natal growth performance of lactating goats revealed that Does supplemented with turmeric powder had least values for intakes than the control group. Does fed TP-5g had overall best post-natal performance. The Does had 2kg increase in weight after 12weeks of nursing their kids which resulted into 22.22g/day. The control group on the other hand had highest decrease in the body weight (-3.47kg and -38.58g/day). This suggests that TPI at 5g/kg ensures nutrient balance between the dams and their offsprings during lactation, thus improved performance of the dams.

Interaction effects of breeds of lactating goat and levels of Turmeric powder inclusion on post-natal growth performance showed that KRD fed TP-0 had highest value for total feed intake, whereas the value was least for WAD fed TP-2g. KRD fed TP-5g had overall best post-natal growth performance in terms of final weight and weight changes. The Does were the only ones that added 1.06kg (i.e. 11.80g/day) to their weights during lactation and nursing of their kids that lasted for 12 weeks. This indicated that inclusion of turmeric powder at 5g/kg improved the growth performance of KRD at post-natal period compared to other breeds.

Breeds of goats exerted effects on prolactin and oxytocin concentrations of the Does within 24hrs of kidding and at 3months of lactation. KWD had highest values for prolactin (17.09ng/ml) and oxytocin (37.86pg/ml) within 24hrs after kidding, while KRD had least value for same parameters. At 3 months of lactation, KRD had highest values for prolactin

(13.86ng/ml) and oxytocin (32.75pg/ml). KRG had an increase in the value of oxytocin with 1.42pg/ml during lactation, while KWD experienced a decline in same parameter with -6.54pg/ml during lactation.

TPI had effects on the prolactin and oxytocin concentrations at kidding and at 3 months of lactation. Prolactin concentration was highest (17.68ng/ml) and lowest (14.24ng/ml) for Does fed TP-0 and TP-5g within 24hrs of kidding respectively. At 3 months of lactation, Does fed TP-5g recorded highest values for prolactin (14.60ng/ml) and oxytocin (33.11pg/ml), while Does without TPI had least values of 10.55ng/ml and 29.14pg/ml for respective parameter. Does fed TP-5g had the least reduction in the value of prolactin with -0.86ng/ml during lactation, while Does fed TP-0 experienced the highest reduction (-7,89ng.ml) for same parameter. In the same vein, there was an increase in the value of oxytocin (1.01pg/ml) for Does fed TP-5g compared to Does fed TP-0 with -6.24pg/ml decrease in the value of oxytocin during lactation.

Interaction effects of breeds of goat and levels of Turmeric powder inclusion on prolactin and oxytocin concentrations at kidding and at 3 months of lactation showed that KWD and KRD fed diet without turmeric powder had highest values for prolactin and oxytocin respectively within 24hrs of kidding. Conversely, KRD fed TP-5g had the highest values for same parameters at 3 months of lactation which shows that the hormones were positively influenced by TPI at 5g/kg. Similarly, the difference in the values of prolactin and oxytocin at 3 months of lactation and within 24hrs of kidding revealed that WAD and KRD fed TP-5g had increase in the values of the respective parameters by 3.66ng/ml and 7.73pg/ml.

Breeds of goats exerted effects on the milk yield from kidding to 12 weeks of lactation. KRD had overall highest quantity for milk produced, followed by KWD while WAD recorded the least values. Milk yield was generally low at 1st week of lactation for KRD and KWD, while it peaked at 4th week of lactation for KRD with 1210ml/24hrs and KWD with 850ml/24hrs. WAD recorded peak value at 2nd week of lactation with 625.45ml/24hrs. The yield started to decline from the peak in a non-uniform order afterwards. Peak for the milk yield was slightly earlier for the study compared to Abd-El Gadir and El Zubeir (2005) who reported that the peak in milk yield was reached during 40–50 days of lactation. The yields were lower than what was reported by El-Tarabany *et al.* (2016) for Baladi goats at early, mid and late stages of lactation with 1.63kg, 1.33kg and 1.11kg respectively. At 12th week of lactation, KRD had 532.87ml/24hrs, KWD recorded 508.33ml/24hrs while least value of 310.73ml/24hrs was obtained for WAD. Different researches have shown that reproductive and milk production traits of cow, sheep and goat are influenced by a number of factors, such as genetic type, age, lactation stage, parity and management, including the method of milking (Al-Saiady, 2006; Oravcova *et al.*, 2007; El-Tarabany and El-Bayoumi, 2015).

TPI had effect on milk yield of goat. Does fed TP-2g and TP-5g had overall best performance in terms of milk yield from kidding till 12th week of lactation than the control group. This is corroborated by Mardalena *et al.* (2011) who reported milk yield of Etawah dairy goats supplemented with diet containing antioxidant at 0.02%, 0.04% and 0.06% inclusion levels had overall improved milk yield compared to the control group. Milk yield peaked at 2nd week of lactation for TP-2g and TP-5g with 1060ml/24hrs and 953ml/24hrs respectively, while the control group peaked at 4th week with 718.75ml/24hrs. The final milk yields at the 12th week were 526.80ml/24hrs for TP-2g followed by TP-5g with 476.30ml/24hrs. Does fed TP-0 had the lowest yield at 12th week of lactation with 278.12ml/24hrs.

Interaction effects of breeds of goat and levels of Turmeric powder inclusion on milk yield from 1st week of kidding to 12 weeks post-kidding revealed that KRD fed TP-0 had highest milk at 1st week of lactation compared to other dietary treatments. This might be due to the fact that it recorded highest level of oxytocin and reasonable level of prolactin within 24hrs of kidding. KRD fed TP-2g had overall best performance in terms of milk from 2^{nd} to 12^{th} week of lactation except at week 5 where KRD fed TP-0 had highest value of 1160ml/24hrs which was the peak. Whereas, peak value of 1560ml/24hrs was obtained for KRD fed TP-2g at 4^{th} week of lactation. WAD fed TP-0 recorded lowest values for milk yield from weeks 1 to 12 with peak value of 464.67ml/24hrs at 6^{th} week of lactation.

KRD had marginally highest milk crude protein of 4.46% followed by WAD (3.99%), while KWD had least value of 3.87% for same parameter. KWD had milk fat of 10.94%, KRD (9.29%), while 8.43% was obtained for WAD. Breed exerted effects on Titratable Acidity (TTA) and temperature. WAD recorded highest and lowest values of 0.44% and 33.05^{o}C for TTA and temperature respectively.

Supplementation of concentrate diets with turmeric powder had effect on the milk protein. Does supplemented with TP-2g had highest protein of 4.46%, followed by TP-5g with 4.35%, while TP-0 recorded least value (3.58%) for same parameter. Other parameters were not in a particular order. Generally, TPI had marginally higher values for the proximate composition in comparison to the control group. Although the values were inconsistent to Mardalena *et al.,* (2011) who reported that Etawah dairy goats supplemented with diet containing antioxidant had the highest milk protein (3.78%), milk fat (6.72%) and Lactose (5.62%) compared to control. Similarly, El-Tarabany *et al*. (2016) reported milk protein of 3.60%, fat of 3.27%, lactose of 4.09%, Total solids of 10.99% and solid non-fat of 7.74% for dairy Baladi goats reared intensively.

Breeds of goat and Turmeric powder inclusion had interaction effects on proximate composition and some physico-chemical properties of milk collected a week after kidding, although not in a uniform order. KWD fed TP-0 recorded highest values for total solid, milk fat and temperature. Crude protein and solid non-fat values were highest for KRD fed TP-5g. KWD fed TP-2g had highest values for lactose and milk pH.

Breeds of goats had effects on the somatic cell count (SCC) and coliform count. KRD recorded highest value for SCC (3.84×10^6 cell/ml), while 0.40×10^6 CFU/ml was obtained for KWD for coliform count. The bacteria identified from the cultured milk collected from WAD had *Escherichia coli, Staphylococcus aureus, Bacillus subtilis* and *Micrococcus specie,* whereas other breeds only have *Staphylococcus saprophyticus* in common with *Escherichia coli* and *Bacillus subtilis* as the second bacteria for KRD and KWD respectively.

Does fed TP-2g had lowest value (0.57×10^6 CFU/ml) for total bacteria count (TBC) compared to the control group with 1.69×10^6 CFU/ml which is highest value. Does fed TP-0 had highest number of bacteria identified which included *Escherichia coli, Staphylococcus saprophyticus, Staphylococcus aureus* and *Micrococcus specie*. While TP-2g and TP-5g had *Bacillus subtilis* and *Staphylococcus aureus* respectively. This suggests that turmeric powder has antimicrobial/antibiotic (Peter, 2000; Nur *et al.*, 2016) properties which led to the elimination of the other bacteria found in control group.

Interaction effects of breeds of goat and levels of Turmeric powder inclusion on cholesterol, somatic cell count, coliform count, microbial population and identification of milk collected a week after kidding revealed that WAD and KWD fed diets without turmeric powder inclusion had highest (68.50mg/dl) and lowest (36.15mg/dl) values for milk cholesterol respectively. Total bacteria count (TBC) of 2.20×10^6 CFU/ml which was the highest value was obtained for KRD fed TP-0, while KRD fed TP-2g recorded lowest value (0.17×10^6 CFU/ml) for same parameter. For bacteria identification, *Escherichia coli, Staphylococcus saprophyticus, Staphylococcus aureus, Bacillus subtilis* and *Micrococcus specie* were identified from the milk collected. Does fed diets without turmeric powder inclusion had almost all the bacteria in common, whereas only one of the bacteria was found common to

Does fed diets containing turmeric powder. KRD fed TP-2g had none of the bacteria in common. This is an indication of antibiotic property of turmeric powder.

Breeds of goats have effects on oxidative stress markers and cortisol concentrations from mating till kidding. Results obtained for breed were not in a particular order. Difference between thiobarbituric reacting substances (TBARS) within 24hrs post-kidding and before mating revealed that WAD had highest reduction in the TBARS while KRD recorded the least reduction in same parameter. This is an indication that WAD had reduced oxidative stress during the course of pregnancy than others. On the other hand, KWD had least reduction in the difference of superoxide dismutase (SOD) than other breeds. This suggests that KWD had reduced oxidative stress than the other breeds. Glutathione peroxidase (GSH-Px) difference was least for KRD, whereas least reduction value of glutathione (GSH) was obtained for KWD. WAD experienced an increased value at the end of the study for cortisol compared to other breeds.

Nowadays, trends on applying nutritional antioxidants in ailments related to oxidative stress have gained immense interest. Herbal plants such as turmeric are known to exert their health effects by scavenging free radicals and modulating antioxidant defence system (Azza *et al.*, 2011). Curcuminoids, such as curcumin, demethoxycurcumin and bisdemethoxycurcumin, have anti-oxidative activities. These curcuminoids are major antioxidative compounds of turmeric (Cousins *et al.*, 2007). Curcumin is a potent quencher of singlet oxygen species (Das and Das, 2002) and the major anti-oxidative component of turmeric. It has the ability to inhibit lipid peroxidation and scavenge the superoxide anion and hydroxyl radicals (Motterlini *et al.*, 2000). The results obtained revealed anti-oxidant property of turmeric in the Does by reducing the thiobarbituric reactive substances (TBARS) and improving the values of superoxide dismutase (SOD), glutathione peroxidase (GSH-Px) and glutathione (GSH). Inclusion of turmeric powder at 2g/kg exerted the greatest effect on the oxidative stress markers determined for the study. Dinfa *et al.* (2015) reported that Wenchang broilers fed diets supplemented with 300g/100kg of turmeric powder improved the antioxidant capacity of the birds by increasing SOD and GSH-Px activities and decreasing serum malondiahehyde (MDA) concentrations of the birds. Similarly, results obtained by Bucaka *et al.* (2010) revealed that Angora goats' semen supplemented with curcumin extracted from turmeric had effect on some oxidative stress markers of the goat. According to him, MDA was reduced, while SOD and GSH-Px were increased by the curcumin supplementation. In another research conducted by Alagawany *et al.* (2016) on the liver of New Zealand White rabbits revealed that supplementation of turmeric at 6g/kg recorded highest values for GSH-Px and GSH with 220 mmol/min/ml and 9.90ng/g tissue, while it also recorded least value for MDA (2.83nmol/ml). Does fed diets containing turmeric powder at 5g/kg exerted greatest effect on the reduction of cortisol level than the control with least reduction in same value.

Interaction effects of breeds of goat and levels of Turmeric powder inclusion on oxidative stress markers and cortisol from mating till kidding revealed that Thiobarbituric Acid Reactive Substance (TBARS) was highest for KWD placed under TP-2g before mating and at 1st trimester. KRD fed TP-5g recorded highest value at 2nd trimester, whereas the value for TBARS was highest for KWD fed TP-0 recorded highest value within 24hrs of kidding. The difference in the values of TBARS within 24hrs of kidding and before mating showed that KWD fed TP-2g had the least value of 2.70u/ml, which indicated that the Does had a decrease in the value of TBARS by 2.70u/ml from mating till kidding. Other Does fed turmeric powder, especially at 2g/kg inclusion experienced a reduction in the value of TBARS compared to the control diet. The reduction in the value of TBARS which is the major indicator of oxidative stress (i.e. pro-oxidant) could be attributed to ability of turmeric powder inclusion especially at 2g/kg to alleviate oxidative stress. The differences in the values obtained for endogenous antioxidants like Superoxide Dismutase (SOD), Glutathione

Peroxidase (GSH-Px) and Glutathione (GSH) within 24hrs of kidding and before mating were not in a particular order, but it was observed that Does fed diets containing turmeric powder had improvement in the values of the antioxidants compared to control groups. Thus, the reduction in the value of TBARS. KWD fed TP-5g had least value for the difference in the values of cortisol taken within 24hrs of kidding and before mating, the Does lost 2.93ng/ml during pregnancy.

The life of all flesh is the blood and its usefulness for assessing the health status, chemical evaluation for survey, physiological/pathological conditions and diagnostic and prognostic evaluation of various types of diseases in animals cannot be over emphasized (Tambuwal *et al.*, 2002; Alade *et al.* 2005). It also helps in distinguishing normal state from state of stress, which can be maturational, environmental or physical (Aderemi, 2004). Haematological values are widely used to determine systematic relationship and physiological adaptation including the assessment of general health condition of animal (Kamal *et al.*, 2007). The changes in these parameters have been studied in cattle (Ghergaria *et al.*, 1984); sheep and red Sokoto goat (Tambuwa *et al.*, 2002). Breeds of goats had effect on the haematological parameters determined in the study, although not in a particular order. KWD had improved haemoglobin, PCV, MCH, MCHC, MCV compared to other breeds. Whereas, WAD had the least reduction in the RBC. Different studies (Daramola *et al.*, 2005; Oderinwale *et al.*, 2017b) have revealed the effect of breed on the haematology of goat.

Turmeric powder inclusion (TPI) exerted effects on some haematological parameters taken on the goats. The values obtained were within the range recommended for a clinically normally goat (Radostits *et al.*, 2000). This shows that the goats were in good state during the study. TPI at 2g/kg recorded highest value for RBC. Generally, Does supplemented with TP-5g had improved values for the haematological parameters determined. Increase in PCV values may be attributed to increase in environmental temperature (Isidahomen *et al.*, 2010). High PCV haematocrit values indicates either an increase in the number of circulating RBC or reduction in circulating plasma volume (Kopp and Hetesa, 2000).

Interaction effects of breeds of goat and levels of Turmeric powder inclusion on haematology did not follow a particular order. The haemoglobin of KWD fed TP-5g was increased by 2.31g/l during pregnancy, whereas KRD fed TP-0 lost 2.25g/l. In the same vein, WAD fed TP-2g had an increase by 2.88×10^{12}/l in the value of red blood cells, while KWD fed TP-0 had a reduction of 10.61×10^{12}/l for same parameter during pregnancy. KRD fed TP-0 and KWD fed TP-2g recorded increase and reduction in the values of white blood cells (WBC) by 7.15×10^{9}/l and 2.55×10^{9}/l respectively during pregnancy. This indicates that KRD fed diet without turmeric powder inclusion were challenged healthwisely, thus the increase in the value of WBC. Turmeric powder inclusion at 2g/kg improved the values of packed cell volume, mean corpuscular haemoglobin, mean corpuscular volume and mean corpuscular haemoglobin concentration during the pregnancy compared to control group.

The results obtained for serum biochemistry revealed that there were effects of breed on some parameters taken. KWD had improved values for total protein, albumin, globulin and glucose. Least reduction in the value of cholesterol was observed in WAD while KWD had least difference values for urea, creatinine, ALP and bilirubin.

The inclusion of turmeric powder had effect only on the cholesterol level of the Does. Does fed TP-5g had highest value for cholesterol at mating with 114.01mg/dl, followed by TP-0 (96.57mg/dl), while Does fed TP-2g recorded the least value of 87.93mg/dl for same parameter. TPI at 5g/kg had the least value (84.04mg/dl) for cholesterol within 24hrs of kidding i.e. final. The difference in the values for cholesterol at the final and initial stage of the study revealed that TPI at 5g/kg had the highest reduction in the cholesterol by

26.63mg/dl than other dietary treatments. Rajput *et al*. (2013) reported highest reduction in blood cholesterol for broiler birds fed diets supplemented with curcumin at 200mg/kg. Moreover, Gandhi *et al*. (2011) and Kumari *et al*. (2007) reported that curcumin significantly decreased total cholesterol, which might be due to inhibition of active enzyme hepatic 3-hydroxyl-3-methyglutaryl CoA- reductase (HMGCR), which is responsible for cholesterol synthesis in the liver (Galib *et al*., 2011). The results of Alagawany *et al.* (2016) conducted on New Zealand White rabbits revealed that supplementation of turmeric at 4g/kg had the lowest value for Cholesterol (85.63mg/dl). Mardalena *et al.* (2011) reported slightly higher cholesterol (121.99mg/dl) for Etawah dairy goats fed diets supplemented with antioxidants.

Interaction effects of breeds of goat and levels of Turmeric powder inclusion on serum biochemistry concentrations revealed that the interaction effects did not follow a particular order. KWD fed TP-2g lost 0.43g/dl of total protein during pregnancy, whereas KRD fed TP-0 recorded highest reduction in value (2.45g/dl) for same parameter. KWD fed TP-0 and KRD fed TP-5g had best improvements in the values of albumin and globulin respectively. Turmeric powder inclusion had increased serum cholesterol levels for all the breeds of goats compared to others, although highest value was recorded for KWD fed TP-2g.

Body weights and growth rates in pre-weaning are often considered as an early indicator of the late growth and economic benefit, and can affect body weight at puberty and at first kidding (Portolano *et al.*, 2002; Hanford *et al.*, 2006). Kids produced by KRD had overall best growth performance at the pre and post-weaning periods, followed by kids from KWD and lastly by the kids from WAD. KRD kids had the highest weight at birth (3.25kg), followed by KWD (2.40kg), while WAD kids had least value of 1.95kg. Weaning weight of 14.54kg was obtained for KRD kids which was the highest, followed by KWD kids with 11.21kg. WAD kids had the least weight of 7.78kg at week 12 when weaning was done. Weight gains obtained within 12 weeks of pre-weaning period were 11.25kg and 133.98g/day for KRD kids. WAD kids had least weight gains of 5.83kg and 69.40g/day. KRD kids were heaviest and performed best than kids of other breeds maybe due to big size of KRD compared to other breeds used. There is a direct and linear relationship between dams' weight and kids produced. This is corroborated by Mandal *et al.* (2006) who reported that reproductive process, birth weight and early growth rate of animals are determined not only by genetic potential, but also by maternal and environmental factors. KWD kids had highest mortality (20%), followed by KWD kids with 5%. None of the WAD kids died during the study at the pre-weaning stage. This suggests hardiness of WAD which is being transferred to their offsprings since mortality is always very high at early stage of life for goat kids.

KRD kids had highest intakes at the post-weaning period that lasted for 4 weeks. Total feed intakes of 361.80 and 313.30g/day DM were obtained for kids by KRD and KWD respectively. This indicated that KRD kids consume much due to their big size compared to kids of other breeds. KRD kids had highest final weight of 12.07kg, followed by 11.88kg, while WAD kids had least value (11.82kg) at the post-weaning phase. KRD kids recorded marginally highest values for all other post-weaning parameters taken, while WAD kids had least values for same parameters. KRD and KWD did not have any kid mortality at post-weaning phase, whereas KRD kids had 10% mortality.

Supplementation of turmeric powder had no effects on all the pre-weaning parameters taken. Kids of Does fed diet containing turmeric powder especially at 2g/kg had overall best performance than the control group. This is in line with Sameh *et al.* (2018) who reported kids of Baladi, Damascus and Zaraibi goats supplemented with antioxidant to have overall best pre-weaning performance, especially weaning weight compared to other groups. Kids of Does fed diet without turmeric had highest mortality (14.28%), while kids of Does fed diet containing turmeric recorded least values of 4.54% and 5% for TP-2g and TP-5g respectively at the pre-weaning stage. Post-weaning parameters such as grass intake, final weight, weight gains, feed conversion ratio (FCR) and protein efficiency ratio (PER) were influenced by TPI. Kids fed TP-0 had highest grass intake of 73.24g/day DM, while 54.26g/day DM was obtained for kids fed TP-2g which was the least intake for grass. Kids fed TP-2g had highest values for final weight (12.19kg); and weight gains (1.64kg and 58.62g/day). The kids also recorded lowest value of 6.21 for FCR which indicated better feed utilization. PER was highest (1.36) for kids fed TP-5g which is an indication of better protein utilization by the kids. Kids fed TP-5g had no mortality at the post-weaning phase compared to kids fed diet without turmeric powder supplementation with 4.76% as the highest mortality recorded for the study.

Interaction effects of breeds of goat kids and levels of Turmeric powder inclusion (TPI) on growth performance and mortality from birth to post-weaning revealed that TPI improved the growth performance of the kids produced by Does fed diets containing turmeric powder. Kids produced by KRD fed TP-5g had highest body weights from kidding till week 11. Kids of KRD fed TP-2g had the highest body weight at 12th week when weaning was done. The kids also recorded highest value for pre-weaning weight gains (12.51kg; 148.93g/day) compared to other dietary treatments. Kids of WAD fed TP-0 recorded highest total feed intake of 370.50g/day on DMB for post-weaning performance that lasted for 1 month. Kids of KRD fed TP-2g had overall best performance at post-weaning period in terms of final weight, weight gains and feed conversion ratio, whereas protein efficiency ratio was highest for kids of KWD fed TP-5g. Kids of KWD fed TP-0 had highest pre-weaning mortality which was 28.57%. Post-weaning mortality of 14.28% was obtained for kids of KRD fed TP-0 and TP-2g, while none was recorded for other dietary treatments.

Gastrointestinal nematode infections are the main prevalent parasitic diseases affecting small ruminant productivity worldwide, especially in tropics and sub-tropics (Torres-Acosta and Hoste, 2008; Calvete *et al.*, 2014; Omar *et al.***,** 2016). Goats are highly susceptible to gastrointestinal nematodes in general and to *Haemonchus contortus* in particular, more so than sheep. Helminths worm load obtained among the breeds of kids used ranged between 0.09 to 0.23×10^3 EPG. KRD and KWD kids recorded highest and lowest values for faecal egg count respectively. Faecal egg identification revealed that all the kids of KRD had *Haemonchus contortus* and *Trichostrongylus specie*, whereas kids of KWD and WAD had none of the worms identified which were *Haemonchus contortus, Trichostrongylus specie, Stronglyloides species, Trichuris blobulosa* and *Nematodius specie* in common. These indicated that KWD and WAD kids are more tolerant to helminthiasis than KRD kids. Factors affecting worm load include location, season and age (Sissay *et al.*, 2007; Zvinorova *et al.*, 2016). Rain-fall and temperature also play significant roles in the epidemiology of gastrointestinal parasites as reported by Regassa *et al.* (2006).

The use of herbs and herbal extracts has gained tremendous attention over the past decades. A number of ethno-biological inventions have yielded results in treating intestinal parasites in animals. Research findings have listed many plants as possessing medicinal properties (Athanasiadou and Kyriazakis, 2004; Fajimi and Taiwo, 2005; Githiori *et al*., 2006; Adedapo *et al.*, 2007; Adediran *et al*., 2014; Adediran and Uwalaka 2015). The use of seeds, stems, leaves and roots of some plants such as turmeric, mint, onion and garlic have been exploited to treat animals that suffer from gastro-intestinal parasitism. Turmeric powder supplementation influenced worm load of the kids used. Kids fed diet without turmeric powder had highest faecal egg count of 0.26×10^3 EPG compared with kids fed TP-5g with lowest value of 0.09×10^3 EPG for same parameter. Result of faecal egg identification revealed that kids fed TP-0 had *Haemonchus contortus* and *Stronglyloides species* in common. Whereas kids fed turmeric powder had none of the worms identified which were *Haemonchus contortus, Trichostrongylus specie, Stronglyloides species, Trichuris blobulosa* and *Nematodius specie* in common. This indicated anti-helminthic capability of turmeric when fed to animals, especially goat kids. The relative inability of kids fed TP-0 to resist helminthiasis, and the associated pathophysiological consequences, is believed to be due to poorly developed immunological responses (Hoste *et al.*, 2001). Studies have shown *Trichostrongylus spp* (Jurasek *et al*., 2010), *Stronglyloides spp* (Afzan and Muhammad, 2016) and *Haemonchus* spp (Zvinorova *et al.*, 2016) as the most pathogenic, prevalent and economically important parasites of small ruminants. Parasitic burden results in sub-optimal ruminant livestock production (Adeniji *et al.*, 2017).

Interaction effects of breeds of goat kids and levels of Turmeric powder inclusion on faecal egg count (FEC) and identification revealed that breed and turmeric powder inclusion influenced worm load as obtained from faecal egg count conducted on faeces collected from the kids fed the dietary treatments at the end of 4^{th} week of post-weaning growth performance evaluation. Does fed diets containing turmeric powder had reduced values for faecal egg count compared to control groups for each breed of goat kids used. All the kids fed TP-0 had highest value for FEC especially KRD kids, while KWD kids fed TP-2g had value of 0 for FEC. *Haemonchus contortus* was the most prevalent of the internal parasites identified. The parasite was common to all the kids fed TP-0. Other internal parasites identified included *Trichostrongylus specie, Stronglyloides species* and *Nematodius specie.* All these parasites were common to KRD kids fed TP-2g, whereas the parasites were not common in kids of KRD fed TP-5g; kids of KWD and WAD fed TP-2g and TP-5g. This indicated that turmeric powder has anti-helminthic property.

Breeds had influence on the haematology of goat kids. KW kids had highest values for haemoglobin (11.12g/l), RBC (6.7×10^{12}/l), WBC (12.45×10^{9}/l) and PCV (34.22%) compared to other kids. KR kids had lowest values for haemoglobin (6.95g/l) and 3.67×10^{12}/l for RBC which were below the recommended (Radostits *et al.,* 2000) values for goats. Low

RBCs count may be associated with iron deficiency, bleeding, anaemia or some vitamins deficiency (Al-Bulushi *et al.*, 2017). Bishnu (2016) also reported difference in the haematology of kids from different breeds of goats (Ganjam, Black Bengal and Bolangir) in India. Although the values obtained were inconsistent with what was obtained for the study. Similarly, KWD kids recorded highest values for total protein (5.79g/dl), albumin 3.48g/dl and globulin (2.31g/dl) compared to other breeds of kids.

Kids fed diets containing turmeric powder had least values for eosinophil and monocytes. Whereas, kids fed TP-0 had highest values of 0.75 and 1.44% for eosinophil and monocytes respectively. These indicated that the kids were challenged by internal parasites and had health issues compared to other kids.

Serum biochemistry refers to chemical analysis of blood serum. The analysis is conducted to evaluate renal function, electrolyte metabolism, serum proteins, digestion, injury, lipids, pancreatic function, and the liver. Specialized chemistry testing can also be undertaken to assess thyroid glands and liver function (Miami, 2014). Kids fed TP-2g had highest albumin value of (3.33g/dl), while kids fed TP-0 recorded lowest value of 2.72g/dl for same parameter. Low albumin (hypoalbuminemia) maybe caused by liver disease, malabsoprtion, malnutrition and genetic variations among others. Kids fed TP-2g and TP-5g had highest values for ALT and ALP respectively. Although, least value was obtained for kids fed TP-5g. This is in line with the Akbarian *et al.* (2012) who reported a decrease in ALT with no significant difference in AST for broiler birds fed diets supplemented with turmeric powder at 0.5g/kg. The reduction of ALT activity by turmeric powder can be indicative of better function of liver.

Interaction effects of breeds of goat kids and levels of Turmeric powder inclusion (TPI) on haematological parameters and serum biochemistry concentration showed that turmeric powder inclusion influenced the haematology and serum biochemistry of the kids. All the kids fed diets containing turmeric powder especially KWD kids fed TP-5g had highest values for haemoglobin, red blood cells and packed cell volume compared to control group which is an indication that TPI at 5g/kg improved the values of the parameters. Similarly, KWD fed TP-0 had the highest value of 13.30×10^9/l for white blood cells (WBC), the value which was 4.10×10^9/l for KRD kids fed TP-2g. This shows that the kids had infection/health challenges that led to increase in the value of WBC. All the kids fed diet containing turmeric powder especially at 2g/kg had highest values for total protein, albumin and globulin compared to control groups.

Feed types influenced *in vitro* gas production. Concentrate diet had highest volume of gas produced during the period of incubation up to 48hrs. Combination of concentrate and *Brachiaria ruziziensis* at 75% and 25% inclusion respectively had intermediate values for gas produced while incubation of *Brachiaria ruziziensis* had the least gas production for 48hrs. The amount of gas produced per unit of fermented material reflects the level of fermentation of the grasses/substrate. The gas production for the study increased as time of incubation increased, the greatest proportion of the production occurred in the first 24^{th} hours, this is in line with what was reported by Al-Masri (2007) that the greatest gas volume was produced in the first 24 hours when he experimented on mixture of forages from the range.

In vitro gas production techniques are widely used to evaluate the anti-methanogenic potential of rumen fermentation modifiers, such as plant secondary metabolites (García-González *et al.*, 2008) those plant secondary metabolites at lower concentrations could be used to manipulate rumen fermentation favourably (Medjekal *et al.*, 2017). Turmeric powder inclusion (TPI) had no influence on *in vitro* gas production. Feed supplemented with TP-0 recorded highest gas production, whereas turmeric supplementation especially at TP-2g had reduced gas production which indicated that TPI hasten digestibility of feed.

Results obtained from the study revealed that there was interaction effect of feed types and turmeric powder inclusion (TPI) on *in vitro* gas production. Mixture of 75% Concentrate and 25% *Brachiaria ruziziensis* without turmeric powder supplementation recorded highest values for gas production from 6th hour of incubation till 48th hour while *Brachiaria ruziziensis* containing TP-2g had lowest gas production for same period of time.

Feed types influenced *in vitro* post-incubation parameters and gas production kinetics in the study. Concentrate diet had highest value for the parameters measured, followed by combination of concentrate and *Brachiaria ruziziensis* at 75% and 25% inclusion respectively, while *Brachiaria ruziziensis* recorded least value for the parameters. Dry matter digestibility (DMD) obtained for concentrate indicated that it is more digestible than other feed types.

Metabolisable energy is a good index for measuring the quality of feeds particularly forages. This indicated that the concentrate diet is of good quality followed by combination of concentrate and *Brachiaria ruziziensis,* while *Brachiaria ruziziensis* has least quality as sole feed for ruminant animals. Gas production is a reflection of generation of short chain fatty acids (SCFA) and microbial mass (Getachew *et al*., 1994; 1998). The short chain fatty acids (SCFA) estimated from the gas production in this study revealed that nutrients contained in concentrate feed will be readily utilized after digestion for maintenance and production. Concentrate feed had highest methane gas production (11.33ml/200mg DM) than other feed types.

Concentrate diet had highest fractional rate of gas production (c) which was 0.08ml/hr. The relatively higher values obtained in this study for concentrate may be attributed to higher nutrient composition of the feed. The value obtained for c further showed that concentrate is highly digestible as the rate at which a particular feed or its chemical constituents are digested in the rumen is as important as the extent of digestion. Similarly, Khazaal *et al.* (1996) suggested that the intake of a feed is mostly explained by the fractional rate of gas production (c) which affects the rate of passage of the feed through the rumen. Thus, the values obtained for the fractional rate of gas production (c) of the concentrate may indicate a better nutrient availability for rumen microorganisms (Getachew *et al.*, 2004).

The interaction effects of feed types and Turmeric powder inclusion on *in vitro* post-incubation parameters and gas production kinetics showed that concentrate diet supplemented with TP-2g had highest values for organic matter digestibility, dry matter digestibility and metabolisable energy which implied that the inclusion of turmeric powder influenced the digestion of concentrate compared to others. Short chain fatty acid was highest for concentrate supplemented with TP-5g. Mixture of 75% Concentrate and 25% *Brachiaria ruziziensis*; and concentrate diet without turmeric powder supplementation resulted in highest values for production of carbon IV oxide and methane gas respectively.

5.1 Conclusions and Recommendation

It can be concluded from the results obtained from the study that:

1. Breeds of goat; Turmeric powder (TP) inclusion; and their interaction had effects on pre-natal performance of the Does.

   Kalahari Red had highest values for prenatal performance indices such as Concentrate diet and Grass intakes; Gross and Net weight gains.

   TP inclusion at 2g/kg had overall best prenatal performance in terms of Gross and Net weight gains; and Feed conversion ratio (FCR).

Kalahari Red (KR) Does fed diet with TP at 2g/kg had overall best prenatal performance in terms of Gross and Net weight gains, while KalaWAD (KW) fed diets with TP at 2g/kg and 5g/kg had best values for FCR and protein efficiency ratio (PER) respectively at prenatal period.

2. TP inclusion; and interaction between breeds of goat and TP inclusion influenced post-natal performance of the lactating Does.

   TP inclusion at 5g/kg had overall best postnatal performance in terms of final weight and weight gains at the weaning time.

   KR Does fed diet with TP at 5g/kg had best values for postnatal performance in terms of final weight and weight gains at the weaning time.

3. Breeds of goat, TP inclusion and their interaction had effects on reproductive performance of the Does.

   KR Does had overall best performance for reproduction indices such as birth and litter weights; product of pregnancy within 24 hours before kidding and foetal growth rate. West African Dwarf (WAD) Does had shortest gestation length.

   Pregnancy variables such as product of pregnancy within 24 hours before kidding and foetal growth rate were lowest for TP inclusion at 2g/kg.

   KR Does fed diet with TP at 5g/kg had highest value for birth weight. Product of pregnancy within 24 hours before kidding and foetal growth rate were lowest for KR Does fed diet with TP at 2g/kg. Gestation length was shortest for WAD Does fed diet without TP.

4. Breeds of goat, TP inclusion and their interaction had effects on prolactin and oxytocin concentrations of the lactating Does.

KW Does had highest values for prolactin and oxytocin within 24 hours of kidding, whereas KR Does had highest values for same parameters at the end of 3^{rd} month of lactation.

TP inclusion at 5g/kg had highest values for prolactin and oxytocin concentrations at the end of 3^{rd} of lactation.

KW does fed diet without TP and with TP at 2g/kg had highest values for prolactin and oxytocin concentrations respectively within 24 hours of kidding. KR Does fed diet with TP at 5g/kg had highest values for prolactin and oxytocin concentrations at the end of 3^{rd} of lactation.

5. Breeds of goat, TP inclusion and their interaction had effects on milk yield, proximate composition and milk quality of the lactating Does.

   KR Does produced highest quantities of milk per 24 hours and for total milk yield per 12 weeks. Milk from the Does also had lowest somatic cell count.

   TP inclusion at 2g/kg had highest values for milk yield per 24 hours, total milk yield per 12 weeks, crude protein; and it also had lowest value for total bacterial count for milk collected.

   KR Does fed diet with TP at 2g/kg had highest values for milk yield per 24 hours and total milk yield per 12 weeks; and lowest value for total bacterial count for milk collected, while KR Does fed diet with TP at 5g/kg had highest milk crude protein.

6. Breeds of goat, TP inclusion and their interaction had effects on oxidative stress of the Does.

   WAD Does had reduced value for thiobarbituric acid reactive substances (TBARS) and improved value for glutathione (GSH). KR Does had improved value for glutathione peroxidase (GSH-Px) and decrease in cortisol concentration. Superoxide dismutase value (SOD) was improved by KW Does.

TP inclusion at 2g/kg improved values of SOD and GSH-Px, while GSH value was improved by TP inclusion at 5g/kg.

KW Does fed diet with TP at 2g/kg had highest reduction in the value of TBARS, whereas KW Does fed diet with TP at 5g/kg had improvement in the value for SOD. KR Does fed diets with TP at 2g/kg and 5g/kg had improvement and reduction in the values of GSH-Px and cortisol concentration respectively. WAD Does fed diet with TP at 5g/kg had improvement in GSH value.

7. Breeds of kid, TP inclusion and their interaction influenced performance and faecal egg count (FEC) of the kids.

   KR Does' kids had best pre-weaning performance from birth till weaning and weight gains; and final post-weaning weight. No pre-weaning kid mortality was recorded for WAD kids. KW Does' kids had lowest FEC at the end of post-weaning.

   Kids fed diet with TP at 2g/kg had highest final weight, weight gains and reduced value for FCR for post-weaning performance. Kids fed diet with TP at 5g/kg had highest value for PER and reduced FEC at the end of post-weaning.

   KR Does' kids fed diet with TP at 5g/kg performed best at the pre-weaning period in terms of weights from birth till weaning, and also had highest pre-weaning weight gains. KR Does' kids fed diet with TP at 5g/kg performed best at the post-weaning period in terms of final weight and weight gains. KW Does' kids fed diet with TP at 5g/kg had lowest and highest values for FCR and PER respectively at the post-weaning period. KW Does' kids fed diet with TP at 5g/kg had lowest FEC at post-weaning.

8. Feed types; and the interaction between feed types and TP inclusion influenced *in vitro* studies and digestibility.

Concentrate diet had highest values for parameters measured such as *in vitro* gas production for 48 hours of incubation; organic matter digestibility (OMD); dry matter digestibility (DMD); metabolisable energy (ME); and short chain fatty acids (SCFA). *Brachiaria ruziziensis* had lowest values for carbon IV oxide (CO_2) and methane (CH_4) gas production.

Brachiaria supplemented with TP at 2g/kg had lowest value for *in vitro* gas production for 48 hours of incubation. Concentrate diet supplemented with TP at 2g/kg had improved values for OMD, DMD and ME. *Brachiaria* supplemented without TP and with TP at 2g/kg had highest reduction in the values of CO_2 and CH_4 respectively.

Recommendation

It can be recommended based on the results obtained for the study that effects of turmeric powder should be evaluated at same or other graded levels on non-pregnant goats to test its efficacy on the parameters undertaken in the study.

REFERENCES

Abd El Gadir, M.E., El Zubeir, I.E.M., 2005. Production performance of crossbred (Saanen and Nubian) goats in the second kidding under Sudan conditions. *Pakistan Journal of Biological Science,* 8: 734–739.

Adedapo A. A., Otesile A. T. and Soetan K. O. 2007. Assessment of the Anthelmintic efficacy of the aqueous crude extract of *Vernonia amygdalina*. *Pharmaceutical Biology*, 45(7): 564-568.

Adediran O. A. and Uwalaka E. C. 2015. Effective valuation of Levamisole, Albendazole, Ivermectin and *Vernonia amygdalina* in West African Dwarf Goats. *Journal of Parasitology Research*. 5 pages.http://dx.doi.org/10.1155/2015/706824.

Adediran O. A., Uwalaka E. C. and Kolapo T. U. 2014. Anti-helminthic and Anti-coccidial effects of *Vernonia Amygdalina* in Goats. *Journal of Veterinary Advances,* 4(7): 610-615.

Adeloye, A. 1998. Water utilization by the goat fed with maize cob. *Nutrition Report International.* 32(6): 1461-1466.

Adeniji S A, O A Adediran, T O Ososanya and E C Uwalaka 2017. Antihelminthic and anticoccidial effects of *Zingiber officinale* Roscoe fortified diets fed to Yankasa rams. *Livestock Research for Rural Development.* 29(7): 34-42

Aderemi, F.A 2004. Effects of replacement of wheat bran with cassava root sieviate supplemented of unsupplemented with enzyme on the Haematology and serum biochemistry of pullet chicks. *Tropical Journal of Animal Science*, 7:147-153

Afzan Mat Yusof and Muhammad Lokman Md Isa 2016. Prevalence of gastrointestinal nematodiasis and coccidiosis in goats from three selected farms in Terengganu, Malaysia. *Asian-Pacific Journal of Tropical Biomedicine*, 6(9): 735–739.

Agyei, A.D., Odonkor, M. and Osei-Somuah, A. 2004. Concurrence of Eimeria and helminth parasitic infections in West African dwarf kids in Ghana. *Small Ruminant Research*. 51: 29-35.

Ahamefula I, Onwuka G. I. and Nwankwo C. 2014. Nutritional Composition of Tumeric (Curcuma longa) and its Antimicrobial Properties. *International Journal of Scientific and Engineering Research*, 5(10): 1085-1089.

Akbarian Abdollah, Abolghasem Golian, Hassan Kermanshahi, Ali Gilani and Sajad Moradi 2012. Influence of turmeric rhizome and black pepper on blood constituents and performance of broiler chickens. *African Journal of Biotechnology*, 11(34): 8606-8611,

Akingbade, A.A., Nsahlai, I.V., Bonsi, M.L.K., Morris, C.D. and Du Toit L.P. 2001. Reproductive performance of South African indigenous goats inoculated with DHP-degrading rumen bacteria and maintained on Leucaena leucocephala/grass mixture and natural pasture. Small Ruminant Research. 39: 73-85.

Akram M., Shahab-Uddin, A. Ahmed, K. Usmanghani, A. Hannan, E. Mohiuddin, and M. Asif 2010. *Curcuma Longa* and Curcumin: A Review Article. Rom. J. Biol. Plant Biol., 55, 2: 65–70

Alade, A. A., Bambose, A. M. Ogutona, E.B. and Fanimo, A.O. 2005. Heamatological parameters, serum metabolites carcass characteristic of weaner Rabbits fed yam feel meal diets. Proceedings of 10th annual conference of Animal science Association of Nigeria Dairo, F.A.S. So. K Fajemilehin and G.E Onobi (Eds) held on 12-15 September at university of Ado-Ekiti, Nigeria: 280-282

Alagawany Mahmoud, Elwy Ali Ashour and Fayez Mohamed Reda 2016. Effect of dietary supplementation of garlic *(Allium sativum)* and turmeric *(Curcuma longa)* on growth performance, carcass traits, blood profile and oxidative status in growing rabbits. *Annal of Animal Science*, 16(2): 489–505.

Al-Bulushi S, Shawaf T, Al-Hasani A 2017. Some haematological and biochemical parameters of different goat breeds in Sultanate of Oman “A preliminary study”, *Veterinary World*, 10(4): 461-466.

Alexandre, G., González-García, E., Lallo, C.H.O., Ortega-Jimenez, E., Pariacote, F., Archimède, H., Mandonnet, N. and Mahieu, M. 2010. Goat management and systems of production: Global framework and study cases in the Caribbean. *Small Ruminant Research*, 89: 193-206.

Al-Masri, M. R. 2007. An *in vitro* evaluation of some drought-tolerant native range plants in terms of ruminal microbial nitrogen, microbial biomass and their fermentation characteristics utilising a gas-production technique. *Tropical Grasslands* 41: 292–300

Al-Saiady, M.Y., 2006. Effect of restricted feeding, breed and diet on sheep milk yield. *Journal of Applied Animal Research*, 30, 85–88.

Ammon, H., H. Safayhi, T. Mack and J. Sabieraj 1993. Mechanism of anti-inflammatory actions of curcumin. J. Ethnophar. 38: 113-9

Anthropogenic Methane Emissions in the United States: Estimates for 1990, Report to Congress, U. S. Environmental Protection Agency, Office of Air and Radiation, Washington,

AOAC 2005. *Official Methods of Analysis* (18th Edition). Association of Official Analytical Chemists, Washington DC, USA.

Argel, P. J. ; Miles, J. W. ; Guiot, J. D. ; Cuadrado, H. ; Lascano, C. E., 2007. Cultivar Mulato II (*Brachiaria hibrido* CIAT 36087) - Graminea de alta calidad y produccion forrajera resistente al salivazo y adaptada a los suelos tropicales acidos bien drenados. CIAT, Grupo Papalotla

Argel, P. J. ; Miles, J. W. ; Guiot, J. D. ; Lascano, C. E., 2005. Cultivar Mulato (*Brachiaria híbrido* CIAT 36061) - Gramínea de alta producción y calidad forrajera para los trópicos. CIAT, Grupo Papalotla

Athanasiadou S. and Kyriazakis I. 2004. Plant secondary metabolites: anti-parasitic effects and their role in ruminant production systems. *Proceedings of the Nutrition Society*, 63: 631–639.

Awodi, S.; J.O. Ayo A.D Atodo and T. Dzende 2005. Some Haematological, parameters and the Erythrocyte osmotic fragility in the laughing Dove (*Streptopella senegalensis*) and the village weaver Bird (Ploceus cucullatus) proceedings 10th Annual conference of Animal science Association of Nigeria. Dairo F.A.S., S.O.K. Fajemilehin and G.E. Onibi (Eds) held on 12-15 September at university of Ado Ekiti, Nigeria. 384-387.

Azza M. El-Wakf, EL-Said M. Elhabiby, Waffa M. El-kholy and Eman Abd El-Ghany 2011. Use of Tumeric and Curcumin to Alleviate Adverse Reproductive Outcomes of Water Nitrate Pollution in Male Rats. *Nature and Science*, 9(7); 229-239.

Baker, N.F. 1975. Control of parasitic gastroenteritis in goats. *Journal of American Veterinary Medicine Association*. 167: 1069-1075.

Baker SK, 1999. Rumen methanogens, and inhibition of methanogenesis. Australian J. of Agri. Res. 50:1293-1298.

Bancroft J 2005. The endocrinology of sexual arousal. *The Journal of Endocrinology* 186 (3): 411–27.

Barberis C, Mouillac B, and Durroux T 1998. Structural bases of vasopressin/oxytocin receptor function. *The Journal of Endocrinology*, 156 (2): 223–9.

Barham, D. and Trinder, P., 1972. An Improved Colour Reagent for the Determination of Blood Glucose by the Oxidase System. *Analyst*. 97: 142-145.

Baulieu E, and Schumacher M 2000. Progesterone as a neuro-active neuro-steroid, with special reference to the effect of progesterone on myelination. *Steroids*, 65 (10-11): 605–12

Beauchemin, A. K. and S. M. McGinn. 2005. Methane emissions from feedlot cattle fed barley or corn diets. *Journal of Animal Science*, 83:653-661.

Bernabucci, U., Ronchi, B., Lacetera, N., Nardone, A., 2002. Markers of oxidative status in plasma and erythrocytes of transition dairy cows during hot season. *Journal of Dairy Science* 85: 2173–2179.

Bernabucci, U., Ronchi, B., Lacetera, N., Nardone, A., 2005. Influence of body condition score on relationships between metabolic status and oxidative stress in periparturient dairy cows. *Journal of Dairy Science*, 88: 2017–2026.

Bianospino, E.; Wechsler, F. S.; Fernandes, S.; Roça, R. O.; Moura, A. S. A. M. T., 2010. Growth, carcass and meat quality traits of straightbred and crossbred botucatu rabbits. *World Rabbit Science,* 14(4): 237-246

Bick J, and Dozier M 2010. Mothers' and Children's Concentrations of Oxytocin Following Close, Physical Interactions with Biological and Non-biological Children. *Developmental Psychobiology*, 52 (1): 100–107.

Bishnu Charan Pradhan 2016. Evaluation of haematological and biochemical parameters of goats of central Odisha environment fed on natural grazing land of Odisha, India. *Pharma Innovation Journal,* 5(5): 83-90

Bodas R, López S, Fernández M, García-González R, Rodríguez AB, Wallace RJ, González JS. 2008. *In vitro* screening of the potential of numerous plant species as antimethanogenic feed additives for ruminants. *Animal Feed Science and Technology.* 145: 245–258.

Bole-Feysot C, Goffin V, Edery M, Binart N, and Kelly PA 1998. Prolactin (PRL) and its receptor: actions, signal transduction pathways and phenotypes observed in PRL receptor knockout mice. *Endocr. Rev.*, 19 (3): 225–68.

Bucaka Mustafa Numan, Serpil Sarıözkan, Pürhan Barbaros Tuncer, Fatih Sakin, Ahmet Atessahin, Recai Kulaksız, Mesut Cevik 2010. The effect of antioxidants on post-thawed Angora goat (Capra hircus ancryrensis) sperm parameters, lipid peroxidation and antioxidant activities. *Small Ruminant Research,* 89:24–30.

Burger, Henry G 2002. Androgen production in women. *Fertility and Sterility*, 77: 3–5.

Calonego, J. and Rosolem, C. A., 2013. Phosphorus and potassium balance in a corn-soybean rotation under no-till and chiseling. *Nutrition and Cycling Agro-ecosystem,* 96 (1): 123-131

Calvete, C., Ferrer, L., Lacasta, D., Calavia, R., Ramos, J., Ruiz-de-Arkaute, M., Uriarte,J., 2014. Variability of the egg hatch assay to survey Benzimidazole resistancein nematodes of small ruminants under field conditions. *Veterinary Parasitology*. 203(1): 102–113.

Cardozo, P. W., S. Calsamiglia, A. Ferret and C. Kamel. 2004. Effects of natural plant extracts on ruminal protein degradation and fermentation profiles in continuous culture. *Journal of Animal Science*, 82(11): 3230-3236.

Castillo, C., Hernandez, J., Bravo, A., Lopez-Alonso, M., Pereira, V., Benedito, J.L., 2005. Oxidative status during late pregnancy and early lactation in dairy cows. *The Veterinary Journal,* 169: 286–292.

Castillo, C., Hernandez, J., Valverde, I., Pereira, V., Sotillo, J., Alonso, M.L., Benedito, J.L., 2006. Plasma malonaldehyde (MDA) and total antioxidant status (TAS) during lactation in dairy cows. *Research in Veterinary Science,* 80: 133–139.

Ceccon, G.; Concenço, G., 2014. Mass yield and burn down of perennial forages for crop-livestock integration. *Planta Daninha*, 32 (2): 319-326

Celi P., A. Di Trana and S. Claps 2010. Effects of plane of nutrition on oxidative stress in goats during the peripartum period. *The Veterinary Journal*, 184: 95–99

Celi, P 2011. Oxidative Stress in Ruminants. In '*Studies on Veterinary Medicine*.' (Eds L Mandelker, P Vajdovich.). 5: 191-231. (Humana Press: New York). doi: 10.1007/978-1-61779-071-3_13

Chaudhry, A. S. 2008. Slaughtered cattle as a source of rumen fluid to evaluate supplements for *in vitro* degradation of grass nuts and barley straw. *Open Veterinary Science Journal,* 2:16-22.

Chineke C.A., Olugun, A. G. and Ikeobi, C.O.N. 2006. Haematological parameters in Rabbit Breeds and crosses in Humid Tropics. *Pakistan Journal of Biological sciences*, 9(11):2102-2106.

Christensen A, Dewing P, and Micevych P 2011. Membrane-initiated estradiol signaling induces spinogenesis required for female sexual receptivity. *J. Neurosci.*, 31 (48): 17583–17589.

Clayton, W. D., Harman, K. T., Williamson, H., 2006. Grass Base - The Online World Grass Flora. The Board of Trustees, Royal Botanic Gardens, Kew

Cook, B. G., Pengelly, B. C., Brown, S. D., Donnelly, J. L., Eagles, D. A., Franco, M. A., Hanson, J., Mullen, B. F., Partridge, I. J., Peters, M. and Schultze-Kraft, R., 2005. *Tropical Forages*. CSIRO, DPI and F(Qld), CIAT and ILRI, Brisbane, Australia

Cornelius, C.E. 1980. The economic impact of coccidiosis in domestic animals. In: Fitzgerald, P.R. and Brandly, C.A. (eds.), *Advances in Veterinary Science and Comparative Medicine*. Academic Press, New York, USA, 121-143.

Cotana, F., Petrozzi, A., Pisello, A.L., Cavalaglio, G., Coccia, V., Moretti, E. 2013. An innovative small sized anaerobic digester integrated in historic building. *Energy Proceedia*, 45: 333–341.

Cousins, M., Adelberg, J., Chen, F., Rieck, J., 2007. Antioxidant capacity of fresh and dried rhizomes from four clones of turmeric (*Curcuma longa* L.) grown *in vitro*. *Indian Crop Production*, 25:129-135.

Craven AJ, Nixon AJ, Ashby MG, Ormandy CJ, Blazek K, Wilkins RJ, and Pearson AJ 2006. Prolactin delays hair regrowth in mice. *Journal of. Endocrinology*, 191 (2): 415–25.

Daramola, J.O., Adeloye, A.A., Fatoba, T.A. and Soladoye, A.O. 2005. Haematological and biochemical parameters of West African Dwarf goats. *Livestock Research for Rural Development.* 17(8).

Das, K.C., Das, C.K., 2002. Curcumin (diferuloylmethane), a singlet oxygen ($1O_2$) quencher. *Biochemistry and Biophysical Research Conference,* 295:62-66.

Das, S. K., Das, A. and Bujarbaruah, K. M., 2006. Productive performance, reproductive performance and carcass traits of broiler rabbits in different generations under agro climatic conditions of Meghalaya. *Indian Journal of Animal Research*, 40(1): 38-41

Das, S. K. and Sikka, A. K., 2007. Effect of different housing and feeding systems on the performances of broiler rabbit in Eastern Himalayan Region of India. *Livestock Research for Rural Development*, 19(8): 202-209

David, Scarfe 2012. Management and control of goat coccidia. http://www.goatworld.com/articles/coccidiosis/goatcoccidia.shtml

Devendra, C. and C. C. Sevilla. 2002. Availability and use of feed resources in crop-animal systems in Asia. *Agricultural System*, 71(1- 2): 59-73.
Di Trana, A., Celi, P., Claps, S., Fedele, V., Rubino, R., 2006. The effect of hot season and nutrition on the oxidative status and metabolic profile in dairy goats during mid-lactation. *Animal Science,* 82: 717–722.

Dingfa Wang, Huifang Huang, Luli Zhou, Wei Li, Hanlin Zhou, Guanyu Hou, Jia Liu & Lin Hu 2015. Effects of Dietary Supplementation with Turmeric Rhizome Extract on Growth Performance, Carcass Characteristics, Antioxidant Capability, and Meat Quality of Wenchang

Doumas, B.T., Watson, B.T., and Biggs, H.C., 1971. Albumin Standard and the Measurement of Serum with Bromo Cresol Green. *Clinica Chimica Acta*. 31: 87-96.

Drackley, J.K., 1999. Biology of dairy cows during the transition period: the final frontier. *Journal of Dairy Science,* 82: 2259–2273.

Droge, W., 2002. Free radicals in the physiological control of cell function. *Physiology Reviews,* 82: 47–95.

Duncan, D. B. 1955. Multiple range and Multiple F-tests. Biometrics. 11: 1-42.

Durrani F.R., Ismail M., Sultan A., Suhail S.M., Chand N., and Durrani Z. 2006. Effect of different levels of feed added turmeric (*Curcuma longa*) on the performance of broiler chicks. *Journal of Agricultural and Biological Science,* 1(2): 9-11

Eckard, R.J., Grainger, C., de Klein, C.A.M 2010. Options for the abatement of methane and nitrous oxide from ruminant production: A review. *Livestock Science*, 130: 47–56.

Ecoport, 2014. Ecoport database. Ecoport

EDE Consulting, 2015. Use of *Brachiaria ruziziensis* as cover crop for coffee plantations. Coffee and Climate

Edward A. Le-Viness, 2015. Vital Signs in Animals: What Cattle Producers Should Know About Them. Beef Cattle Handbook- Product of Extension Beef Cattle Resource Committee Adapted from the Cattle Producer's Library, University of Wisconsin-Extension, Cooperative Extension.

Egbe-Nwiyi, T., Igwenagu, E. and Samson, M. 2015. The influence of sex on the haematological values of apparently healthy adult Nigerian Sahel goats. *Sokoto Journal of Veterinary Science*, 13: 54-58.

Ekins, R.P., 1998. Ligand Assays: from Electrophoresis to Miniaturized Microarrays. *Clinical Chemistry*, 44: 2015-2030.

Elitok, B. 2012. Reference values for haematological and biochemical parameters in Saanen goats breeding in Afyonkarahisar Province. *Kocatepe Veterinary Journal*, 5: 7-11.
Ellman, G. L. 1959. Tissue Sulfhydryl Groups. *Archive of Biochemistry Biophysics*. 82:70–77.

El-Tarabany, M.S., El-Bayoumi, K.M., 2015. Reproductive performance of backcross Holstein_Brown Swiss and their Holstein contemporaries under subtropical environmental conditions. *Theriogenology*, 83, 444–448.

El-Tarabany Mahmoud S., Akram A. El-Tarabany, Elshimaa M. Roushdy 2016. Impact of lactation stage on milk composition and blood biochemical and haematological parameters of dairy Baladi goats. *Saudi Journal of Biological Sciences*. http://dx.doi.org/10.1016/j.sjbs.2016.08.003

Emadi M and Kermanshahi H. Effect of turmeric rhizome powder on the activity of some blood enzymes in broiler chickens. *International Journal of Poultry Science*, 6: 48-51. 2007.

Epstein, H. 1971. The origin of the domestic animals of Africa. Volume II. Africana Publishing Corporation, Leipzig, Germany. 573-719pp http://faostat.fao.org/site/573/DesktopDefault.aspx?PageID=573#anc

Faber, J., Kollmann, D., Heise, A., Bauer, C., Failing, K., Burger, H.J. and Zahner, H. 2002. Eimeria infections in cows in the periparturient phase and their calves. Oocyst excretion and level of specific serum and colostrum antibodies. *Veterinary Parasitology*. 104: 1-17.

Faecal Egg Counting (FEC) 2012. http://www.ansci.cornell.edu/goats/Resources/GoatArticles/GoatHealth/GoatParasites/TakingFecalSamples.pdf

Faizal, A.C.M., Rajapakse, R.P.V.J., Jayasinghea, S.R. and Rupasinghe, V. 1999. Prevalence of Eimeria Spp. and gastrointestinal nematodes versus weight gains in treated goats raised in the dry areas of Sri Lanka. *Small Ruminant Research.* 34: 21-25.

Fajimi A. K. and Taiwo A. A. 2005. Herbal remedies in animal parasitic diseases in Nigeria: a review. *African Journal of Biotechnology*, 4: 303–307

FAO 2006. Livestock's long shadow. In Environmental Issues and Options; Food and Agriculture Organization of the United Nations: Rome, Italy.

FAO 2010. Greenhouse gas emissions from the dairy sector. In A Life Cycle Assessment; Food and Agriculture Organization of the United Nations: Rome, Italy.

FAO, 2015. Grassland Index. A searchable catalogue of grass and forage legumes. FAO, Rome, Italy

Fatet, A., Pellicer-Rubio, M.T. and Leboeuf, B. 2011. Reproductive Cycle of Goats. *Animal Reproductive Science.* 124: 211-219.

Feedipedia 2018. Congo Grass (*Brachiaria ruziziensis*) Hay. Animal Feed Resources Information System. http://www.feedipedia.org.node/484

Fievez, V., O.J. Babayemi, and D. Demeyer. 2005. "Estimation of Direct and Indirect Gas Production in Syringes: A Tool to Estimate Short Chain Fatty Acid Production Requiring Minimal Laboratory Facilities". *Animal Feed Science and Technology*. 123-124:197-210.

Flachowsky G., Lebzien P. 2012. Effects of phytogenic substances on rumen fermentation and methane emissions: a proposal for a research process. *Animal Feed Science and Technology*, 176: 70–77.

Foreyt, W.J. 1990. Coccidiosis and cryptosporidiosis in sheep and goats. *Veterinary Clinics of North America: Food Animal Practical*. 6: 655-669.

Fridovich I. 1999. Fundamental aspects of reactive oxygen species, or what's the matter with oxygen? Annals of the New York Academy of Sciences, 893, 13–18.

Gaál, T., Ribiczeyné-Szabó, P., Stadler, K., Jakus, J., Reiczigel, J., Kövér, P., Mézes, M., Sümeghy, L., 2006. Free radicals, lipid peroxidation and the antioxidant system in the blood of cows and newborn calves around calving. Comparative Biochemistry and Physiology Part B: *Biochemistry and Molecular Biology*, 143: 391–396.

Gabai, G., Testoni, S., Piccinini, R., Marinelli, L., Stradaioli, G., 2004. Oxidative stress in primiparous cows in relation to dietary starch and the progress of lactation. *Animal Science*, 79: 99–108.

Galib AMA, Mohseen MA and Abd-AL-Jaleel AR. 2011. Modification of productive performance and physiological aspects of broilers on the addition of a mixture of cumin and turmeric to the diet. *Research Opinions in Animal and Veterinary Sciences*, 1: 31-34.

Gandhi P, Khan K and Chakraverty N. 2011. Soluble curcumin: a promising oral supplement for health management. *Journal of Applied Pharmaceutical Science*, 1: 1-7.

Ganong W.F. 2005. Review of Medical physiology. 22nd Edition McGraw-Hill Medical Publication Asias, 459: 516-532.

García-González R, López S, Fernández M, Bodas R, González JS 2008. Screening the activity of plants and spices for decreasing ruminal methane production *in vitro*. *Animal Feed Science and Technology.* 147: 36-52.

Garcia, R. A., Li, Y. and Rosolem, C. A., 2013. Soil organic matter and physical attributes affected by crop rotation under no-till. *Soil Science Society of America Journal*, 77(5): 1724-1731

Getachew, G., Said, A. N. and Sundstol, F. 1994. The effect of forage legume supplementation and body weight gain by sheep fed a basal diet of maize stover. *Animal Feed Science and Technology* 46: 97-108.

Getachew, G., Blummel, M., Makkar, H. P. S and Becker, K. 1998. In vitro gas measuring techniques for assessment of nutritional quality of feeds: A review. *Anim. Feed Sci. Technol.* 72:261-281.

Getachew, G., Makkar, H. P. S. and Becker, K. 2000. Stoichiometric relationship between short chain fatty acid and in vitro gas production in presence and absence of polyethylene glycol for tannin containing browses. In: EAAP Satellite Symposium, Gas Production: Fermentation Kinetics for Feed Evaluation and to Assess Microbial Activity, Wageningen, August 18–19, pp. 46–47.

Getachew, G., De Peter, E. J. and Robinson, P.H. 2004. In vitro gas production provides effective method for assessing ruminant feeds. *California Agriculture.* 58: 1-12.

Ghergariu S, Rowlands, G.J. Pop, N and Moidova, A. 1984. A comparative study of matabolic profiles obtained in Dairy Herds in Romania. *British veterinary Journal.* 140:600-608.

Ghosh, P. K., Saha, R., Gupta, J. J., Ramesh, T., Das, A., Lama, T. D., Munda, G. C., Bordoloi, J. S., Verma, M. R. and Ngachan, S. V., 2009. Long-term effect of pastures on soil quality in acid soil of North-East India. *Australian Journal of Soil Research*, 47(4): 372-379

Giancotti, P. R. F., Nepomuceno, M. P., Alves, P. L. C. A. and Yamauti, M. S., 2015. Ideal desiccation periods of *Urochloa ruziziensis* for a no-till sunflower crop. *International Journal of Plant Production*, 9 (1): 39-50

Gibbs M. J. and R. A. Leng 1993. "Methane Emissions from Livestock", *Methane and Nitrous Oxide, Proceedings of the International IPCC Workshop,* Amersfoort, the Netherlands, 73-79.

Gimpl G, and Fahrenholz F 2001. The oxytocin receptor system: structure, function, and regulation. *Physiological Reviews*, 81 (2): 629–83.

GINSENG 2018. Turmeric. http://en.mr-ginseng.com/turmeric/#Turmeric_Composition

Girma, Abebe 2012. Reproduction in Sheep and Goats. *Sheep and Goat Production Handbook for Ethiopia*. http://www.esgpip.org/handbook/Handbook_PDF/Chapter%205_%20Reproduction%20in%20Sheep%20and%20Goats.pdf

Githiori J. B., Athanasiadou S. and Thamsborg S. M. 2006. Use of plants in novel approaches for control of gastrointestinal helminths in livestock with emphasis on small ruminants. *Veterinary Parasitology*, 139: 308–320.

Goodson WH, Handagama P, Moore DH, and Dairkee S 2007. Milk products are a source of dietary progesterone. *30th Annual San Antonio Breast Cancer Symposium*. 2028.

Gonzalo C.B., Linage B., Carried J.A., De La Fuente L.F. 2008. Evaluation of the accuracy of the De Laval cell counter for somatic cell count in ovine milk. Effect of soak time in diluted and undiluted milk samples. *Journal of Diary Science*, 91: 3114-3118

Grieve, C. M. and Osbourne, D. F. 1965. The nutritional value of some tropical grasses. *Journal of Agricultural Science*, 65(3): 411-417

Guerra, M.M.P., Silva, S.V., Batista, A.M., Coleto, Z.F., Silva, E.C.B., Monteiro, P.L.J. and Carneiro, G.F. 2011. Goat reproductive biotechnology in Brazil. *Small Ruminant Research*. 98: 157–163.

Gunun P, Wanapat M, Gunun N, Cherdthong A, Sirilaophaisan S, Kaewwongsa W. 2016. Effects of condensed tannins in mao (Antidesma thwaitesianum Muell. Arg.) seed meal on rumen fermentation characteristics and nitrogen utilization in goats. *Asian-Australian Journal of Animal Science*, 29:1111–1119.

Gupta, J. J., Doley, S. and Bujarbaruah, K. M., 2007. Evaluation of forage based feeding system for rabbit production in north-eastern region of India. *Indian Journal of Animal Nutrition*, 24 (4): 216-218

Halliwell, B., and Gutteridge, J.M.C. 1989. Free radicals in biology and medicine. Oxford: Oxford University Press, 543.

Handa RJ, Ogawa S, Wang JM, and Herbison AE 2012. Roles for oestrogen receptor β in adult brain function. *J. Neuroendocrinol*., 24 (1): 160–173.

Hanford K J, van Vleck L D and Snowder G D 2006. Estimates of genetic parameters and genetic trend for reproduction, weight, and wool characteristics of Polypay sheep. *Livestock Science*, 102:72–82.

Hedges, A.J. 2002. Estimating the precision of serial dilution and viable bacteria count. *International Journal of Food Microbiology*, 76(3): 207-214

Heiman JR, Rupp H, Janssen E, Newhouse SK, Brauer M, and Laan E 2011. Sexual desire, sexual arousal and hormonal differences in premenopausal US and Dutch women with and without low sexual desire". *Horm Behav.*, 59 (5): 772–779.

Heise, A. 2012. Artificial Insemination in Veterinary Science, A Bird's-Eye View of Veterinary Medicine, Dr. Carlos C. Perez-Marin (Ed.), InTech, Available from: http://www.intechopen.com/books/a-bird-s-eye-view-of-veterinary-medicine/artificial-insemination-in-veterinaryscience.

Henry, R.J., Canon, D.C., and Winkelman, J.W., 1974. Clinical Chemistry Principles and Techniques. 2nd Edition, Harper and Row, New York, pp: 1196.

Herrero, M., Valle, C. B., Hughes, N. R. G., V O. Sabatel and Jessop, N. S. 2001. Measurements of physical strength and their relationship to the chemical composition of four species of Brachiaria. *Animal Feed Science and Technology*, 92(3-4): 149-158

Hess RA, Bunick D, Lee KH, Bahr J, Taylor JA, Korach KS, and Lubahn DB 1997. A role for estrogens in the male reproductive system. *Nature*, 390: 447–8.

Hill RA, Pompolo S, Jones ME, Simpson ER, and Boon WC 2004. Estrogen deficiency leads to apoptosis in dopaminergic neurons in the medial preoptic area and arcuate nucleus of male mice. *Mol. Cell. Neurosci.*, 27 (4): 466–76.

Hodjatpanah A.A., Msegaran M.D., and Vakili A.R. 2010. Efeects of diets containing Monensin, garlin oil or turmeric powder on ruminal and blood metabolite responses of sheep. *Journal of Animal and Veterinary Advances,* 9(24): 3104-3108.

Holtz, W. 2005. Recent Developments in Assisted Reproduction in Goats. *Small Ruminant Research*.60: 95–110.

Hoste H, Leveque H, Dorchies P. 2001. Comparison of nematode infections of the gastrointestinal tract in Angora and dairy goats in a rangeland environment: relations with the feeding behaviour. *Veterinary Parasitology*, 101: 127–135.

Howeler, R. H., Tongglum, A., Jantawat, S. and Utomo, W. H., 1998. The use of forages for soil fertility maintenance and erosion control in cassava in Asia. In: Stür, W. W., Proc. 3rd Reg. Meet. Forages for Smallholders held at the Agency for livestock services, East Kalimatan, Indonesia. 23-26 march 1998. CIAT working paper no. 188: 196-211

Husson, O., Charpentier, H., Razanamparany, C., Moussa, N., Michellon, R., Naudin, K., Razafintsalama, H., Rakotoarinivo, C., Rakotondramanana and Séguy, L. 2008. *Brachiaria sp*., B. ruziziensis, B. brizantha, B. decumbens, B. humidicola. CIRAD, Manuel pratique du semis direct à Madagascar, Vol. III, Chap. 3, par. 4.1

Ibrahim, M. N. M., Tamminga, S. and Zemmelink, G. 1995. Degradation of tropical roughages and concentrate feeds in the rumen. *Animal Feed Science and Technology*, 54(1-4): 81-92.

Igbokwe, I.O., Ribadu, A.Y. and Bukar, M.M. 1998. Erythrocyte glutathione concentrations in Nigerian Sahel goats. *Small Ruminant Research.* 30:1-6.

ILRI, 2013. Ruzi grass (*Brachiaria ruziziensis*) for livestock feed on small-scale farms. ILRI, Nairobi, Kenya

INFIC, 1978. Data from International Network of Feed Information Centres. Rome, FAO

Insung, O., Vearasilp, T., Ter meulen, U.; and Chakeredza, S. 2004. Influence of plant species and conservation methods on voluntary intake and digestibility of dry matter and organic matter of ruzi grass (Brachiaria ruziziensis) and Streblus leaves (Streblus asper Lour) in goats under the humid tropical climate in southern part of Thailand. *Proceeding of the Deutscher Tropentag*, 259-264

Intergovernmental Panel on Climate Change (IPCC) 2001. The scientific basis. Contribution of working group I to the third assessment report of the intergovernmental panel on climate change. Cambridge, UK: Cambridge University Press.

Inyang, U. I., 2009. Management of Brachiaria cultivar mulato in South Florida. Master of Sciences, University of Florida

Isidahomen, E.C, Ikhimioya, I, Njidda A.A and Okoruwa, M. I. 2010. Haematological parameters and Blood chemistry of different species of Ruminant animals in Humid Tropical environment. *Nigerian Journal of Agriculture and forestry*, 3(1): 85-90.

Jain, N.C., 1993. Essentials of Veterinary Haematology. Lea and Ferbeiger, Pennsylvania, U.S.A. pp 7.

Jalila, A., Dorny, P., Sani, R., Salim, N.B. and Vercruysse, J. 1998. Coccidiosis infections of goats in Selangor, peninsular Malaysia. *Veterinary Parasitology*. 74: 165-172.

Janegitz, M. C., Inoue, B. S. and Rosolem, C. A. 2013. Soil phosphorus pools as affected by brachiaria and white lupin. *Ciência Rural*, 43(8):1381-1386

Jim, Miller 2012. Internal and external parasites of goats. Louisiana State University. http://www.luresext.edu/goats/training/parasites.pdf

John, Hibma 1998. Fecal Examinations for Caprine Parasites. http://www.dairygoatjournal.com/issues/89/894/fecal_examinations_for_caprine_parasites.html

Johnson KA, and Johnson DE, 1995. Methane emissions from cattle, Journal of Anim. Sci. 73, 2483-2492.

Jurasek, M.E., Bishop-Stewart, J.K., Storey, B.E., Kaplan, R.M., Kent, M.L., 2010. Modification and further evaluation of a fluorescein-labeled peanut agglutinintest for identification of Haemonchus contortus eggs. *Veterinary Parasitology*. 169(1): 209–213.

Kamal Shah M., A. Khan, F. Rizvi, M. Siddique and Sadeeq-ur-rehman 2007. Effect of cypermethrin on clinico-Haematological parameters in Rabbits. *Pakistan Veterinary Journal,* 27(4):171-175.

Kandiannan K., Sasikumar B., Thankamani C.K., Suseela Bhai R., Santhosh J. Eapen, Devasahayam. S. and John Zachariah T. 2009. Turmeric. *Indian Institute of Spices Research*. Eds: Kandiannan K., Thankamani C. K., Srinivasan V., Rajeev P. Niseema Printers and Publishers, Kochi -18

Karami Morteza, Abd Razak Alimon, Yong Meng Goh, Awis.Qurni Sazili and Michael Ivan 2010. Effects of Dietary Herbal Antioxidants Supplemented on Feedlot Growth Performance and Carcass Composition of Male Goats. *American Journal of Animal and Veterinary Sciences,* 5(1): 33-39

Karaskova K., P. Suchy, E. Strakova 2015. Current use of phytogenic feed additives in animal nutrition. *Czech Journal of Animal Science,* 60(12): 521–530

Katanos, J., Skapetas, B., Laga, V., 2005. Machine milking ability and milk composition of some imported dairy goat breeds and some crosses in Greece. *Czech Journal of Animal Science,* 50, 394–401.

Kausslish, S.K and Arora, K.L. 1977. Studies on Reproduction in sheep. Blood andplasma contents before and after parturition in Nehi sheep. *Haryna Veterinarian* 16(2):74- 77.

Kawashima, T., Sumamal, W., Pholsen, P., Chaithiang, R. and Kurihara, M. 2006. Comparative study on energy and nitrogen metabolisms between Brahman cattle and swamp buffalo fed with low quality diet. *Japan Agricultural Research Quarterly*, 40(2): 183-188

Kawashima, T., Sumamal, W., Pholsen, P., Chaithiang, R. and Terada, F. 2007. Comparative study on energy and nitrogen metabolism of Brahman cattle and sheep given ruzi grass hay with different levels of soybean meal. *Japan Agricultural Research Quarterly*, 41(3): 253-260

Kendrick KM 2004. The Neurobiology of Social Bonds. *British Society for Neuroendocrinology*. Retrieved 2009-04-13.

Khalesizadeh A., Vakili A., Mesgaran M.D., and R. Valizadeh 2011. The effects of Garlic Oil (Allium sativa), Turmeric Powder (Curcuma longa Linn) and Monensin on Total Apparent Digestibility of Nutrients in Baloochi Lambs. *World Academy of Science, Engineering and Technology,* 59: 915-917.

Khan, M. M. H. and Chaudhry, A. S. 2010. Chemical Composition of Selected Forages and Spices and the Effect of These Spices on In vitro Rumen Degradability of Some Forages. *The Asian-Australian Journal of Animal Science,* Vol. 23, No. 7: 889 – 900.

Khandaker, Z. H., H. Steingass and W. Drochner. 1998. Supplementation of wheat straw with sesbania on voluntary intake, digestibility and ruminal fermentation in sheep. *Small Ruminant Research*, 28(1): 23-29.

Khanum, S. A., Hussain, H. N., Hussain, M. and Ishaq, M., 2010. Digestibility studies in sheep fed sorghum, sesbania and various grasses grown on medium saline lands. *Small Ruminant Research*, 91 (1): 63-68

Khazaal, K., Parissi, Z., Tsiouvaras, C., Nastis, A. and Orskov, E. R. 1996. Assessment of phenolics-related anti-nutritive levels used the in vitro gas production technique: a comparison between different types of polyvinyl/polypyrroliodone or polyethylene glycol. *Journal of Science of Food* and *Agriculture* 71: 405-414.

Kim D.H., Kim K.H., Nam I.S., Lee S.S., Choi C.W., Kim W.Y., Kwon E.G., Lee K.Y., Lee M.J., and Oh Y.K. 2013. Effect of Indigenous Herbs on Growth, Blood Metabolites and

Carcass Characteristics in the Late Fattening Period of Hanwoo Steers. *Asian Australian Journal of Animal Science*, 26 (11): 1562-1568.

Kiuchi, F., Y. Goto, N. Sugimoto, N. Akao, K. kondo and Y. Tusda. 1993. Nematocidal activity of turmeric: synergestic action of curcuminoids. Chem. Pharm Bull (Tokyo). 41: 1640-3.

Konyalı, A., Tölü, C., Daş, G. and Savaş, T. 2007. Factors Affecting Placental Traits and Relationships of Placental Traits with Neonatal Behaviour in Goat. *Animal Reproduction Science*. 97: 394-401.

Kopp, R and J. Hetesa 2000. Changes of Haemotological studies in adolescent breeding cocks. *Acta veterinary,* 69:189-194.

Krumholz LR, Forsberg CW, and Veira DM, 1983. Association of methanogenic bacteria with rumen protozoa, Canadian J. of Micro., 29, 676-680.

Kumari P, Gupta MK, Ranjan R, Singh KK and Yadav R. 2007. *Curcuma longa* as feed additive in broiler birds and its patho-physiology effect. *Indian Journal of Experimental Biology*, 45: 272-277.

Lans Cheryl, Nancy Turner, Tonya Khan, Gerhard Brauer and Willi Boepple 2007. Ethnoveterinary medicines used for ruminants in British Columbia, Canada. *Journal of Ethnobiology and Ethnomedicine*. 3:11; 1-22

Larbi, A., Smith, J. W., Adekunle, I. O. and Kurdi, I. O. 1996. Studies on multipurpose fodder trees and shrubs in West Africa: Variation in determinants of forage quality in *Albizia* and *Paraserianthes* species. *Agroforestry System*, 33: 1-11.

Larsen CM, and Grattan DR 2012. Prolactin, neurogenesis, and maternal behaviors. *Brain Behav. Immun.*, 26 (2): 201–9.

Lascano, C. E. and Euclides, V. P. B. 1996. Nutritional quality and animal production of Brachiaria pastures. In: Miles et al. ed., Brachiaria: biology, agronomy and improvement, CIAT, EMBRAPA, 106-123

Lassen, J., Løvendahl, P. and Madsen, J. 2012. Accuracy of non-invasive breath methane measurements using Fourier transform infrared methods on individual cows. *Journal of Dairy Science*, 95: 890–898.

Latimer, K.S., E.A Mahaffey and K.W Prasse 2004. Clinical pathology: veterinary laboratory medicine 4th Ed., Iowa State University press Ames, Iowa U.S.A.

Lean, IJ, DeGaris, PJ, Celi, P, McNeill, DM, Rodney, RM, Fraser, DR 2014. Influencing the future: interactions of skeleton, energy, protein and calcium during late gestation and early lactation. *Animal Production Science*, 54: 1177–1189.

Lebas, F., Coudert, P., de Rochambeau, H. and Thébault, R. G. 1997. The Rabbit-Husbandry, Health and Production. *FAO Animal Production and Health*, 21 (new revised version)

Lebas, F., 2013. Estimation of protein digestibility and digestible energy content of raw materials for the rabbit, with a system of equations. 15èmes Journées de la Recherche Cunicole, Le Mans, 19-20 nov: 27-30

Lee HJ, Macbeth AH, Pagani JH, and Young WS 2009. Oxytocin: the great facilitator of life. *Progress in Neurobiology*, 88 (2): 127–51.

Lima S. F. I., Timossi, P. C. I, Almeida, D. P. and Silva U. R., 2014. Weed suppression in the formation of brachiarias under three sowing methods. *Planta Daninha*, 32(4): 699-707

Lopes, F. C. F., Paciullo, D. S. C., Mota, E. F., Pereira, J. C., Azambuja, A. A., Motta, A. C. S., Rodrigues, G. S. and Duque, A. C. A. 2010. Chemical composition and in-situ ruminal degradability of four Brachiaria species. *Archive of Brazilian Medicine and Veterinary Zootecnica*, 62(4): 883-888

Lowilai, P, Saigram, Y. and Wilaipon, B. 2002. Effects of formic acid on the quality of ruzi grass silage. *Kaen Kaset Journal*, 30(3): 170-180

Lucas BK, Ormandy CJ, Binart N, Bridges RS, and Kelly PA 1998. Null mutation of the prolactin receptor gene produces a defect in maternal behavior. *Endocrinology*, 139 (10): 4102–7.

Lusby, K.S., Enis, S.O. and McNew, R.W. 1979. Twenty-Four vs 30-Month-Old Calving with Hereford Heifers. Oklahoma Agricultural Experiment Station. *Animal Science Research Report*. 90-93.
Lykkesfeldt, J., and Svendsen, O. 2007 Oxidants and antioxidants in disease: Oxidative stress in farm animals. *The Veterinary Journal*, 173: 502-511

MAFF (Ministry of Agriculture, Fisheries and Food) 1984. Energy Allowance and Feeding Systems for Ruminants. 2nd Edition, Chalcombe Publications, Marlow, UK. 85pp

Maia, G. A., Costa, K. A. P., Severiano, E. C., Epifanio, P. S., Neto, J .F., Ribeiro, M. G., Fernandes, P. B., Silva, J. F. G. and Gonçalves, W. G. 2014. Yield and chemical composition of brachiaria forage grasses in the offseason after corn harvest. *American Journal of Plant Science*, 5: 933-941

Maia, G.A., De Pinho Costa, K.A., Da Costa Severiano, E., Epifanio, P.S., Neto, J.F., Ribeiro, M.G., Fernandes, P.B., Silva, J.F.G. and Gonçalves, W.G. 2014. Yield and Chemical Composition of Brachiaria Forage Grasses in the Offseason after Corn Harvest. *American Journal of Plant Sciences*, **5**, 933-941. http://dx.doi.org/10.4236/ajps.2014.57106

Mandal A, Neser, F W C, Rout P K, Roy R and Notter D R 2006 Estimation of direct and maternal (co)variance components for pre-weaning growth traits in Muzaffarnagari sheep. *Livestock Science*, 99:79–89.

Mardalena, L. Warly, E. Nurdin, W.S.N. Rusmana and Farizal 2011. Milk quality of dairy goat by giving feed supplement as antioxidant source. *Journal of Indonesian Tropical Animal Agriculture*, 36(3): 205-211.

McCrabb GJ, and Hunter RA, 1999. Prediction of methane emissions from beef cattle in tropical production systems, Australian J. Agri. Res., 50, 1335-1339.

McDonald P., Stirling A.C., Henderson A.R., Dewar W.A., Stark G.H., Davie W.G., Macpherson H.T., Reid A.M., and Salter J. 1960. Studies on ensilage. Technical Bulletin No. 24. pp. 1–83. Edinburgh School of Agriculture, Edinburgh, Scotland.

Meale, S. J., Chaves, A. V., Baah, J. and McAllister, T. A. 2012. Methane production of different forages in *in vitro* ruminal fermentation. *Asian-Australian Journal of Animal Science*, 25(1): 86-91

Mechoulam R, Brueggemeier RW, and Denlinger DL 2005. Estrogens in insects. *Cellular and Molecular Life Sciences*, 40 (9): 942–944.

Medjekal S, Ghadbane M, Bodas R, Bousseboua H, López S 2016. Volatile fatty acids and methane production from browse species of Algerian arid and semi-arid areas, *Journal of Applied Animal Research.* 45; 1-6.

Medjekal S, Bodas R, Bousseboua H and López S 2017. Evaluation of three medicinal plants for methane production potential, fiber digestion and rumen fermentation *in vitro*. *Energy Procedia*. 119; 632-641.

Mellado, M., Valdez, R., Lara, L.M. and Garcia, J.E. 2004. Risk Factors Involved in Conception, Abortion, and Kidding Rates of Goats under Extensive Conditions. *Small Ruminant Research.* 55: 191–198.
Mellado, M., Valdez, R., Garcia, J.E., ´Opez R.L. and Rodr´ıguez, A. 2006. Factors affecting the reproductive performance of goats under intensive conditions in a hot arid environment. *Small Ruminant Research*. 63: 110–118.

Mellor, D.J. and Stafford, K.J. 2004. Animal Welfare Implications of Neonatal Mortality and Morbidity in Farm Animals. *Veterinary Journal.* 168: 118–133.

Menke, K. H. and Steingass, H. 1988. Estimation of the energetic feed value from chemical analysis and in vitro gas production using rumen fluid. *Animal Research and Development*, 28: 7-55

Miami 2014. Serum Biochemistry http://cpl.med.miami.edu/pathology-research/veterinary-clinical-pathology-laboratory/serum-biochemistry
Miguel, P. S. B., rocha, W. S. D. da, Sobrinho, F. S., Martins, C. E., Gomes, F. T., Oliveira, A. V. de and Carvalho, C. A. de, 2011. *Brachiaria Ruziziensis* genotypes selection. II: Evaluation of the aluminum tolerance. *Revised Ciências Agrár.*, 34(1): 90-97

Miles, J. W., Maas, B. L., do Valle, C. B. and Kumble, V., 1996. Brachiaria: biology, agronomy and improvement. CIAT, EMBRAPA

Miller, J.K., Brzezinska-Slebodzinska, E., Madsen, F.C., 1993. Oxidative stress, antioxidants, and animal function. *Journal of Dairy Science*, 76: 2812–2823.

Minson DJ, 1990. Forage in Ruminant Nutrition. Academic Press, London, UK.

Mirzaei-Aghsaghali A., and N. Maheri-Sis. 2011. Factors affecting mitigation of methane emission from ruminants I: Feeding strategies. - *Asian Journal of Animal and Veterinary Advances*, 6: 888-908.

Mishra, A., Chatterjee, U.S. and Mandal, T.K. 2013. Induction of chronic renal failure in goats using Cisplatin: A new animal model. *Toxicology International*, 20: 56-60.

Moran, L.K., Gutteridge, J., Quinlan, G.J., 2001. Thiols in cellular redox signalling and control. *Current Medicinal Chemistry*, 8: 763.

Moss D.W. and Henderson A.R. 1999. Clinical enzymology In: Burtis CA, Ashwood ER, editors. Tietz Textbook of Clinical Chemistry. 3rd ed. Philadelphia: W.B Saunders Company; 617-721

Moss AR, Jouany J, and Newbold J, 2000. Methane production by ruminants: its contribution to global warming. Annales de Zoot., 49, 231-253.

Motterlini, R., Foresti, R., Bassi, R., Green, C.J., 2000. Curcumin, an antioxidant and anti-inflammatory agent, induces hemeoxygenase-1 and protects endothelial cells against oxidative stress. *Free Radical Biological Medicine*, 28:1303-1312.

Muetzel, S., E. M. Hoffmann and K. Becker. 2003. Supplementation of barley straw with *Sesbania pachycarpa* leaves *in vitro*: effects on fermentation variables and rumen microbial population structure quantified by ribosomal RNAtargeted probes. *British Journal of Nutrition*, 89(4): 445-453.

Muro-Reyes A., H. Gutierrez-Banuelos, L.H. Diaz-Garcia, F.J. Gutierrez-Pina, L.M. Escareno-Sanchez, R. Banuelos-Valenzuela, C.A. Medina-Flores, and A. Corral Luna. 2011. Potential Environmental Benefits of Residual Feed Intake as Strategy to Mitigate Methane Emissions in Sheep. - *Journal of Animal and Veterinary Advances*, 10: 1551-1556

Nakkitset, S., Mikled, C. and Ledin, I., 2008. Evaluation of head lettuce residue and Mimosa pigra as foliages for rabbits compared to Ruzi grass: Effect on growth performance and production costs on-farm. *Livestock Research for Rural Development*, 20 (supplement)

Napasirth, V. and Sivilay, B. 2009. The study of chemical composition of animal feed resource in Central Lao PDR: Vientiane Capital. *Lao Journal of Agricultural Forestry*, 16: 111-118

National Research Council (NRC) 2007. Nutrient Requirements of Small Ruminants: Sheep, Goats, Cervids, and New World Camelids. Committee on the Nutrient Requirements of Small Ruminants, National Research Council Report. ISBN: 978-0-309-10213-1.384.

Nazário, W., Mandorino I., Maravolta V.A., Dupas W. and Weyand S. C., 1985. Fotossensibilização em ovinos mantidos em pastagem de Brachiaria ruziziensis Germain et Evrard, no Estado de São Paulo, com provável participação do fungo Pithomyces chartarum. *Revised Brazilian Medicine and Veterinary*, 7(7): 216-218

Nelson LR, and Bulun SE 2001. Estrogen production and action. *J. Am. Acad. Dermatol,* 45 (3): 116–124.

Njidda, A., Hassan, I. and Olatunji, E. 2013. Haematological and biochemical parameters of goats of semi-arid environment fed on natural rangeland of Northern Nigeria. *Journal of Agricultural and Veterinary Science*, 3: 1-8.

Norman Adler, Donald Pfaff, and Robert W. Goy 2012. Handbook of Behavioral Neurobiology Volume 7 Reproduction (1st Ed.). New York: Plenum Press. p. 189.

Notter, D.R. 2012. Genetic improvement of reproductive efficiency of sheep and goats. *Animal Reproduction Science*. 130: 147– 151.

Nunes, J.F. and Salgueiro, C.C.M. 2011. Strategies to improve the reproductive efficiency of goats in Brazil. *Small Ruminant Research*. 98: 176- 184.

Nur Syakila Azmi, Rajeev Bhat and Yeoh, T.K 2016. Quality evaluation of novel cookies prepared by supplementing with fresh turmeric flower (*Curcuma longa* L.) extracts as a value added functional ingredient. *International Food Research Journal*, 23(4): 1514-1522

Nutrition-and-you 2018. Turmeric nutrition facts. http://www.nutrition-and-you.com/turmeric.html

Oderinwale O. A., B. O. Oluwatosin, O. S. Sowande, M. N. Bemji, S. D. Amosu and G. O. Sanusi 2017a. Concentrate supplementations of grazing pregnant Kalahari Red goats: Effects on pregnancy variables, reproductive performance, birth types and weight of kids. *Tropical Animal Health and Production*, 49:1125-1133. DOI 10.1007/s11250-017-1303-y

Oderinwale O.A., B.O. Oluwatosin, S.D. Amosu, S.O. Ganiyu and A.J. Adeyemo 2017b. Haematology, Serum Biochemistry and Growth Performance of Pregnant Kalahari Red Goats fed concentrate diets at three protein levels in Nigeria. *Bulletin of Animal Health and Production*, 65(3): 515-625

Odubute, I.K., Akinokun, J.O. and Ademosun, A.A. 1992. Production characteristics of West African dwarf goats under improved management system in the humid tropics of Nigeria. Proc. Intl. Workshop, Ile-Ife, Nigeria. 202-207.

Ohkawa, H., Ohishi, N., and Yagi, K., 1979. Assay for lipid peroxides in animal tissues by thiobarbituric acid reaction. *Analytical Biochemistry. 95(2):351-358.*

Oladimeji, A. 1994. Effects of heat stress indices in Yankasa sheep.

Olanite, J. A., Tarawali, S. A. and Aken'ova, M. E., 2004. Biomass yield, quality and acceptability of selected grass-legume mixtures in the moist savanna of West Africa. *Tropical Grassland*, 38(2): 117-128

Olff M, Frijling JL, Kubzansky LD, Bradley B, Ellenbogen MA, Cardoso C, Bartz JA, Yee JR, and Van Zuiden M 2013. The role of oxytocin in social bonding, stress regulation and mental health: an update on the moderating effects of context and interindividual differences. *Psycho-neuroendocrinology*, 38 (9): 1883–94.

Omar AI, MBB Alam, MO Faruque, MM Mondal, MS Raihan, AA Adetula, Z Wu, AA Bhuiyan, F Soudy, J Cao, S Zhao, X Du 2016. Variability in fecal egg count of *Haemonchus* *contortus* infection to native goat breeds of China and Bangladesh under natural grazing condition. *Progressive Agriculture*, 27 (4): 473-481

Opara, M., Udevi, N. and Okoli, I. 2010. Haematological parameters and blood chemistry of apparently healthy West African Dwarf. *New York Science Journal*, 3(8): 68-72.

Oravcova, M., Margetin, M., Peskovicova, D., Dano, J., Milerski, M., Hetenyi, L., Polak, P., 2007. Factors affecting ewe's milk fat and protein content and relationships between milk yield and milk components. *Czech Journal of Animal Science*, 52, 189–198.

ORBDA, 2013. Ogun-Osun River Basin Development Authority, Nigeria.

Osawa, T., Y. Sugiyama, M. Inayoshi and S. Kawakisi. 1995. Anti-oxidative activity of tetrahydrocurcuminoids. Biotech Biochem. 59: 1609-161.

Otoikhian, C.S.O., Orheruata, J.A., Imasuen, J.A. and Akporhuarho, O.P. 2009. Physiological response of local (West African Dwarf) and adapted Switzerland (White Bornu) goat breed to varied climatic conditions in South-South Nigeria. *African Journal of General Agriculture*, Nigeria, 5(1): 1-6

Ottenstein D.M., and Bartley D.A. 1971. Separation of free acids C2–C5 in diluted aqueous solution column technology. Journal of Chromatographic Science 9, 673–681. doi:10.1093/chromsci/9.11.673

Partridge, I. J., 2003. Better pastures for the tropics and subtropics. *Tropical Grassland Society of Australia*. 34: 23-29

Patel, B., Elguero, S., Thakore, S., Dahoud, W., Bedaiwy, M., and Mesiano, S. 2014. Role of nuclear progesterone receptor isoforms in uterine pathophysiology. *Human Reproduction Update*, 21 (2): 155–173.

Patra, A. K., D. N. Kamra and N. Agarwal. 2006. Effect of plant extracts on *in vitro* methanogenesis, enzyme activities and fermentation of feed in rumen liquor of buffaloes. *Animal Feed Science Technology*, 128(3-4): 276-291.

Pe´rez-Razo, M., Sa´nchez, F., Torres-Herna´ndez, G., Becerril-Pe´rez, C., Gallegos-Sa´nchez, J., Gonza´lez-Cosı´o, F. and Meza-Herrera, C. 2004. Risk Factors Associated with Dairy Goats Stayability. *Livestock Production Science*. 89: 139–146.

Pedernera, M, Celi, P, García, SC, Salvin, HE, Barchia, I, Fulkerson, WJ 2010. Effect of diet, energy balance and milk production on oxidative stress in early-lactating dairy cows grazing pasture. *The Veterinary Journal*, 186: 352-357.

Penzhorn, B.L., Rognlie, M.C., Hall, L.L. and Knapp, S.E. 1994. Enteric coccidian of Cashemire goats in southwestern Montana, USA. *Veterinary Parasitology*. 55: 137–142.

Perez Infante, F. and Gonzalez, F. 1985. Performance of different pasture species with grazing dairy cows. *Cuban Journal of Agricultural Science*, 19(3): 249-256

Peter KV 2000. Informatics on turmeric and ginger. *India Spices*. 36(2):12-14

Piccione G., S. Casella, A. Assenza, F. Fazio, and Caola G. 2008. Evaluation of serum homocysteine and oxidative stress during lactation in ewes. *Czech Journal of Animal Science,* 53, (11): 462–465.

Pierre, F., 1984. Photosensitization dermatosis in sheep in the interior of the Ivory Coast. *Rev. Elev. Méd. Vét. Pays Trop.,* 37 (3): 277-285

Platel K. and K. Srinivasan 1996. Influence of dietary spices or their active principles on digestive enzymes of small intestinal mucosa in rats. *International Journal of Food and Nutrition*, 47: 55-59

Platel K. and K. Srinivasan 2000. Influence of dietary spices and their active principles on pancreatic digestive enzymes in albino rats. *Food/Nahrung*, 44: 42-46

Portolano B, Todaro M, Finocchiaro R and van Kaam JHBCM 2002 Estimation of the genetic and phenotypic variance of several growth traits of the Sicilian Girgentana goat. *Small Ruminant Research*. 45:247–253.

Prasad, S, Aggarwal, B. B., Benzie, I. F. F., and Wachtel-Galor, S. 2011. Benzie IFF, Wachtel-Galor S, eds. *Turmeric, the Golden Spice: From Traditional Medicine to Modern Medicine*; In: Herbal Medicine: Biomolecular and Clinical Aspects; chap. 13. 2nd edition. CRC Press, Boca Raton (FL). *PMID 22593922*

Purchio, A., Correa, B., Galhardo, M. and Pelicci, P. 1988. Ocorrência de surto de eczema facial em ovinos, na região de São Manuel, Estado de São Paulo. *Rev. Fac. Med. Vet. Zoot. Univ. São Paulo, 25(1): 135-137*

Quattrocchi, U., 2006. CRC World dictionary of grasses: common names, scientific names, eponyms, synonyms, and etymology. CRC Press, Taylor and Francis Group, Boca Raton, USA

Radostits, O.M., Gay, C.C., Blood, D.C. and Hinchcliff, K.W. 2000. Clinical Examination of Farm Animals. *Veterinary Medicine*, 9th edn, W.B. Saunders, London. 1819–1822.

Rajput Nasir, Naeem Muhammad, Rui Yan, Xiang Zhong and Tian Wang 2013. Effect of Dietary Supplementation of Curcumin on Growth Performance, Intestinal Morphology and Nutrients Utilization of Broiler Chicks. *Journal of Poultry Science,* 50: 44-52

Ramsay, K., Harris, L. and Kotze, A. 2001. Landrace Breeds: South Africa’s Indigenous and Locally developed Farm Animals. *Publication Farm Animal Conservation Trust*, ISBN: 0-620-25493-9.

Regassa, F., Sori, T., Dhuguma, R., Kiros, Y., 2006. Epidemiology of gastrointestinalparasites of ruminants in western Oromia, Ethiopia. *International Journal of Applied Research in Veterinary Medicine*, 4(1): 51-59

Reitman, S., and Frankel, S., 1957. A colorimetric method for determination of serum glutamate oxaloacetate and glutamic pyruvate transaminase. *America Journal of Clinical Pathology,* 28: 56-58.

Riet-Correa, B., Castro, M. B., Lemos, R. A. A., Riet-Correa, G., Mustafa, V. and Riet-Correa, F. 2011. Brachiaria spp. poisoning of ruminants in Brazil. *Veterinary Brazil*, 31(3): 183-193

Rira M, Chentli A, Boufenerab S, Boussebouaa H, 2015. Effects of plants containing secondary metabolites on ruminale methanogenesis of sheep *in vitro. Energy Proceedia*. 74: 15 – 24.

Rossi, F. and Nicolini, A. 2011. Experimental investigation on a novel electrolyte configuration for cylindrical molten carbonate fuel cells. *Journal of Fuel Cell Science and Technology*, 8: 34-42 doi:10.1115/1.4003773.

Rossi, F. and Nicolini, A. 2013. Ethanol reforming for supplying molten carbonate fuel cells. *International Journal of Low-Carbon Technology*, 8, 140–145.

Rouviere PE, and Wolfe RS, 1988. Novel biochemistry of methanogenesis, *Journal of Biological Chemistry*, 263: 7913-7916.

Rubino, R., Moioli, B., Fedele, V., Pizzillo, M., Morand-Fehr, P., 1995. Milk production of goats grazing native pasture under different supplementation regimes in southern Italy. *Small Ruminant Research*, 17: 213–221.

Russell, J.B. and A.J., Houlihan 2003. Ionophore resistance of Ruminal bacteria and its potential impact on human health. FEMS *Microbiology Revision*, 27: 65-74

Russell JB, 1998. The importance of pH in the regulation of ruminal acetate to propionate ratio and methane production. J. of Dairy Sci., 81, 3222–3230.

Ryan K.J. 1982. Biochemistry of aromatase: significance to female reproductive physiology. *Cancer Research.* 42 (8): 3342–3344.

SAS 2004. SAS/STAT 9.1 User's Guide. Statistical Analysis System. Institute, Incorporation Cary., NC.

Salih N. Hussein 2013. Effect of Turmeric (Curcuma longa) powder on growth performance, carcass traits, meat quality, and serum biochemical parameters in broilers. *Journal of Advanced Biomedical and Pathobiology Research,* 3 (2): 25-32.

Sameh Gad Abdelhak Ramadan, Hamada Dahy Hussein Mahboub, Mohamed Atef Yousef Helal, Mohamed Abdallah Sallam 2018. Effect of Vitamin E and Selenium on Performance and Productivity of Goats. *International Journal of Chemical and Biomedical Science.* 4(2): 16-22.

Sanger, C.M., Hammond, D.M., Thorne, J.L., Johnson, A.E. and Wells, G.M. 1959. Resistance of calves infection with *Eimeria bovis*. *Journal of Protozoology.* 6: 51–58.

Santoso B., Mwenya B., Sar C., and Takahashi J. 2007. Methane production and energy partition in sheep fed timothy hay silage- or hay-based diets. *Journal of Animal Science and Veterinary,* 12, 27–33.

Scaut, A., 1959. Détermination de la digestibilité des herbages frais. Institut national pour l'étude agronomique du Congo belge. Série scientifique. No 81, 86pp.

Schultze-Kraft, R. and Teitzel, J. K., 1992. Brachiaria ruziziensis Germain & Evrard. Record from Proseabase. Mannetje, L.'t and Jones, R.M. (Editors). PROSEA (Plant Resources of South-East Asia) Foundation, Bogor, Indonesia

Shingo T, Gregg C, Enwere E, Fujikawa H, Hassam R, Geary C, Cross JC, and Weiss S 2003. Pregnancy-stimulated neurogenesis in the adult female forebrain mediated by prolactin. *Science*, 299: 117–20.

Shrestha S., Y.R. Bindari, N. Shrestha, and T.N. Gaire. 2013. Methane Gas Emission in Relation to Livestock: a Review. - *Journal of Animal Production Advances,* 3 (5): 187-191.

Singh GP, Nagpal AK, and Sainj N, 2005. Methane production in relation to productivity of livestock and environment: a review. Indian J. of Anim. Sci., 75, 143-148.

Sissay, M.M., Uggla, A., Waller, P.J., 2007. Epidemiology and seasonal dynamics ofgastrointestinal nematode infections of sheep in a semi-arid region of Eastern Ethiopia. *Veterinary Parasitology*. 143(3), 311–321.

Sivakumar A. V. N., G. Singh and V. P. Varshney 2010. Antioxidants Supplementation on Acid Base Balance during Heat Stress in Goats. *Asian-Australian Journal of Animal Science,* 23(11): 1462 - 1468

Snyman, M.A. 2010. Factors Affecting Pre-Weaning Kid Mortality in South African Angora Goats. *South African Journal of Animal Science.* 40: 54-64.

Soe, A.K. and Pomroy, W.E. 1992. New species of Eimeria (Apicomplexa: Eimeriidae) from the domesticated goat, *Capra hircus* in New Zealand. *Systemic Parasitology.* 23: 195–202.

Soliman, M.F.M. and Zalat, S.M. 2003. Prevalence and intensity of *Nematodirus* sp. and *Eimeria* sp. infections in the domestic goats of St. Katherine's Protectorate (Sinai, Egypt): relations with some ecological & biological factors. *Egypt Journal of Botany*. 5: 78-85.

Song, H.B., Jo, I.H. and Sol, H.S. 2006. Reproductive Performance of Korean Native Goats under Natural and Intensive Conditions. *Small Ruminant Research*. 65: 284–287.

Soni. K. B., M. Lahiri, and Chakradeo P. 1997. Protective effect of food additives on aflatoxin-induced mutagenicity and hepatocarcinogenicity. *Cancer Letters.* 115(2): 129-133.

Sonibare A.O., Kumshe H.A., Okewole E.A., Joshua R.A., Luka J. and Otesile E.B. 2014. Haematological responses of three Nigerian goat breeds to field acquired helminthes infection and their haemoglobin types. *Biokemistri,* 26(1): 25–30.

Sordillo, L.M., O'Boyle, N., Gandy, J.C., Corl, C.M., Hamilton, E., 2007. Shifts in thioredoxin reductase activity and oxidant status in mononuclear cells obtained from transition dairy cattle. *Journal of Dairy Science*, 90: 1186–1192.

Soriani, M., Pietraforte, D., Minetti, M., 1994. Antioxidant potential of anaerobic human plasma: role of serum albumin and thiols as scavengers of carbon radicals. *Archives of Biochemistry and Biophysics*, 312: 180–188.

State Workbook 1995. *Methodology For Estimating Greenhouse Gas Emissions*, EPA 230-B-92-002, U. S. Environmental Protection Agency, Office of Policy, Planning and Evaluation, Washington, DC.

Steele, M. 1996. The Tropical Agriculturalist: Goats. Macmillan Education Limited, London. 14:111-112.

Steudler PA, Bowden RD, Melillo JM, and Aber JD, 1989. Influence of nitrogen fertilisation on methane uptake in temperate soils, *Nature*, 341: 314-316.

Stewart CS, Flint HJ, and Bryant MP, 1997. The rumen bacteria. In: Hobson, P.N., Stewart, C.S. (Eds.), The rumen microbial ecosystem. Blackie Academic & Professional, London, pp. 21-72.

Stumm CK, Gitzen HJ, and Vogels GD, 1982. Association of methanogenic bacteria with ovine rumen ciliates, British J. of Nutr., 48: 417-431.

Takayanagi Y, Yoshida M, Bielsky IF, Ross HE, Kawamata M, Onaka T, Yanagisawa T, Kimura T, Matzuk MM, Young LJ, and Nishimori K 2005. Pervasive social deficits, but normal parturition, in oxytocin receptor-deficient mice. *Proceedings of the National Academy of Sciences of the United States of America*, 102 (44): 16096–101.

Tambuwal F. M, Agale, B. M. and Bangana, A. 2002. Haematological and Biochemicalvalues of Apparently Healthy Red Sokoto goats. Proceedings of 27th Annual conference Nigerian society of Animal production (NSAP) March 17-21, 2002 FUTA, Akure.

Tedeschi, L.O., Fox, D.G. and Tylutki, T.P 2003. Potential environmental benefits of ionophores in ruminant diets. *Journal of Environmental Quality*, 32: 1591–1602.

Tedonkeng Pamo, E., Boukila, B., Fonteh, F. A., Tendonkeng, F., Kana, J. R. and Nanda, A. S., 2007. Nutritive value of some grasses and leguminous tree leaves of the Central region of Africa. *Animal Feed Science and Technology*, 135(3-4): 273-282

Tekoa L. King, and Mary C. Brucker 2010. Pharmacology for Women's Health. Jones and Bartlett Publishers. pp. 372–373. ISBN 978-1-4496-5800-7.

Tietz, N. W., 1995. Clinical Guide to Laboratory Test, 3rd Edition. W. B. Sanders Company, Philadephia. 518-519.

Tilley J.M.A., and Terry R.A. 1963. A two-stage technique for the in vitro digestion of forage crops. *Journal of the British Grassland Society*, 18: 104–111.

Torres González, A. M. and Morton, C. M., 2005. Molecular and morphological phylogenetic analysis of Brachiaria and Urochloa (Poaceae). *Molecular Phylogenetic Evolution*, 37(1): 36–44

Torres-Acosta, J., Hoste, H., 2008. Alternative or improved methods to limitgastro-intestinal parasitism in grazing sheep and goats. *Small Ruminant Research*, 77(2): 159–173.

Trevisan M., Browne R., Ram M., Muti P., Freudenheim J., Carosella A.N., and Armstrong D. 2001. Correlates of markers of oxidative status in the general population. American Journal of Epidemiology, 154, 348–356.

Tudsri, S., Prasanpanich, S., Sawadipanich, S., Jaripakorn, P. and Iswilanons, S. 2001. Effect of pasture production systems on milk production in the central plains of Thailand. *Tropical Grassland*, 35(4): 246-253

Turmeric for Health 2018. Therapeutic role of Turmeric in relation to Female reproductive system. http://www.turmericforhealth.com/turmeric-benefits/how-turmeric-benefits-female-reproductive-system

Tyzio R, Cossart R, Khalilov I, Minlebaev M, Hübner CA, Represa A, Ben-Ari Y, and Khazipov R 2006. Maternal oxytocin triggers a transient inhibitory switch in GABA signaling in the fetal brain during delivery. *Science*, 314 (5806): 1788–92.

Umeghalu I., and J. Okonkwo. 2012. Mitigating the effect of climate change on Nigerian agricultural productivity. - *Agricultural Advances*, 1(4): 61-67.

Urio, N. A., Sarwatt, S. V. and Mtengeti, E. J. 1988. A review of the potential of Brachiaria species as forage crop for livestock in Tanzania. In: Dwozela, B. H. (Ed.), PANESA, African forage plant genetic resources, evaluation of forage germplasm and extensive livestock production systems. Proc. 3rd Workshop, Int. Conf. Centre, Arusha, Tanzania, 27-30 April 1987. ILCA, Addis Ababa.

USDA National Nutrient data base, 2015. Basic Report: 02043, Spices, turmeric, ground. *United States Department of Agriculture Agricultural Research Service National Nutrient Database for Standard Reference Release 28.* http://ndb.nal.usda.gov/ndb/foods/show/292?man=&lfacet=&count=&max=&qlookup=&offset=&sort=&format=Abridged&reportfmt=other&rptfrm=&ndbno=&nutrient1=&nutrient2=&nutrient3=&subset=&totCount=&measureby=&_action_show=Apply+Changes&Qv=1&Q678=1&Q679=1

USDA, 2015. GRIN - Germplasm Resources Information Network. National Germplasm Resources Laboratory, Beltsville, Maryland

Vallejos, A., Pizarro, E. A., Chaves, C., Pezo, D. and Ferreira, P. 1989. Agronomic evaluation of grasses at Guapiles, Costa Rica. I. Brachiaria ecotypes. *Pasturas Tropicales*, 1

(2): 13-28

Van Leengoed E, Kerker E, and Swanson HH 1987. Inhibition of post-partum maternal behaviour in the rat by injecting an oxytocin antagonist into the cerebral ventricles. *The Journal of Endocrinology*, 112 (2): 275–82.

Varghese, T. and Yayabu, R. 1985. Ovine coccidiosis in Papua New Guinea. *Veterinary Parasitology*. 39: 181-191.

Vorlaphim T., Phonvisay M., Khotsakdee J., Vasupen K., Bureenok S., Wongsuthavas S., Alhaidary A., Mohamed H.E., Beynen A.C., and Yuangklang C. 2011. Influence of Dietary Curcumin on Rumen Fermentation, Macronutrient Digestion and Nitrogen Balance in Beef Cattle. *American Journal of Agricultural and Biological Sciences*, 6 (1): 7-11.

Wanapat, M., Wongnen, N., Sangkloy, W., Pilajun, R. and Kanpukdee, S. 2012. On-farm use of legume (Phaseolus calcaratus) and Ruzi grass on rumen fermentation and milk production in lactating dairy cows. *Agricultural Science*, 3(3): 355-360

Warnock JK, Swanson SG, Borel RW, Zipfel LM, and Brennan JJ 2005. Combined esterified estrogens and methyltestosterone versus esterified estrogens alone in the treatment of loss of sexual interest in surgically menopausal women. *Menopause*, 12 (4): 359–60.

Weimer, P.J. 1998. Manipulating ruminal fermentation: A microbial ecological perspective. *Journal Animal Science*, 76, 3114–3122.

Wikipedia 2018. Turmeric. https://en.wikipedia.org/wiki/Turmeric

Willett E. 2018. The Benefits of Turmeric for Fertility Health. http://natural-fertility-info.com/turmeric-for-fertility.html

Woese CR, Kandler O, and Wheelis JL, 1990. Towards a natural system of organisms: proposal for the domains Archaea, Bacteria and Eucarya, Proceedings of National Academy of Sciences, USA, 87: 4576-4579.

Wuthi-udomler, M., W. Grisanapan, O. Luanratana and Caichompoo W. 2000. Anti-fungal activities of plant extracts. South East Asian J. Trop. Med. Public Health.31, Suppl., 1:178-182.

Youssef M. Kamal E., Amira M. El Newihi, Soad M. Omar and Zeinab S. Ahmed 2014. Assessment of Proximate Chemical Composition, Nutritional Status, Fatty Acid Composition and Antioxidants of Curcumin (Zingiberaceae) and Mustard Seeds Powders (Brassicaceae). *Food and Public Health*, 4(6): 286-292

Zajac, A.M. and Conboy, G.A. 2006. Veterinary Clinical Parasitology. Blackwell publishing, New York, USA, pp: 3-4.

Zajac, A.Z., Conboy, G.A. 2012. Veterinary Clinical Parasitology. 8th Edition, 8-11.

Zvinorova P.I., T.E. Halimani, F.C. Muchadeyi, O. Matika, V. Riggio and K. Dzama 2016. Prevalence and risk factors of gastrointestinal parasitic infections ingoats in low-input low-output farming systems in Zimbabwe. *Small Ruminant Research*, 143: 75–83.