**INFLUENCE OF WATTLE IN RED SOKOTO (*Maradi*) GOATS ON REPRODUCTION, HAEMATOLOGY AND GROWTH PARAMETERS**


## ABSTRACT

A study on the Influence of wattle in Red Sokoto (*Maradi*) goats on reproduction, haematology and growth parameters was carried out at the Teaching and Research Farm of the Department of Animal Production, Federal University of Technology, Minna. Forty (40) Red Sokoto goats comprising of thirty-two (32) does and eight (8) bucks managed semi-intensively were used for the study. Seven experiments were conducted during the period of the research. Experiment one was aimed at determining the relationship between wattle and body weight and some morphometric parameters in Red Sokoto goats. Parameters examined under experiment one included: body weight, body length, head length, head width, height-at-withers, chest depth, chest girth, shoulder point width, rump length, rump width, and shin circumference of Red Sokoto does and bucks. Experiment two was to describe the relationship between wattle and reproductive traits in Red Sokoto does. Parameters examined for experiment two included: gestation gain, gestation length, and body weight of kid(s) at birth, kidding loss, rectal temperature, progesterone and oestrogen profile of the does. Experiment three was aimed at evaluating the relationship between wattle and some dairy characteristics of Red Sokoto does. Parameters observed included udder circumference, distance between teats, change in udder circumference, change in distance between teats, teat length after milking, milk quantity and quality analysis. Experiment four was aimed at evaluating the effect of wattle on growth related traits of growing Red Sokoto kids up till weaning. Parameters measured for experiment four was as detailed in experiment one above. Experiment five was to determine the relationship between wattle and weaning traits of Red Sokoto kids. Data collected for experiment five included: number of kids at weaning, body weight of kids at weaning, weaning sex ratio and survival rate at weaning. Experiment six was to determine the relationship between wattle and haematological characteristics of Red Sokoto goats. and experiment seven was to determine the relationship between wattle and body weight, scrotal size, scrotal circumference and sperm cell concentration of Red Sokoto bucks. Data collected were analyzed using SAS statistical package. After the experiment, it was observed that: Wattle had significant ($p<0.05$) effect only on the initial head width of Red Sokoto does before mating. Non-wattled does in ($T_2$), having the widest ($p<0.05$) head width (11.88±0.38) before mating. Wattle significantly ($p<0.05$) affected the body weight of does after birth with wattle does mated with wattle bucks ($T_4$) having the lowest body weight. Results of the reproductive performance of Red Sokoto does, shows that wattled does mated with wattled buck ($T_4$) had the lowest weight of doe pre and post-partum and had highest kidding lost and least birth weight. Wattled does produced higher litter size (up to 50 % twins). Females mated with non wattled bucks ($T_1$and $T_3$) had the highest conception rate of up to 62.5 %. Mating between the wattle and non-wattle ($T_2$ and $T_3$) had 0 % abortion. Mating between non-wattled does mated with wattled bucks ($T_2$) produced the highest number of males (up to 75 %) while mating between wattled does mated with wattled bucks ($T_4$) had the largest percentage of female kids (66.7 %). Wattle had significant ($p<0.05$) influence on the milk and udder parameters examined. Crosses between the wattle and the non wattled had the highest in terms of udder circumference before and after milking, quantity of milk and average daily milking. Wattled does in ($T_3$ and $T_4$) produced the highest peak yield. Wattled does mated with watted bucks ($T_4$) had the highest total milk yield. Wattle had significant ($p<0.05$) influence on the average body weight and morphometric parameters of Red Sokoto kids. Kids resulting from both parents having wattle had the least in the average head width and average hind leg. Wattle had significant ($p<0.05$) effect on body weight, survival rate, sex of kids and type of birth of Red Sokoto kids at weaning. Non-wattled does mated with wattled bucks ($T_2$) had the highest body weight and survival rate (100 %). Wattled does and bucks had higher HDL, which brought about lower blood cholesterol levels. In conclusion, attention should be focused on the crossess between the wattled and the non-wattled Red Sokoto as it gave best result in most parameters examined for the kids. Deliberate effort must be made to preserve the wattle gene to prevent the goats carrying the gene from going to extinction.

# CHAPTER ONE

## 1.0 INTRODUCTION

### 1.1 Background of the Study

The Red Sokoto goat is the major breed of goat in Northern Nigeria, they are mostly found with the agro-pastoralists in the Northern Sub-humid and semi-arid regions of the country (Akpa *et al*., 2001). They are found around Sokoto environs, spanning from Sokoto province and the middle belt of Nigeria to Niger Republic (Alaku, 2010). They are prolific and have relatively small size (60 cm height and weight of 27 kg), this suggests that the Red Sokoto breed has been crossed with the West African Dwarf goats before selection in its present area of distribution (Wilson, 1991).

Generally, goats possess special qualities that are not common to other ruminants (Silanikove, 2000); they are hardy and can survive under harsh environmental conditions where other ruminants cannot (Devendra, 2000; Alaku, 2010). The expression of various qualitative traits in goats may imply some mechanisms developed for continued existence in dfferent ecological zones of Nigeria (Oseni *et al*., 2006). The possession of wattle in goats has been considered by some as a qualitative trait that could be used during selection for productive purposes (Sabbioni *et al*., 2011).

Wattle is a fleshy appendage hanging from different sections of the neck (Weissengruger, 2000). Wattles are sometimes found in other species such as pigs, sheep, birds and humans (Coras *et al*., 2005). Wattle in goats ranges from zero to two; wattle consists of the epidermis, dermis, subcutis, muscles, nerves, blood vessels and a central cartilage (Reber *et al*., 2015). Although the function of wattles is still been delibrated (Sabbioni *et al*., 2011) but Wikipedia

(2014) associated the presence of wattles in birds as ornamental for courting potential mates; wattle was also correlated to high testosterone levels, quality nutrition, ability to escape predators and disease resistance. Earlier scientists like Mouquet (1895) and Siemens (1921) speculated that wattles in goats, due to their physical structure, represents failed limbs. This hypothesis is supported by studies carried out on Swiss goats by Reber *et al*. (2015) who reported that goats with wattles show similar coat colour patterns with the limbs in multi-coloured goat breeds. Odubote (1994), however, suggested that the possession of wattle in goats could be for thermoregulatory function which help the animal adapt to the environment. Adedeji (2012) observed that West African Dwarf (WAD) goats with wattle had significantly lower rectal temperature and pulse rate than the non- wattled goats, thus it is expected that goats with wattle will adapt better to their environment than those without wattle, hence this research study.

## 1.2 Statement of the Research Problems

Wattle has been viewed as a structural extension in animals (goats) whose purpose is still under dispute. Sabbioni *et al*.(2011) were of the belief that wattle could be used during selection for productive purposes.

Furthermore, studies on the occurrence of wattle and its comperative effect on body dimensions have been carried out by Ozoje (2002) in West African Dwarf sheep and goats. Similarly, many findings on the relationship between wattle and performance (growth, reproduction and heat tolerance) have been done by Casu *et al*. (1970); Osinowo *et al*. (1988); Shongjia *et al*. (1992) and Ozoje and Mbere (2002) on West African Dwarf goats. Casu *et al.* (1970) studied the relationship of wattle with lambing rate in Yankasa ewes while Shongjia *et al*. (1992) carried out a research on the effects of wattle on milk yield and litter size in Sannen does. Osinowo *et* *al.* (1990) studied the relationship between wattle and weaning weight of Yankasa lambs. Odubote (1994) worked on the effect of wattle on yearling weight of West African Dwarf goats. Adedeji *et al.* (2011) examined the influence of wattle on haematology in West African Dwarf goats. Also, the size of the testicules is believed to be the most important yardstick from physiological, genetic and practical perspective towards improved reproductive performance in females (Palasz *et al*., 1994; Keeton *et al*., 1996). Adedeji (2012) carried out a study on the impact of wattle on body and scrotal measurements in West African Dwarf goats but no known work on the relationship between wattle and morphometric parameters, reproduction, growth, heat tolerance, kidding rate, milk yield, weaning weight, haematology and scrotal size have been carried out on the Red Sokoto goats.

Therefore, this research study, if successful, will really show the worth of wattle in productive efficiency and as a physical indicator to productive superiority. If establised, will save the farmer the strain of expunging the wattle out of ignorance, this will help to avert the development of tumors, which often results after surgical removal of wattle.

### 1.3 Justification of the Study

The function of wattle in the body of animals (goats) is still not known, therefore, information on the relationship between wattle and morphometric parameters and growth of Red Sokoto goats can be derived through this study. In addition, the effect of wattle on reproduction, milk yield, kidding rate and weaning weight of Red Sokoto kids can be evaluated. The relationship between wattle and heat tolerance in Red Sokoto goats will provide information for livestock farmers in the tropics on strategies for aleviating heat stress. Furthermore, the effect of wattle on haematological and serum biochemical indices of Red Sokoto goats will asist in monitoring the health status of animals in the tropics. Finally, information on the relationship between wattle and Scrotal parameters (scrotal size, scrotal circumference, sperm cell concentration) in Red Sokoto goat would be derived from this research study.

## 1.4 Aim and Objectives of the Study

The aim of this research is focused at evaluating the influence of wattle in Red Sokoto (*Maradi*) goats on reproduction, haematology and growth parameters

The objectives of this research are to:

1. determine the relationship between wattle and body weight and some morphometric parameters in Red Sokoto goats.
2. ascertain the relationship between wattle and reproductive traits **(**gestation gain, gestation length, and body weight of kid(s) at birth, kidding loss, rectal temperature progesterone and oestrogen profile) in Red Sokoto does.
3. evaluate the relationship between wattle and some dairy characteristics (udder circumference, distance between teats, change in udder circumference, change in distance between teats, teat length, quantity of milk, average daily milk, first test day yield and milk quality analysis) of Red Sokoto does before and after milking.
4. evaluate the relationship between wattle and growth related trait (body weight gain, body length, head length, head width, height-at-withers, chest depth, chest girth, shoulder point width, rump length, rump width, and shin circumference) of growing Red Sokoto kids uptill weaning.
5. determine the relationship between wattle and weaning traits (number of kids weaned, body weight of kids weaning, weaning sex ratio and survival rate at weaning) of Red Sokoto kids.
6. determine the relationship between wattle and haematological characteristics of Red Sokoto goats.

7. establish the relationship between wattle and body weight, Scrotal parmeters and sperm cell concentration of Red Sokoto bucks.

## CHAPTER TWO

## 2.0 LITERATURE REVIEW

### 2.1 Origin and Characteristics of Domestic Goat

The domestic goat (*Capra aegagrus*) originated from Southwest Asia and Eastern Europe and is thought to be a sub-species of domesticated wild goat. Goat belongs to the family *Bovidae* and subfamily *Caprinae* (Alaku, 2010). Estimates show that over three hundred (300) breeds of goat (Hirst and Kris, 2008) exits worldwide. The domestication of goats started about 9,000-11,000 years ago which makes them one of the eailiest animals to be domesticated by man (Alaku, 2010). Wild goats were domesticated by people or farmers for products such as meat, milk, manure, bones, hair, and ligament for clothing, building, and tools (Osaer *et al*., 1999; Hirst and Kris, 2008). The relics of early domesticated goats dating 10,000 BC were found in Choga, Mami, Ganj Dareh in Iran and Jericho (Naderi-Rezaei *et al.*, 2008).

Goats are smaller than animals like camels, horses, and cattle but bigger than guinea pig, rabbits and poultry. Each breed of goat has specific weight, this ranges from about 16 to 23 (cm) in miniature breeds to 20.4 to 27.2 kg in smaller goat to about 136 kg in bucks of Boer goats (large breeds) (Taylor and Field, 1999; Belanger and Bredesen, 2010). Strains which exist within each breed may have different recognized sizes (Belanger and Bredesen, 2010). Goats have two horns, which come apparently in different shapes and sizes depending on the breed (American Goat Society, 2009).

Goats have a four-chambered stomach, they are even-toed. Females have udders consisting of two teats (Taylor, 1998). In most breeds of goats, both male and female goats have beards, and some breeds possess wattles. Goat have short and upward pointed tails, this differentiate them from that of the sheep, which typically hangs down which is usually longer and bigger (Alaku, 2010). Goats can live up to 15 to 18 years, but problems during kidding can lower a doe's expected life span to 10 to 11 years. Also, stresses of going into rut, can lower a buck's expected life span to 8 to 10 years (Anonymous, 2011).

Generally, goats are believed to be hardy animals but are vulnerable to some diseases. This includes respiratory diseases such as pneumonia, foot rot, external and internal parasites, pregnancy toxicosis and feed toxicity. Goats can become infected with various viral and bacterial diseases such as caprine arthritis, foot and mouth disease, pink eye, encephalitis, mastitis, caseous lymphadenitis, and pseudorabies. They can transmit a number of zoonotic diseases to humans such as tuberculosis, brucellosis, and rabies (Smith, 1994).

## 2.2 Goat Management Systems

### 2.2.1 Intensive system

The intensive system of management is suitable for a small size herd, and where land available is grossly insufficient. The system allows complete confinement of the goats where they are stall-fed or zero-grazed completely. The adults (does, bucks) and kids are housed separately (National Farmers Information Service, 2012). The intensive system is very expensive and involve constant human supervision (Oluwatomi, 2010).

### 2.2.2 Semi intensive system

This system allows animals to be kept under confinement for a limited time, but are allowed to move and feed freely in a restricted area. The financial requirement for this system include: building and fencing. This system is mostly used by commercial goat farmers. This system, allow animals go about looking for food and water; they graze on public pasture and are kept in fenced shelter at night. This system is relatively inexpensive and requires marginal human management (Oluwatomi, 2010).

### 2.2.3 Extensive system

This system of goat management is practiced in areas where grazing fields are not a problem. During the dry season, many herdsmen migrate to other areas in search of pasture and water (Oluwatomi, 2010). This system has several advantages, which include small space requirement, less labour and less investment when purchasing and maintaining the animals compared to other systems of managements. This system also has its weaknesses which include inbreeding (since unrestricted or free range system is practiced) which is reported to be the main cause of weakness or susceptibility to diseases in animals. Predators and thefts also constitute problems for the farmers. Finaly in the dry season, the animals have to walk long distances in search of feed and water, which is a major cause of loss of goats (Bounthavone *et al*., 2010)

## 2.3 Red Sokoto Goat

The Red Sokoto (*Maradi*) goat is found around Sokoto province of North-Western Nigeria, spanning to the Middle belt of Nigeria and across Niger Republic (Alaku, 2010). The Red Sokoto goat is a small breed and stands approximately 65 cm at withers; the adult weighs between 20 to 35 kg. The breed varies in size but generally is intermediate between the Sudan (Sahel) and the Southern Dwarf goats of the coastal and rainforest regions of West Africa. The ears are short and horizontal and both sexes have horn; the males have beard. The coat is short and smooth and is glossy red in colour (Osuhor *et al*., 2002; Alaku, 2010). The breed is known for its superior quality skin (Moroccan Leather) that is highly sought for in the international skin market (Akpa *et al.*, 1998a). The daily milk yield for Red Sokoto goats ranges between 0.5 – 1.5 kg (Alaku, 2010).

## 2.4 Adaptation of Goats to its Environment

Goats ability to adapt to its environment is exceptional. In regions of the world where food is scarce, goats subsist on thorny plant and even browse on tree tops (Awake Magazine South Africa, 2004). This explains why goats survive under barren or harsh environmental conditions where sheep and cattle cannot; they have the ability to trek long distances and require less watering than cattle and sheep (Alaku, 2010). Goat have the ability to increase respiration and hence heat loss from water evaporation, which is the principal temperature control mechanism in the body during hot conditions. Sheep are less tolerant to heat than goats and this probably is the reason why sheep are less concentrated in the tropics and the sub-tropics (Alaku, 2010). According to Oseni *et al*. (2006), the expression of different qualitative characters may imply some mechanisms used for adaptation and continued existence in various ecological zones of the world. For instance, Odubote (1994) suggested that the possession of wattle in goats could be for thermoregulatory function which help the animal adapt to the environment. Adedeji *et al*. (2012) observed that West African dwarf goats (bucks) with wattle had significantly lower rectal temperature, pulse rate and higher scrotal length than the bucks with out wattle. Ozoje (2002) reported positive correlation between wattle with tail length and neck circumference in West African Dwaft goats.

## 2.5 Determination of Goat Age

The eight teeth in the lower jaw are used in estimating the age of goats. The method is not an exact or perfect guide, as various factors such as diet influence the growth of the teeth. Goats under twelve months will have small and sharp teeths. These will gradually be replaced by larger permanent teeth. Goats tend to lose the two middle front teeth when they are 12 months of age; these are replaced by larger permanent teeth. At the age of about 24 months, the teeth next to the middle pair are replaced by permanent teeth. At the age of 4 years, goats have six permanent teeth with only one pair of kid teeth remaining. The set of teeth is complete when the goat attain the age of 5 years. The age of goats beyond 5 years must be guessed from the amount of wear on the teeth. This is very variable and diet has big effect on this. Goats on a rough coarse diet will grind their teeth away faster than those on easily crushed diet (Fiascofarm.com, 2009).

## 2.6 Wattle

Wattles are due to a dominant autosomal locus with variable expression (Machado *et al*., 2000). The locus was named wattles (Wa) and has two alleles; wattled $Wa^W$ and wild $Wa^+$ (Lauvergne *et al*., 1987 as quoted by Yakubu *et al.,* 2010). The gene frequencies observed for dominant alleles $Wa^w$ in Red Sokoto breed is 1.69 %, but 17.16 % for West African Dwarf goats (Yakubu *et al.,* 2010). The recessive gene however, had higher frequencies for $Wa^+$, 98.31 and 82.84 % for Red Sokoto breed and West African Dwaft goat, respectively. According to Adebayo and Chineke (2009), only 36.5 % of the goats examined had wattle while the larger percentage (63.5 %) had no wattle in the South Western part of Nigeria. The reports of Odubote (1994) reveals that goats without wattle constituted about 35.70 % of goat population in the South Western region of Nigeria. The $Wa^+$ allele is the dominant of wattles in Albanian goat populations (Vilson *et al.,* 2012); the population is much lower than those observed in Pernambuco state goat populations in Brazil (Oliveira *et al.*, 2006).

## 2.7 The Relationship between Wattle and Haematological Parameters

Haematological parameters were affected by wattle except Packed Cell Volume (PCV) and sodium ($Na^+$). Wattle genes also had significant ($p<0.05$) influence on White Blood Cell (WBC), Red Blood Cell (RBC), serum potassium concentration and Haemoglobin (Adedeji *et al.,* 2011). Goats with bilateral wattle had higher red blood cell counts of $12.66 \pm 0.05x10^6/\mu l$, haemoglobin conctration of 9.08± 0.06g/dl and white blood cell counts of 11.69 ± 0.04 $x10^3/\mu l$. Goats with unilateral wattle however had the lowest RBC while goats with no wattle had the lowest in WBC and Hb. Adedeji *et al.* (2011) observed that wattle significantly ($p<0.05$) influenced serum potassium with the highest value observed in goats with non-wattle and the lowest in the bilateral wattled goats.

## 2.8 Relationship between Wattle and Body Weight of Goats

Adedeji *et al.* (2012) reported that wattle significantly ($p<0.05$) influenced the body weight of the West African dwarft goat. The presence of wattles in Longling Yellow goats of China is said to be associated with heavier body weights from 18 month of age onward (Leng *et al.,* 2010). Odubote (1994) also observed that wattle significantly ($p<0.05$) influenced yearling weight of West African dwarf goats and concluded that bilaterally wattled goats were heavier than non-wattled goats. Osinowo *et al.* (1990) observed better ($p<0.05$) weaning weight in wattled Yankasa lambs than in non-wattled lambs.

## 2.9 Relationship between Wattle and Morphometric Parameters

Goats with wattle had longer body length, stood higher at wither and had better chest depth in Longling Yellow Goats of China (Leng *et al.,* 2010). Ozoje (2002) observed positive correlation between wattle incidence with tail length and neck circumference in West African Dwarf goats. Adedeji *et al.* (2012) reported that chest girth, body length and scrotal length were significantly ($p<0.05$) influenced by presence of wattle in West African dwarf goat.

## 2.10 Relationship between Wattle and Reproductive Traits and Milk Yield of Goats

Shongjia *et al.* (1992) reported significantly ($p<0.05$) higher milk yield and litter size in wattled Saanen does. Casu *et al.* (1970) as cited by Adedeji *et al*. (2012) reported higher lambing rate in wattled ewes. Osinowo *et al.* (1990) observed no significant ($p>0.05$) effect of wattle on fertility traits of Yankasa ewes but concluded that wattled ewes had lower number of oestrus period per conception, higher litter size, higher fertility rate and fewer abortions than the non-wattled ewes,. Gall (1980) as cited by Stultz (2016) stated that wattle in dairy goats is an indication of good milking potentials. Stultz (2016) however concluded that no significant difference ($p>0.05$) exits between dairy goats born with wattle and the non-wattled types.

## 2.11 Relationship between Wattle and Scrotal Parameters

Adedeji *et al*. (2011) observed that West African Dwarf bucks possessing cylindrically shaped wattle had higher scrotal size, which suggest higher fertility rate. Therefore, the biometric evaluation of testicular development is crucial since testicular growth and development have been positively correlated to body size (Osinowo *et al*., 1988 as cited by Adedeji *et al*., 2011). Kafi *et al*. (2004) also stated that male genetic merit for sperm production in the livestock enterprise could be determined through testicular development. Therefore, the occurrence of wattle could be used as a crucial, indirect and affordable means of livestock improvement in the country.

## 2.12 Factors Affecting Birth Weight

The body weight of any animal is very crucial, because it is one of the factors that determines the survivability of individuals. Any individual that deviates too far from the normal birth weight for the species does not normally survive to weaning (Alaku, 2010; Garba *et al.*, 2015).

Factors such as breed, sex, type of birth, litter size, parity and season of the year, influence birth weights of kids (Alaku, 2010; Meza-Herrera *et al.,* 2014).

### 2.12.1 Breed

Breed difference exists in birth weight and subsequent body weight. The Red Sokoto breed in the grassland region (Savannah) of Northern Nigeria have been observed to be significantly ($p<0.05$) superior in body measurements than the West African dwarf goat of the moist tropical environment of Southern Nigeria (Yakubu *et al.,* 2010). Research carried out by Semakula *et al*. (2010) on three breeds of goats in Uganda showed that Mubende breed was superior to Teso and Lugware in live body weight at all age groups except for shoulder width and corpus length whose values were similar to that of the Teso breed. The three breeds of goats in Uganda were shorter than the Kigezi (65.0 cm) and Somali (62.0 cm) breeds but taller than the Nigerian breeds (White Borno and Red Sokoto). Meza-Herrera *et al.* (2014) observed that the Saanen and Alpine breeds had higher birth weight, weight at one month and weaning weight than the Nubian, Granadina and Toggenburg breeds studied in Mexico.

### 2.12.2 Sex

Sex is considered as one important factor responsible for variation in live body weight and morphometric parameters in all the age groups of goats; and goats have been reported to show sexual dimorphism in body weight (Adeyinka and Mohammed, 2006). Samuel *et al*. (2008) also reported that sex significantly ($p<0.05$) influenced body measurements with females continuously showing superiority over the male. Nkungu *et al*. (1995) however reported the superiority of male kids over the female kids up to 12 months of age. Ruvuna *et al*. (1988) also reported on the superiority of male goats (kids) in the daily weight gain over the females from birth to weaninig. Adama and Arowolo (2002) reported that male kids had steady weight gain over the female at various ages up to 100 days in Savannah Brown goats. Hamayun *et al.* (2006), Adeyinka and Mohammed (2006), Zahradeen *et al*. (2008) and Semakula *et al*. (2010) stated that the males were superior over the female goats in body weight and morphometric parameters.

### 2.12.3 Type of birth

Alaku (2010) stated that single born kids are always heavier than twins who in turn are heavier than triplets. Negative relationship between body weight and type of birth has been reported in goats (Boujenane and El Hazzab, 2008; Jafaroghli *et al*., 2010; Barazandeh *et al*., 2012 and Moghbeli *et al*., 2013). Meza-Herrera *et al*. (2014) observed the highest average birth weight and weight at one month in single born kids. Garba *et al*. (2015) also observed that kids obtained from single and twin births had higher live weight changes relative to triplets.

### 2.12.4 Parity

Increases in body weight and weaning weight occurred as the age of the dam increased up to 6 years, thereafter, a gradual decrease in both body weight and weaning weight of kids occurred as goats became older (Garba *et al.* 2015). Alaku (2010) also observed that kids of older dams weighed more than those from younger dams in the West African Sahel goats of Central Mali. The study carried out by Garba *et al.* (2015). revealed that kids obtained from does at third parity had significantly ($p<0.05$) higher birth weight (3.41 kg), followed by kids obtained at second parity (3.10 kg) than from the first and fourth.

### 2.12.5 Litter size

Litter size is affected by year of birth, and such variability suggests differences in the prevailing climatic and environmental conditions, mainly those related to feeding quantity and quality as well as to the general management practices across years (Boujenane and El Hazzab, 2008; Kebede *et al*., 2012).

### 2.12.6 Other factors that influence birth weight of kids

Other factors that influences birth weight include location and management system (Alaku, 2010; Meza-Herrera *et al*. 2014)

## 2.13 Factors Affecting Weaning Weight

Most factors that influence birth weight also affect weaning weight of kids. Factors such as breed, sex, litter size, season of kidding, weaning year, management system and the mothering ability of doe affect the weaning weight of kids (Alaku, 2010).

## 2.14 Breeding

Sexual maturity in goats is attained at 4 -6 months of age. Some will breed at 6-8 months of age but quite often are unsuccessful in their pregnancy. Management practices are therefore, often designed to delay mating until the does are near mature body weight so that pregnancy does not coincide with the period when the females are actively growing. Both the number of kids born and the percentages of kids weaned per doe are directly correlated with the body weight of the dams at breeding time. In the intensive system of management, does are mated at 12 months of age so that they kid for the first time at about 18 months of age instead of at 10 -12 months in the extensive system (Alaku, 2010).

## 2.15 Oestrous Cycle and Gestation Length in Goats

The duration of oestrous cycle in goats is 21 (range of 18 - 22) days (Alaku, 2010; Mel DeJarnette, 2004). The duration of oestrus or standing heat is 24 - 48 hours and considerable variation occurs depending on breed and environment (Alaku, 2010). However, Agrodok (2015) reported the interval between heat to be between 17 – 22 days, but 21 days is the most common and that heat itself last between 6 and 30 hours. Ovulation number per cycle is 2-3. Pregnancy or gestation length is fairly constant, 146 days with a range between 142 – 148 days for tropical breeds (Alaku, 2010).

## 2.16 Oestrous Detection in Goats

Doe on heat is ready for breeding and when effectively mated will become pregnant. Doe(s) on heat will try to approach the buck. By placing the buck in a pen next to the doe(s), doe(s) in heat will try to entice the buck. The buck can also be used to walk beside the pens and doe(s) on heat will present themselves. Search billy or buck are used in larger farms to detect the doe(s) in heat, but effort should be made to ensure that only the desired does on heat are allowed to be mated (Agrodok, 2015). To avoid unwanted mating, a piece of cloth is usually tied around the belly of the buck in front of his sheath (prepuce). With this method, the buck is allowed to jump on any female on heat but not mate them successfully. This method makes heat detection in goats very easy and it is effective to assure that the appropriate buck mates with the appropriate doe (Agrodok, 2015). Goats can be asisted to come into heat by taking them close to the buck. The shortening of days is also one factor that encourages does to come into heat. Flushing also increase conception rates and litter size in doe(s). Flushing means the increase of the level of nutrition or diet a few weeks before the breeding period, by providing some additional concentrates.

According to Agrodok (2015), the general signs of heat in goats (doe) include restlessness, bleating and trying to attract attention of other animals especially the buck. They (does) try to mount other animals, sniffs them and encourages being mounted and sniffed at. The doe wiggles her tail, even when some one places his hand on her loins. Once the does agrees to be mounted and stands, they are on standing heat (this is the most reliable indication of heat and the appropriate moment for mating). Other signs are: provocative urination in the presence of a buck, ruffed hairs on the pelvic region; back, tail head, lips of the vulva becomes more reddish and looks swollen. Discharge of clear (dried) thin mucus may be seen around the vulva, which can be attached to her tail and hind quarters and the milk produced is reduced. After heat there may be a bit of bloody mucus discharge on the hindquarters and tail.

### 2.17 Oestrus Synchronization

The term "oestrous" refers to the point of female sexual excitement in mammals, which causes ovulation. At ovulation, females are most receptive to mating. This period is commonly referred to as heat (TheFreeDictionary.com. 2013). Oestrous synchronization is the method used in bringing female mammals to come to heat within a short period (36 to 96 hours). This is achieved through the use of hormones such as Gonadotropin Releasing Hormone (GnRH) and Prostaglandin F2α; these are two hormones commonly used in the “Synch” protocols during oestrus synchronization. Oestrus Synchronization (OS) in sheep and goats is achieved through manipulation of the luteal phase of the oestrous cycle, this can be done either by providing exogenous progesterone or by stimulating early luteolysis. The latter method is not applicable during seasonal anoestrus, though exogenous progesterone when combined with gonadotropin can be used to synchronize oestrus in anovular does and ewes (Wildeus, 2011).

In the United States of America (USA), OS in small ruminants is restricted by the amount of suitable pharmaceuticals available, there is a need to use products intended and approved for the major livestock species (swine and cattle). The conventional product of choice for OS in sheep and goats is the intravaginal sponge impregnated with progestagen (example flurogestone acetate or methyl acetoxyprogesterone) between 9 to 19 days followed by Pregnant Mares Serum Gonadotropin (PMSG) injected 0 to 48 hours from sponge removal. Another alternative choices of progesterone or progestagen have been Controlled Internal Drug Release (CIDR) devices, that supplies natural progesterone, norgestomet implants, and orally active melengestrol acetate. Other products used alone or in conjunction with progestagens are PGF2α or an analogue (cloprostenol), a combination of PMSG or Human Chorionic Gonadotropin (HCG) and zeranol.

### 2.18 Pregnancy Detection in Goats

Pregnancy detection and determination of the stage of pregnancy as well as foetal numbers are of great value for adequate planning of management procedures (Mohammed *et al.*, 2015). According to Omontese *et al.* (2012), there are two methods of pregnancy diagnosis; the traditional method of abdominal palpation and noting udder enlargement and the use of modern method of ultrasonography. Early pregnancy detection and foetal sexing with the use of ultrasonography improves reproductive management of animals on the farms (Reichenbach *et al.*, 2004; Santos *et al.*, 2004). This is important in livestock production to make culling or rebreeding decisions, for food allocation and for medical and research purposes. Examination of the goat for pregnancy may be due to request by the goat owner who would like to know the pregnancy status of his or her doe or may be done as part of a reproductive herd health programme (Dawson, 1999). Presently, trans-abdominal ultrasonography has been used with high rate of accuracy as a method of pregnancy detection and estimation of foetal numbers in sheep (Garcia *et al.,* 1993), deer (Revol and Wilson, 1991), and goat (Martínez *et al.,* 1998; Gonalez *et al.,* 2004) especially in advanced countries. However, information of such in sheep and goats is inadequate in developing countries like Nigeria (Omontese *et al.,* 2012).

## 2.19 Factors Affecting Gestation Period

The period in which a foetus develops is known as gestation period, the period begins with fertilization and ends at birth. The length of this period varies with species of animals. Smaller animals' species normally have a shorter gestation period than larger species of animals. However, growth does not necessarily determine the length of gestation for all species, especially for those with a breeding season. Seasonal breeders usually give birth during a specific period of the year when food is available. Other factors contribute to determining the duration of gestation. For humans, pregnancy involving male foetus usually gestate few days longer than pregnancy resulting in female kids; also pregnancies involving twins or multiple birth gestate for a shorter period. The sex of calf therefore influence gestation period. In dogs, positive connection exists between gestation period and litter size (MSN Encarta, 2009).

## 2.20 Birth Weight of Red Sokoto Goat Kids

Birth weight of Red Sokoto goat kids range between 1.5 – 2 kg (Osuhor *et al.*, 2002). Results obtained by Garba *et al.* (2015) revealed average weight at birth to be 3.18 kg and 2.87 kg for female and male kids in Red Sokoto goats respectively. Oni (2003) observed the birth weight of Red Sokoto goats to be 1.40 kg, while Alaku (2010) reported the birth weight of Red Sokoto goats to be between 1.4 and 1.45 Kg.

### 2.21 Milk Production Potentials of Red Sokoto Goats

Since the Nigerian breeds of goats are not reared for milk production purpose, only few works have been done on their milking production potentials (Akpa *et al*, 2002). A good dairy goat should give up to 3.4 litres of milk daily which amount to about 900 – 1800 kg of milk in a 305-day lactation period (Haenlein, 1992). Alaku (2010) observed the daily milk yield for Red Sokoto goats to be between 0.5 – 1.5 kg. Cisse *et al.* (2002) observed that the Red Sokoto goat had milk yield ranging between 0.3 – 0.66 g/day. Akpa *et al.* (2002) reported the daily milk yield for Red Sokoto goat to be between 0.03 - 0.66 kg. Luka and Kibon (2014) observed 0.1-0.5 kg in Red Sokoto Goats fed with supplements. The highest peak yield of milk recorded for the Red Sokoto goat of Nigeria was 850 g (Egwu *et al.,* 1995; Ruvuna *et al.,* 1995; Akpa, 1999).

### 2.22 Nutritional Importance of Goat Milk

Literatures have shown that goat milk is rich in basic food nutrients. It has been reported by Ozung *et al.* (2011) that goat milk contains less α – casein and more β-casein than cow milk; goat milk produces higher short and medium chain length fatty acid than cow milk. Smaller fat globules makes goat milk easily digested (Jennes, 1980). Goat milk contains twice vitamin A levels than those found in cow milk. Goat milk is helpful in relieving stress and constipation because of its high digestibility, high vitamin B content and high medicinal value (James *et al.,* 2005). The protein in goat milk is superior to that of human milk in terms of total calories. The total amino acid profile is similar to those of human but the protein differs in composition (Jennes, 1980). The essential amino acids of goat milk are slightly in excess of infant requirements (Ochepo and Momoh, 2010). Goat milk is sufficient for infants in essential fatty acids, with linoleic acid contributing about 1% of total calories. The milk is abundant in vitamins (C and D) and minerals (calcium and phosphorus) which is absent in cow milk, hence, goat milk can be used for infants and diet for weaned children (Jennes, 1980). According to Thear and Fraser (1986), children and adults who are allergic to cow milk do not react to goat milk. It has also been reported that goat milk help in the treatment of migraine and asthma in adults (Ijomanta, 2012).

**2.23 Mammary Morphology and Relationship with Milk Yield**

The udder is the major body part of a dairy animal generally related to its milk production capability. In goats, udder features, milk production, milking time and milking rate are traits with satisfactory genetic variation to allow selection responses (Wang, 1989; Mavrogenis *et al.,* 1989). Adequate knowledge of the relationships between these traits can be used in the planning of breeding programmes to increase milk quantity and quality and as aid to identify certain morphological and physiological factors related to changes in these traits (Shook, 1989).

There are rising interest on small ruminant morphological characteristics with emphasis on the relationship of the characteristics with milk yield and milking management, and factors that affect them (Charon 1990; Mather and Vroyla-Anesti, 1994; Labussiere, 1988). Studies were conducted in Red Sokoto goats to explain udder morphological characteristics, factors affecting them and connection with milk yield (Akpa *et al.,* 2003). From the research carried out by Akpa *et al.* (1998b), it was observed in lactating Red Sokoto goats that the average udder circumference was 38.8 cm; udder height was 17.1 cm; distance between teats was 11.5 cm; teat circumference 7.2 cm; and teat length 5.2 cm. Udder circumference and udder height were low in variability, while the teat size traits were moderately to highly variable. Thus, there is adequate variation in these traits to allow for selection response. Akpa *et al.* (1998b) also investigated the sources of discrepancy in morphological udder characteristics of Red Sokoto goats and concluded that udder and teat size traits of Red Sokoto goats were comparable to those found in dairy goats.

The udder characteristics increase with increase in age and parity of doe; thus indicating the likelihood of the morphological aptitude of the goat udder to mechanical milking improving as parity and age of doe increased. Effect of coat type on these traits showed that does with smooth and shiny coat had higher udder circumference and udder length than those with rough and dull coat implying that coat type can be used for udder characterization of Red Sokoto goat. Wattles had no significant ($p>0.05$) influence on the udder traits in Red Sokoto goats. The udder size characteristics were positively correlated; implying that improvement in one would lead to improvement on the others (Ijomanta, 2012).

According to Mavrogenis *et al.* (1989), increase in parity results to increased udder and teat size up to third ($3^{rd}$) parity but becomes leveled at the fourth and fifth parities. Udder circumference, distance between teats, udder height and milk yield improved with increase in litter size. Udder size characteristics were positively associated with milk yield. Low correlation of teat size with milk yield implies that they can be selected for, without affecting milk yield because their genetic correlations with milk yield are nil or at best low.

Milk yield prediction from external characteristics of the udder in Red Sokoto goat could be based on udder height, udder circumference, distance between teats and teat length. The positive association between udder and teat size traits would imply that as udder height increases, teat length, teat circumference and udder circumference would increase; hence making wider udder desirable since cistern height and teat position and angle may increase (Labussiere, 1988). The season of kidding affects udder characteristics, and therefore; should be used in planning breeding programmes to improve milk yield in Red Sokoto does. Does kidding in rainy season have superior udder circumference than does kidding in the dry season. Akpa *et al.* (1998b), also concluded that coat colour can be used for udder characterization in Red Sokoto goat; and predication of milk yield from external udder traits can be based on udder height, udder circumference and teat length. However, the high heritability estimates of udder circumference, udder height and teat circumference may implicate them as possible selection markers to improving Red Sokoto goat milking ability.

### 2.24 Relationship between Testicular Size and Sperm Production

Testicular sizes of animals are important for identification of those with adequate sperm production (Abba and Igbokwe, 2015). Breeding programmes require assurance of the reproductive capacity of sires. Nevertheless, in areas with low technical and laboratory support for semen evaluation, farmers may need a reference range of testicular sizes, without irrelevant extenuating conditions, which may be associated with adequate sperm reserve for reproductive efficiency (Abba and Igbokwe, 2015). The size of the testicules is believed to be the most important criteria from genetic, physiological and practical viewpoint to improve reproductive performance of females (Peter and Lesile, 1980). Normospermia could be anticipated when caudal epididymal sperm reserve is adequate, since the sperm output in the semen depends on the quantity of sperm stored in the caudal epididymies (Berndtson, 1977). In a study carried out by Abba and Igbokwe (2015), caudal epididymal sperm count correlated significantly ($p<0.05$) with scrotal size variables (scrotal circumference, scrotal length), some testicular size variables (testicular weight, testicular longitudinal length and testicular mid-circumference), and epididymal weight in Sahel bucks.

## 2.25 Relationship between Morphological and Conformation Traits

According to Oseni and Ajayi (2008), conformational traits that were highly correlated with body weight include body length, body depth, hearth girth, height-at-withers and height at rump. However, Semakula *et al.* (2010) reported that coat colour had no significant ($p>0.05$) effect on height-at-withers of small East Africa goat breeds of Uganda. Ozoje and Kadir (2001) also recorded no significant ($p>0.05$) differences in body measurement taken on West Africa Dwarf sheep when coat type was considered.

## 2.26 Relationship between Body Weight and Body Measurements

Thiruvenkadan (2005) reported that correlation coefficient between body weight and body measurements in goats were positive and strong. The correlation coefficient for different body weight ranged between 0.560 and 0.968. The chest girth accounted for maximum of 80.4 and 93.6 % of body weight. Hamayun *et al.* (2006) observed high and significant correlation coefficient between height-at-withers, and heart girth and body weight at 4 to 18 months of age in Beetal goats, suggesting that either of these variables or their combination would provide a good estimate for predicting live body weight in Beetal goat at an early age. The correlation obtained for the above variables were $r = 0.638$ and $r = 0.552$. Hassan and Ciroma (1992) found that body weight in Red Sokoto goat was correlated with body length, height at withers and heart girth within the age groups of 1 -2 years, 3 – 4 years and 5 years respectively. Akpa *et al.* (1998a) reported that Red Sokoto goat body weight was significantly and positively correlated with body length, height at withers and chest girth at 1 – 6 months, 7 -12 months, 13 – 18 months, 19 – 24 months, and 25 – 36 months, respectively. Hence, based on the magnitude of the correlations, heart girth and body length could be used to estimate body weights in Maradi goat across all ages.

According to Singh *et al.* (1992), birth weight, body weight and body measurements can be used in selection indexes to improve body weight at 3 and 6 months of age. An index that incorporated body weight, body length, height at withers, and heart girth at 3 months gave the highest expected genetic gain at 3 and 6 months of age.

### 2.27 Relationship Between Descriptive and Body Conformation Traits

Ozoje and Kadir (2001) reported that tassel significantly ($p<0.05$) affected body measurement traits in West Africa Dwarf goats, goats with tassels had longer body length, height at wither, heart girth, shoulder width, tail length, heart depth, leg length and abdominal circumference. Bratte *et al.* (1999) reported that horn development generally increases with age and body size. The coefficient of determination ($R^2$) relating average horn length to ram age and body weight indicated that 84.13 % of the variation in Average Horn Length (AHL) could be attributed to its linear relationship with ram age, while 54.34 % of the variation can be attributed to body weight. In Salem goats, the body measurements increased progressively as the age advanced (Thiruvenkadan *et al.,* 2000),

## CHAPTER THREE

## 3.0 MATERIALS AND METHODS

### 3.1 Experiment 1: Effect of Wattle on Body Weight and some Selected Morphometric Parameters in Red Sokoto Goats

#### 3.1.1 Description of study area

The study was carried out at the Teaching and Research Farm of the Department of Animal Production, Federal University of Technology, Minna, Niger State, Nigeria. Minna is located within latitude $9^0$ 37′ North and longitude 6° 33′ East of the equator. Minna has a mean annual rainfall of 1,300 mm, with an average highest temperature in the month of March and lowest temperature in the month of August. The mean annual temperature is between 22 to $40^o$ C. Minna is located in the Southern Guinea Savannah vegetation belt of Nigeria and has two distinct seasons; wet from March to October and dry from November to March (Federal University of Technology, Minna, Students Handbook, 2017).

#### 3.1.2 Source and management of the experimental animals

Forty (40) Red Sokoto goats comprising of thirty-two does and eight bucks were used for the experiment. The does were purchased at a fairly young age of between seven to eight months, in order to avoid the purchase of pregnant does while males of about one and half to two years were purchased to ensure effective breeding (the ages of the goats were determined by dental examination). The animals were sourced from within Niger State, principally from neighbouring communities and goat markets (Minna, Mariga, Beji, Kanfaninbobi and Bida goat markets). The purchased goats were acclimatized to the new environment for a period of eight (8) weeks (this was done purposely to allow the does more time for sexual maturity).

During acclimatization, the goats were administered with Ivomectin®; a broad spectrum anti parasitic drug, to remove both internal and external parasites. Vaccination against peste des petits ruminants (PPR) was done using PPR-VAC®. Broad spectrum anti-biotic (20 % oxyteracycline: Heibei Huarun Pharmacy Co. Ltd., China), penstrep® (Kepro, Holland), envite® multi vitamin (Ventidia pharmaceutical Ltd, India), albendazole® (Jawa International Limited, Lagos, Nigeria) and other drugs were administered when necessary to keep the animals in good health. The pen was constructed from wood and metal sheets. Water were provided *ad-libitum*, feed (yam peels, maize offal, beans husk and sorghum chaff) were given individually around 9. am every morning at the rate of 10 kg per treatment before the animals were relased for grazing. The proximate composition of feeds given to the goats is shown in Table 3.1

### 3.1.3 Treatments and experimental design

After the attainment of sexual maturity, thirty-two does and four bucks were allotted to four treatments in a Completely Randomised Design (CRD). Treatment one (**$T_1$**) comprised of goats without wattles in both sexes (serving as the control). Treatment two (**$T_2$**) comprised of does without wattle mated with wattled bucks. Treatment three (**$T_3$**) comprised of wattled does mated with non-wattled bucks while Treatment four (**$T_4$**), comprised of wattled bucks and does. Each treatment having eight replicates with each replicate containing one doe. The four bucks were divided among the four treatment groups (one buck per treatment) and were kept separately from the does. The animals were tagged properly for identification. The does were raised semi intensively while the bucks were confined before mating (to prevent unwanted breeding) and raised semi-intensively after mating. The animals were allowed to graze in the daytime and housed later in the evening after grazing.

**Table 3.1. Proximate composition of the experimental feeds**

| Parameters | Yam peel | Maize offal | Beans husk | Sorghum charf |
|---|---|---|---|---|
| Dry matter (%) | 91.09 | 86.05 | 87.58 | 89.28 |
| Crude protein (%) | 7.87 | 14.87 | 8.75 | 6.12 |
| Crude fibre (%) | 11.70 | 13.10 | 32.45 | 32.90 |
| Ether extract (%) | 1.70 | 2.20 | 1.60 | 5.88 |
| Ash (%) | 4.80 | 0.95 | 8.51 | 4.21 |
| Nitrogen Free Extract (%) | 65.02 | 54.93 | 36.27 | 40.17 |
| Metabolizable Energy (Kcal/g) | 307.66 | 299.09 | 194.48 | 238.08 |

### 3.1.4 Data collection

Data on the body weight and morphometric parameters (body length, head length, head width, height at withers, heart girth, horn length, ear length and rump width) of does were taken immediately after they were allotted to their various treatment groups and after parturition. The data for bucks were also taken at the same time but the values/figures were added up and divided by two to get the average. Data on quantitative traits (body weight, body length, head length, head width height-at-withers, heart girth, horn length, ear length and rump width) were also taken weekly. Measurements were taken following the FAO (2012) guidelines. The reference points were as follows:

**Body weight (Kg):** This was measured using a hanging spring balance. The measurement was done with the aid of a 50 kg capacity hanging balance (Raj engineering industries, India).

The following were measured in **cm** using tailors measuring tape:

**Body length:** Measured as the horizontal distance from the shoulder point to the pin bone.

**Head length:** This was measured as the distance from the nostril to the poll.

**Head width:** This was measured as the distance between the outer canthus of the right and left eye.

**Height-at-withers:** This was measured as the vertical height from the hoof to the highest point of the shoulder.

**Heart girth:** This was taken as the circumference of the body immediately behind the shoulder blades in a vertical plane perpendicular to the long axis of the body.

**Horn length:** This was taken as the Length of horn on its exterior side from its root at the poll to the tip

**Ear length:** This was the length of the external ear from its root on the poll to the tip.

**Rump width**: This was measured as the distance between the two points of the ischium.

### 3.1.5 Data analysis

Data collected were analyzed using SAS statistical package (SAS, 2000). Data collected were analysed with T-Test of the same package. Means were separated using Duncan Multiple Range Test.

## 3.2 Experiment 2: Effect of Wattle on Selected Reproductive Traits in Red Sokoto Does

### 3.2.1 Description of study area

Same as in experiment 1.

### 3.2.2 Treatments and experimental design:

The treatments and experimental design is as described in experiment 1.

### 3.2.3 Data collection

This experiment began after the does and bucks were allotted to their various treatments (this is to ensure equity of distribution in size and body weigth). Oestrous was synchronized with the use of oil ostradiol at the rate of 2 ml per doe. This ensured that the does came on heat at about the same time. This also ensured that the does were served at about the same time and also, kidded at about the same time. This made record keeping easy, and ensured that kids born are exposed to the same management practices and the same climatic regime. Does on heat were taken to the male pen of their treatment group for mating. Mating was repeated three weeks after the first mating as a means of checking if pregnancy had resulted after the first mating. Data were collected on the gestation length, gestation gain, kidding loss, weight of does pre partum, weight of doe post-partum, conception rate, rate of abortion/miscarriage, number of kid(s) at birth, birth weight of kid(s), sex ratio, survival and mortality rate of kids in each treatment group. Blood serum were collected from the doe for hormonal assay (progesterone and oestrogen). The goats were sufficiently calmed before blood samples were collected. Necessary precautions were taken in order not to pierce the lung tube with the needle (22-guage needle). Once the jugular vein was located, a thumb was used to press the lower part of the vein to prevent blood from flowing. 5 ml of blood samples were collected by jugular venipuncture and was dispensed into plain (anticoagulant free) bottles and were also labelled properly. The blood samples were collected before the does were mated, during the five month of pregnancy and a week after the does kidded. The progesterone and oestrogen in the serum were analysed at the Biotechnology Centre, Federal University of Technology, Minna, using Accubind Elisa microwells kits (ISO 13485 and 9001, Monobind Inc, USA). The rectal temperature of does were take using digital thermometer (Hicks thermometers, Model DT-101, India).

**Parameters measured**

**Gestation length**: This was achieved by counting in days from the day does were mated to the day they kidded.

**Gestation gain**: This was measured in kg using a 50 kg capacity spring balance (Raj Engineering Indusries, Idia) and was calculated by subtracting the weight of doe(s) at mating from their weight one-day pre-partum/before birth.

**Kidding loss:** This was measured in kg using the scale mentioned above and was taken as the difference between doe’s weight a day before kidding and its weight a day post–partum/after kidding.

**Weight of doe pre-partum:** This was measured using a 50 kg spring balance and taken as the weight of does a day before parturition.

**Weight of doe post-partum:** This was measured using a 50 kg spring balance and taken as the weight of does immediately after parturition.

**Conception rate:** This was evaluated using the formula:

$$\frac{\text{Number of pregnant does}}{\text{Total number of does mated}} \times 100$$

**Abortion rate/miscarriage:** This was measured using the formula:

$$\frac{\text{Number of pregnancies that ended before kidding}}{\text{Total number of does that kidded}} \times 100$$

**Number of kids weaned**: This was the number of kids at birth was obtained by counting.

**Body weight of kid(s)**: The body weight of each kid at birth was taken in kg using a 5 kg capacity kitchen weighing scale.

**Sex ratio:** This was obtained by counting, and was taken as the ratio of males to females kids in each treatment.

**Survival rate:** This was calculated using the formula:

$$\frac{\text{Number of kids alive when assessing the kids}}{\text{Total number of kids born}} \times 100$$

**Mortality rate:** This was calculated using the formula:

$$\frac{\text{Number of dead when assessing the kids}}{\text{Total number of kids born}} \times 100$$

### 3.2.4 Data analysis

Data collected was analyzed using SAS statistical package (SAS, 2000). Means were separated using Duncan Multiple Range Test.

## 3.3 Experiment 3: Determination of the Effect of Wattle on Selected Dairy Characteristics of Red Sokoto Does

### 3.3.1 Description of study area

Same as in experiment 1.

### 3.3.2 Treatments and experimental design:

The treatments and experimental design is as described in experiment 1.

### 3.3.3 Data collection

Data collection started after the does had given birth; milk samples from all the lactating does were collected from the first week of lactation to the twelfth week. Milk production was collected once a week by hand milking for the period of twelve weeks. The night before milking, kids were separated from their dams for 12 hours (6:00 pm to 6:00 am). The next morning, the does were completely hand milked and the quantity of milk was recorded. Before milking, the teats were washed with soap mixed with disinfectant (Detol®) and cleaned using towel. The milk obtained was multiplied by 2 to obtain the daily milk yield as described by (Bencini *et al.*, 2003). Milk yields was measured using Pyrex measuring cylinder of 2 litre capacity. The quantity of milk collected at each milking was recorded. Other parameters that were recorded weekly included:

**Udder circumference (cm):** This was done using cloth tape measure (Apollo industries, India). The measurements were taken as the distance round the middle of the udder; this was repeated after milking to observe the effect of milking on the udder.

**Distance between teats (cm):** This was measured using the measuring tape mentioned above. The measurement was done as the distance between two tips of the teat. The procedures was also repeated after milking to observe the change in distance between the teats.

**Teat length (cm):** This was done using the above measuring tape. It was measured as the distance between the base of the udder to the tip of the teats. This was also repeated after milking to see the effect of milking on the teat length.

Data on all the above mentioned parameters were recorded weekly from the first week up to 12 weeks of lactation.

Data was also collected on the following:

**First test day yield:** This is the milk yield at day 7 post-partum.

**Peak yield:** This is the highest recorded test day milk yield within the twelve weeks sampling period.

**Total yield:** This is the summation of the weekly milk production for 90 days post-partum.

**Last test day Yield:** Milk yield on day 90 post-partum.

The collected samples were fed back to the kids (bucket feeding) whose mothers were milked. Portions of the milk were collected from the does weekly from the 1$^{st}$ week up to the 12$^{th}$ week of lactation for milk quality analysis (dry matter, crude protein, ether extract, ash, milk solid, nitrogen free extract, vitamin and mineral content). The milk samples were quickly transported to the Animal Production Laboratory, Federal University of Technology Minna for analysis.

### 3.3.4 Data analysis

Data collected were analyzed using SAS statistical package (SAS, 2000). Means were separated using Duncan Multiple Range Test. Correlation analysis were employed to identify the degree of association between milk yield and udder traits.

## 3.4 Experiment 4: Determination of the Relationship between Wattle and the Growth Trait of Growing Red Sokoto Goats till Weaning

### 3.4.1. Description of study area

As in experiment 1.

### 3.4.2 Treatments and experimental design

The treatments and experimental design is as described in experiment1.

### 3.4.3 Data collection

Immediately after birth, data on quantitative traits of kids (body weight, body length, head length, head width, height at withers, heart girth, horn length, ear length and rump width) were measured weekly until weaning. Measurements were taken following the FAO (2012) guidelines. The reference points were as described in experiment 1. Body weigth of kids from birth to six weeks were taken using 1-5 kg KCA weighing scale manufactured in China. While body measurement from seven to twelve weeks were carried out using Camry 20 kg capacity weighing scale (Model SPR 20) manufactured in China. Other body measurements were taken using cloth tape measure manufactured by Apollo industries India.

### 3.4.4 Data analysis

Data collected were analyzed using SAS statistical package (SAS, 2000) Means were separated using Duncan Multiple Range Test.

## 3.5 Experiment 5: Determination of the Relationship between Wattle and Weaning Traits of Red Sokoto Goats

### 3.5.1 Description of study area

The study was as in experiment 1.

### 3.5.2 Treatments and experimental design

The treatments and experimental design is as described in experiment 1.

### 3.5.3 Data collection

After birth, the kids were raised with their mothers (does) for three months before weaning. At weaning, data on the number of kids at weaning, body weight of kids at weaning, weaning weight gain, weaning sex ratio and survival rate at weaning were collected as follows: .

**Number of kids at weaning**: This was obtained by counting the number of kids weaned per treatment.

**Final Body weight at weaning:** This was measured in kg using 20 kg Camry weighing scale as the weight of the kids on the last day of the experiment.

**Body weight gain of kids at weaning**: This was done using the scale mentioned above. The body weight gain of the kids was obtained by subtracting the initial body weight of the kids from their final body weight.

**Weaning sex ratio**: This was taken as the proportion of male to female kids at weaning.

**Survival rate at weaning:** This was taken in percentage using the formula:

$$\frac{\text{Kids size at weaning}}{\text{Kids size at birth}} \times 100$$

### 3.5.4 Data analysis

Data collected were analyzed using SAS statistical package (SAS, 2000). Means were separated using Duncan Multiple Range Test.

## 3.6 Experiment 6: Determination of the Effect of Wattle on the Haematological Characteristics of Red Sokoto Goats

### 3.6.1 Description of study area

The Blood samples were collected from the goats at the Teaching and Research Farm of the Department of Animal Production, Federal University of Technology, Minna and was transported to Falala Rabi Laboratory, Tunga, Minna for analysis.

### 3.6.2 Treatments and experimental design

As in experiment 1.

### 3.6.3 Data collection

Blood samples from each goat were collected. The goats were sufficiently calmed before blood samples were collected. Necessary precautions were taken in order not to pierce the lung tube with the needle (5 ml syringe and 22-guage needle were used). Once the jugular vein was located, a thumb was used to press the lower part of the vein to prevent blood from flowing. Out of the 5 ml of blood collected, 2.5 ml was dispensed into Ethylene Diamine Tetra Acetic Acid (EDTA) bottle and labelled according to the treatment group, while the remaining 2.5 ml was dispensed into plain (anticoagulant free) bottles and were also labelled properly. The blood samples were transported to the laboratory for analysis. Blood samples with anticoagulants were used to analyze for the Packed Cell Volume (PCV), Red Blood Cell (RBC), White Blood Cell (WBC) and Haemoglobin (HB) with the aid of Abacus 380, haematology analyzer (Diamond Diagnostics, USA). The clotted blood was used to determine the serum protein, albumin, globulin concentration, creatinine concentration, serum glucose, nitrogen and urea. Others including cholesterol, serum sodium, potassium and serum hepatic enzymes namely Aspatate aminotransferase (AST), Alanine amino tranferese (ALT) and Alkaline phosphatase (ALP) were analyzed using Chem 5V3 semi-automatic analyzer (Alliance instruments, France).

### 3.6.5 Data analysis

Data collected were analyzed using SAS statistical package (SAS, 2000). The variation were separated using Duncan Multiple Range Test.

## 3.7 Experiment 7: Determination of the Relationship between Wattle and Body Weight, Scrotal Length, Scrotal Circumference and Sperm Cell Concentration in Red Sokoto Bucks

### 3.7.1 Location of study area

As in experiment 1.

### 3.7.2. Treatments and experimental design:

Eight Red Sokoto bucks were allotted to two (2) treatments groups. Treatment 1 contained bucks without wattle. Treatment 2 contained bucks with wattle. The experiment was in a Completely Randomised Design (CRD) model; each treatment had four replicates (i.e one buck/ replicate). The bucks were tagged for proper identification. The bucks were raised semi intensively. All other procedures were as in experiment 1.

### 3.7.3 Data collection

The bucks were adequately restrained and calmed before data collection. Data were collected on the body weight of bucks, scrotal circumference, scrotal length (left and right), testis width (left and right), semen volume, semen pH, semen motility, colour and the mean rectal temperature. Measurements of scrotal length and scrotal circumference were taken with the aid of tape mentioned above in centimetre following the methods of Adedeji *et al*. (2012).

**Scrotal length:** The length was taken as the distance from the point of attachment of the scrotal sac to the tip of the scrotum.

**Scrotal circumference:** This was measured as the width of the middle parts of the scrotum.

**Semen collection:** The semen was collected using electro-ejaculation method and analyzed in the Department of Animal Production laboratory. Sperm cells were counted with a manual cytometer (haemocytometer) as described by Igbokwe *et al.* (2014) to obtain the sperm cell concentration.

### 3.7.4 Data analysis

Data collected were analyzed using SAS statistical package (SAS, 2000). The variation in the treatment means were separated using Duncan Multiple Range Test.

# CHAPTER FOUR

## 4.0 RESULTS

### 4.1 Effect of Wattle on the Initial Body Weight and Morphometric Parameters of Red Sokoto Does

The result of the initial body weight and morphometric parameter of does in table 4.1 shows that only the head width was significantly ($p<0.05$) affected. The body weight, body length, head length, height-at-withers, chest girth, horn length, rump length, rump width, hind leg length, fore leg length, shin circumference and ear length showed no significant ($p>0.05$) difference. The wattled does in $T_2$ had wider head width (11.88±0.38).

### 4.2. Effect of Wattle on the Body Weight and Morphometric Parameters of Red Sokoto Does Post-Partum

The results of the body weight and morphometric parameters of Red Sokoto does used for the experiment post-partum (Table 4.2) revealed a significant ($p<0.05$) difference only in the body weight of does post-partum. The body length, head length, head width, height-at-wither, chest girth, horn length, rump length, rump width, fore leg, hind leg, shin circumference and ear length showed no significant ($p>0.05$) difference. $T_1$, $T_2$ and $T_3$ showed significant higher body weight over $T_4$.

### 4.3 Effect of Wattle on the Average Body Weight and Morphometric Parameters in Red Sokoto Bucks Raised Semi Intensively

The result of the average body weight and morphometric parameters of Red Sokoto bucks raised semi intensively in table 4.3 shows a significant difference ($p<0.05$) in the body weight, head width, rump length and the fore leg length. Other parameters like the body length, head length, height-at-withers, chest girth, horn length, rump width, hind leg length, shin

**Table 4.1. Effect of wattle on the initial body weight and morphometric parameters of Red Sokoto does**

| Parameters | Treatments | Mean | Standard. Error Mean | P-value | Eta-value |
|---|---|---|---|---|---|
| **Body weight (kg)** | Non wattle | 10.18±1.46 | 0.51 | | |
| | wattled | 11.26±1.64 | 0.58 | 0.18 | 0.35 |
| **Body length (cm)** | Non wattle | 47.83±2.90 | 1.03 | | |
| | Wattled | 48.83±1.92 | 0.68 | 0.43 | 0.21 |
| **Head length (cm)** | Non wattle | 13.91±0.77 | 0.27 | | |
| | Wattled | 13.60±0.91 | 0.32 | 0.47 | 0.20 |
| **Head width (cm)** | Non wattle | 11.26[b]±0.44 | 0.16 | | |
| | Wattled | 11.88[a]±0.38 | 0.13 | 0.01 | 0.62 |
| **Height-at-withers (cm)** | Non wattle | 46.41±1.53 | 0.54 | | |
| | Wattled | 47.89±0.98 | 0.35 | 0.40 | 0.52 |
| **Chest girth** | Non wattle | 50.91±2.96 | 1.05 | | |
| | Wattled | 51.46±3.36 | 1.18 | 0.73 | 0.09 |
| **Horn length (cm)** | Non wattle | 3.01±0.82 | 0.29 | | |
| | Wattled | 3.28±1.12 | 0.40 | 0.60 | 0.142 |
| **Rump length (cm)** | Non wattle | 13.90±0.99 | 0.35 | | |
| | Wattled | 11.91±3.64 | 1.29 | 0.16 | 0.370 |
| **Rump width (cm)** | Non wattle | 13.53±0.88 | 0.31 | | |
| | Wattled | 14.20±0.74 | 0.26 | 0.12 | 0.41 |
| **Foreleg length (cm)** | Non wattle | 39.80±1.83 | 0.65 | | |
| | Wattled | 41.40±1.81 | 0.64 | 0.10 | 0.43 |
| **Hind leg length (cm)** | Non wattle | 45.10±2.23 | 0.79 | | |
| | Wattled | 46.61±2.31 | 0.82 | 0.20 | 0.34 |
| **Shin Circumference(cm)** | Non wattle | 6.30±0.16 | 0.06 | | |
| | Wattled | 6.43±0.40 | 0.14 | 0.43 | 0.22 |
| **Ear length (cm)** | Nonwattled | 10.75±1.00 | 0.25 | | |
| | Wattled | 10.44±1.31 | 0.33 | 0.46 | 0.137 |

circumference and ear length show no significant difference ($p>0.05$). The non wattled bucks had superior ($p<0.05$) body weight (15.50±0.71) and head width (15.10±0.34) while the wattled bucks in $T_2$ had superior rump length (16.40±0.66) and fore leg length (47.07±2.16) .

## 4.4. Effect of Wattle on the Reproductive Traits of Red Sokoto Does Raised Semi Intensively

The effect of wattle on the reproductive traits of Red Sokoto does is presented in Table 4.4 Significant ($p<0.05$) effect of wattle was observed in all the traits except gestation gain and gestation length. Weight of does pre partum was significantly ($p<0.05$) highest in non-wattled does mated to wattled bucks in $T_2$ (19.40) while the lowest ($p<0.05$) value was observed in $T_4$ (wattled does mated to wattled bucks with17.00 kg). Wattle to wattle mating ($T_4$) also had the significantly ($p<0.05$) the lowest weight of does post-partum (14.75). Kidding loss and litter size followed a similar trend; wattled does mated with non-wattle in $T_4$ had significantly ($p<0.05$) higher values over $T_1$ and $T_2$ but were statistically similar ($p>0.0$) to the result obtained from wattled does mated with non-wattled bucks in $T_3$. Non-wattled does mated with non-wattled bucks ($T_1$) and non-wattled does mated with wattled bucks ($T_2$) however had the least values but had statistically similar values ($p>0.05$) with does in $T_3$. The birth weight of kids in $T_2$ and $T_3$ were higher ($p<0.05$) than in$T_1$ and $T_4$.

## 4.5. Effect of Wattle on Conception Rate, Abortion Rate, Survival Rate, Type of Birth and Sex Ratio of Red Sokoto Does Raised Semi Intensively

The effect of wattle on conception rate, survival rate, types of birth and sex ratio of Red Sokoto Does raised semi intensively is shown in Table 4.5. Non-wattled does mated with non wattled bucks ($T_1$) and wattled does mated with non-wattled bucks in ($T_3$) had significantly ($p<0.05$) the highest conception rate of 62.5 % followed by non-wattled does mated with wattled bucks in $T_2$ (50 %), $T_4$ (wattled does mated with wattled bucks) had the least conception rate (25 %). Goats in $T_4$ had the highest ($p<0.05$) number of does that failed to conceive (75 %) followed by does in $T_2$ (50 %). $T_1$ (non-wattled does mated with non-wattled bucks) and $T_3$ had significantly ($p<0.05$) the least (37.5 %) conception rate. Does in $T_4$ had significantly ($p<0.05$) the highest abortion rate (50 %) followed by non-wattled does mated with non-wattled bucks ($T_1$) (20 %) while $T_2$ and $T_3$ had significantly ($p<0.05$) the least abortion rate (0 %). Does in $T_2$ and $T_3$ had 100 % ($p<0.05$) parturition of does that conceived while $T_1$ and $T_4$ had up to 80 % and 50 % parturition rate respectively of does that conceived. Kids in $T_2$ had significantly ($p<0.05$) the highest survival rate (100 %) followed by kids in $T_1$ with 75 % survival rate; $T_3$ had 66.7 % while $T_4$ had 33.3 % survival rate. $T_4$ had significantly ($p<0.05$) the highest mortality rate (66.7 %) followed by $T_3$ (33.3 %), $T_1$ (25 %) and $T_2$ (0 %) respectively. Mating between wattled does and wattled buck in $T_4$ yielded more ($p<0.05$) twins (50 %) than wattled does and non-wattled bucks in $T_3$ (25 %), non-wattled doe and non-wattled bucks in $T_1$ (0 %) and between non-wattled does and wattled buck in $T_2$ (0 %). $T_2$ had the highest ($p<0.05$) percentage of males (75 %), followed by $T_1$ and $T_3$ (50 %) while $T_4$ (25 %) had the least. $T_4$ had significantly ($p<0.05$) the largest proportion of females (66.7%) followed by $T_1$ and $T_3$ (50 %), $T_2$ had the least female population (25 %).

## 4.6 Pattern of the Mean Progesterone Levels of Wattled and Non-wattled Does Raised Semi Intensively, before Mating, during Pregnancy and after Kidding

The pattern of progesterone (ng/ml) levels of wattled and non-wattled Red Sokoto does raised semi intensively, before mating, during pregnancy and after kidding, is shown in Figure 4.1 The serum progesterone of does before mating revealed no significant ($p>0.05$) difference among the treatment group. The progesterone levels during the first five months of pregnancy and the first month after birth however revealed significant ($p>0.05$) differences. The figure

**Table 4.2. Effect of wattle on the body weight and morphometric parameters of Red Sokoto does post-partum**

| Parameters | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| Body weight | 17.00[a] | 17.50[a] | 16.50[a] | 14.75[b] | 0.32 |
| Body length (cm) | 54.14 | 53.34 | 52.52 | 56.42 | 5.32 |
| Head length (cm) | 14.60 | 14.04 | 14.24 | 14.32 | 5.29 |
| Head width (cm) | 12.16 | 12.62 | 12.73 | 12.52 | 5.07 |
| Height-at-wither (cm) | 51.48 | 53.54 | 52.74 | 52.04 | 4.99 |
| Chest girth (cm) | 63.22 | 62.38 | 61.18 | 63.98 | 5.04 |
| Horn length (cm) | 9.08 | 6.78 | 8.64 | 8.98 | 4.77 |
| Rump length (cm) | 15.62 | 16.20 | 16.46 | 15.76 | 4.77 |
| Rump width (cm) | 17.30 | 18.52 | 18.76 | 18.42 | 4.83 |
| Fore leg (cm) | 42.38 | 44.98 | 44.92 | 43.94 | 4.94 |
| Hind leg (cm) | 52.20 | 51.74 | 52.96 | 51.48 | 5.35 |
| Shin circumference (cm) | 7.42 | 7.24 | 7.26 | 7.32 | 4.93 |
| Ear length (cm) | 12.44 | 11.50 | 11.70 | 12.24 | 5.12 |

[abcd] Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$**= Non-wattled does mated with non-wattled bucks; **$T_2$**= Non-wattled does mated with wattled bucks;
**$T_3$**= Wattled does mated with non-wattled buck; **$T_4$**= Wattled does mated with wattled bucks.
**SEM=** Standard error of mean

**Table 4.3 Effect of wattle on the average body weight and morphometric parameters of Red Sokoto bucks raised semi intensivel.**

| Females | Trt | Mean | Standard Error Mean | P-value | Eta-value |
|---|---|---|---|---|---|
| **Body weight (kg)** | Nonwattled | 10.74±1.49 | 0.37 | | |
| | Wattled | 11.29±1.55 | 0.39 | 0.310 | 0.19 |
| **Body length (cm)** | Nonwattled | 45.70[b]±3.23 | 0.81 | | |
| | Wattled | 48.71[a]±2.72 | 0.68 | 0.008 | 0.46 |
| **Head length (cm)** | Nonwattled | 13.57±0.72 | 0.18 | | |
| | Wattled | 13.28±0.74 | 0.19 | 0.274 | 0.20 |
| **Head width (cm)** | Nonwattled | 1.16±0.52 | 0.13 | | |
| | Wattled | 1.20±0.59 | 0.15 | 0.066 | 0.33 |
| **Height-at-withers (cm)** | Nonwattled | 46.61±1.31 | 0.33 | | |
| | Wattled | 47.24±2.26 | 0.56 | 0.339 | 0.18 |
| **Chest girth** | Nonwattled | 50.56±2.56 | 0.64 | | |
| | Wattled | 50.50±2.86 | 0.71 | 0.948 | 0.01 |
| **Horn length (cm)** | Nonwattled | 2.79±0.82 | 0.21 | | |
| | Wattled | 2.87±1.27 | 0.32 | 0.844 | 0.04 |
| **Rump length (cm)** | Nonwattled | 13.59±0.99 | 0.25 | | |
| | Wattled | 13.01±2.82 | 0.70 | 0.441 | 0.14 |
| **Rump width (cm)** | Nonwattled | 13.47[b]±0.81 | 0.20 | | |
| | Wattled | 14.06[a]±0.73 | 0.18 | 0.037 | 0.37 |
| **Foreleg length (cm)** | Nonwattled | 39.00±1.46 | 0.37 | | |
| | Wattled | 38.94±3.19 | 0.80 | 0.944 | 0.01 |
| **Hind leg length (cm)** | Nonwattled | 44.19[b]±2.20 | 0.55 | | |
| | Wattled | 45.06[a]±2.72 | 0.68 | 0.0325 | 0.18 |
| **Shin Circumference(cm)** | Nonwattled | 6.00±0.00 | 0.00 | | |
| | Wattled | 6.00±0.37 | 0.09 | 1.000 | 0.00 |
| **Ear length (cm)** | Nonwattled | 10.75±1.00 | 0.25 | | |
| | Wattled | 10.44±1.31 | 0.33 | 0.456 | 0.13 |

**Table 4.4 Effect of wattle on the reproductive traits of Red Sokoto does raised semi intensively**

| Parameters | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| Gestation length (days) | 147.33 | 146.83 | 147.83 | 147.50 | 0.44 |
| Weight of does pre partum (kg) | $18.75^{ab}$ | $19.40^{a}$ | $18.60^{ab}$ | $17.00^{b}$ | 0.33 |
| Weight of does post-partum (kg) | $17.00^{a}$ | $17.50^{a}$ | $16.50^{a}$ | $14.75^{b}$ | 0.32 |
| Gestation gain (kg) | 5.75 | 6.64 | 6.60 | 5.50 | 0.26 |
| Kidding loss (kg) | $1.75^{b}$ | $1.88^{b}$ | $2.16^{ab}$ | $2.50^{a}$ | 0.11 |
| Litter size/number of kids | $1.00^{b}$ | $1.00^{b}$ | $1.20^{ab}$ | $1.50^{a}$ | 0.08 |
| Birth weight of kids (kg) | $1.50^{bc}$ | $1.84^{a}$ | $1.70^{ab}$ | $1.27^{c}$ | 0.08 |

$^{abcd}$ Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$**= Non-wattled does mated with non-wattled bucks;
**$T_2$** = Non-wattled does mated with wattled bucks;
**$T_3$**= Wattled does mated with non-wattled buck:
**$T_4$**= Wattled does mated with wattled bucks.
**SEM=** Standard error of mean

**Table 4.5 Effect of wattle on conception rate, abortion rate, survival rate, type of birth and sex ratio of Red Sokoto does raised semi intensively**

| Parameters (%) | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| Conception rate | $62.50^{a}$ | $50.00^{b}$ | $62.50^{a}$ | $25.00^{c}$ | 4.62 |
| Failed conception | $37.50^{c}$ | $50.00^{b}$ | $37.50^{c}$ | $75.00^{a}$ | 4.62 |
| Abortion | $20.00^{b}$ | $0.00^{c}$ | $0.00^{c}$ | $50.00^{a}$ | 6.17 |
| Parturition | $80.00^{b}$ | $100.00^{a}$ | $100.00^{a}$ | $50.00^{c}$ | 10.22 |
| Survival rate | $75.00^{b}$ | $100^{a}$ | $66.70^{b}$ | $33.33^{c}$ | 7.31 |
| Mortality rate | $25.00^{c}$ | $0.00^{d}$ | $33.30^{b}$ | $66.7^{a}$ | 7.20 |
| Single | $100.00^{a}$ | $100.00^{a}$ | $75.00^{b}$ | $50.00^{c}$ | 6.25 |
| Twin | $0.00^{c}$ | $0.00^{c}$ | $25.00^{b}$ | $50.00^{a}$ | 6.25 |
| Male | $50.00^{b}$ | $75.00^{a}$ | $50.00^{b}$ | $33.33^{c}$ | 4.49 |
| Female | $50.00^{b}$ | $25.00^{c}$ | $50.00^{b}$ | $66.70^{a}$ | 38.03 |

$^{abcd}$ Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$**= Non-wattled does mated with non-wattled bucks;
**$T_2$** = Non-wattled does mated with wattled bucks;
**$T_3$**= Wattled does mated with non-wattled buck:
**$T_4$**= Wattled does mated with wattled bucks.
**SEM=** Standard error of mean

showed that $T_1$ (11.64 ng/ml) $T_2$ (10.93 ng/ml) and $T_3$ (10.23 ng/ml) had the highest ($p<0.05$) progesterone level while $T_4$ (9.15 ng/ml) had the least ($p>0.05$) in the first month of pregnancy. Does in $T_{1,}$ $T_2$ and $T_4$ had the higher ($p<0.05$) progesterone levels of 17.85, 16.91 and 16.25 ng/ml respectively, over $T_3$ (15.01ng/ml) with the least in the second month of pregnancy. In the third and fourth months of pregnancy, the progesterone levels followed a similar trend with does in, $T_2$, $T_3$ and $T_4$ having statistically ($p<0.05$) the highest progesterone levels while $T_1$ had significantly ($p<0.05$) the least progesterone levels in the fifth month of pregnancy. Does in $T_2$ and $T_3$ had a statisticaly higher ($p<0.05$) progesterone level followed by those in $T_4$ and $T_{1,}$ respectively after paturition.

## 4.7 Pattern of the Mean Oestrogen Levels of Wattled and Non-wattled Does Raised Semi Intensively, before Mating, during Pregnancy and after Kidding

The pattern of the mean oestrogen (pg/ml) levels of wattled and non-wattled Red Sokoto does raised semi intensively, before mating, during pregnancy and after kidding (Figure 4.2) revealed that wattle had significant ($p<0.05$) influence on the pattern of oestrogen before mating, during five month of pregnancy and after kidding in does raised semi intensively. Before mating, the estrogen levels in $T_1$, $T_2$ and $T_3$ (12.50, 10.25 and 9.80 pg/ml) were higher ($p<0.05$) while $T_4$ (8.20 pg/ml) had the lowest but similar ($p>0.05$) to $T_2$ and $T_3$. In the first month of pregnancy, $T_2$ (132.90 pg/ml) had significantly ($p<0.05$) higher oestrogen followed by $T_3$ (128.97 pg/ml), $T_4$ (118.74 pg/ml) and $T_1$ (92.50 pg/ml). In the second month of pregnancy, does in $T_3$ (265.80 pg/ml) had significantly ($p<0.05$) higher levels of oestrogen, followed by does in $T_2$ (262.70 pg/ml), $T_4$ (259,50 pg/ml) and $T_1$ (253.67 pg/ml), repectively. Does in $T_2$ (525.33 pg/ml) had the highest ($p<0.05$) oestrogen level followed by those in $T_4$ (451.00 pg/ml), $T_1$ (402.67 pg/ml) and $T_3$ (331.67 pg/ml) in the third month of pregnancy. Does in $T_1$ (638.75 pg/ml) and $T_2$ (636.33 pg/ml) had ($p<0.05$) higher levels of oestrogen than $T_3$

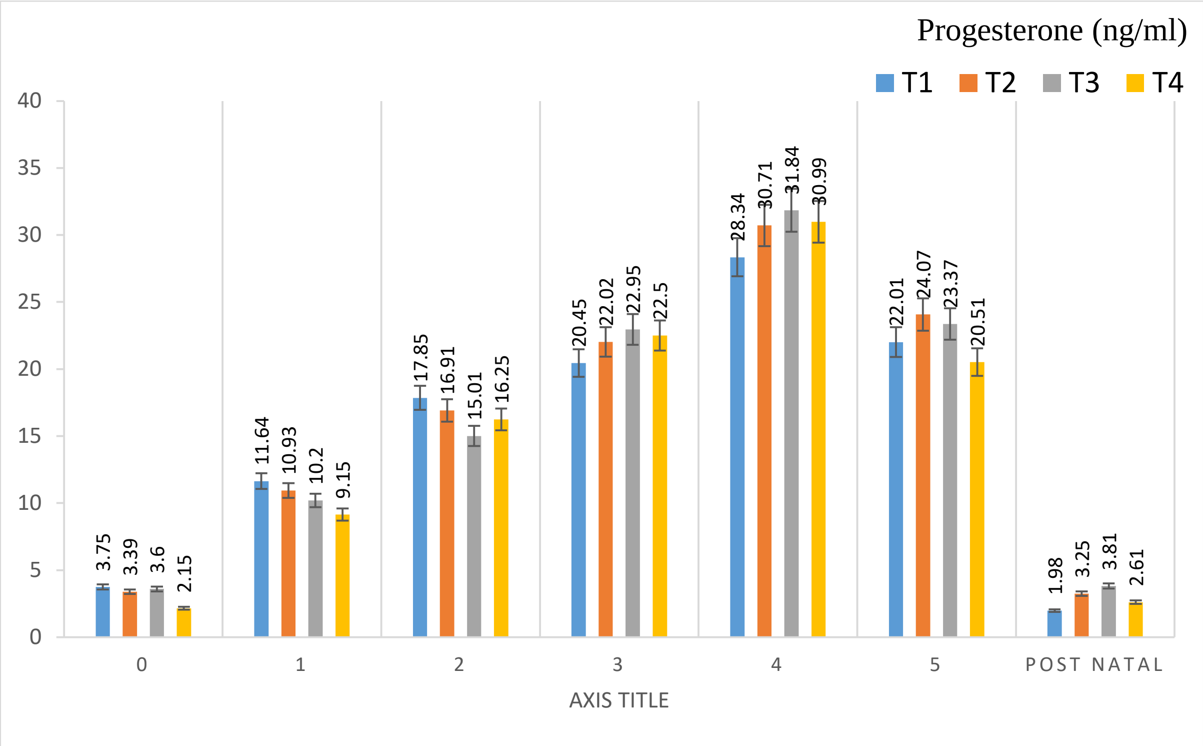


**Figure 4.1 Pattern of progesterone levels of wattled and non-wattled does raised semi intensively, before mating, during pregnancy and after kidding**

**$T_1$**= Non-wattled does mated with non-wattled bucks;
**$T_2$** = Non-wattled does mated with wattled bucks;
**$T_3$**= Wattled does mated with non-wattled buck:
**$T_4$**= Wattled does mated with wattled bucks.

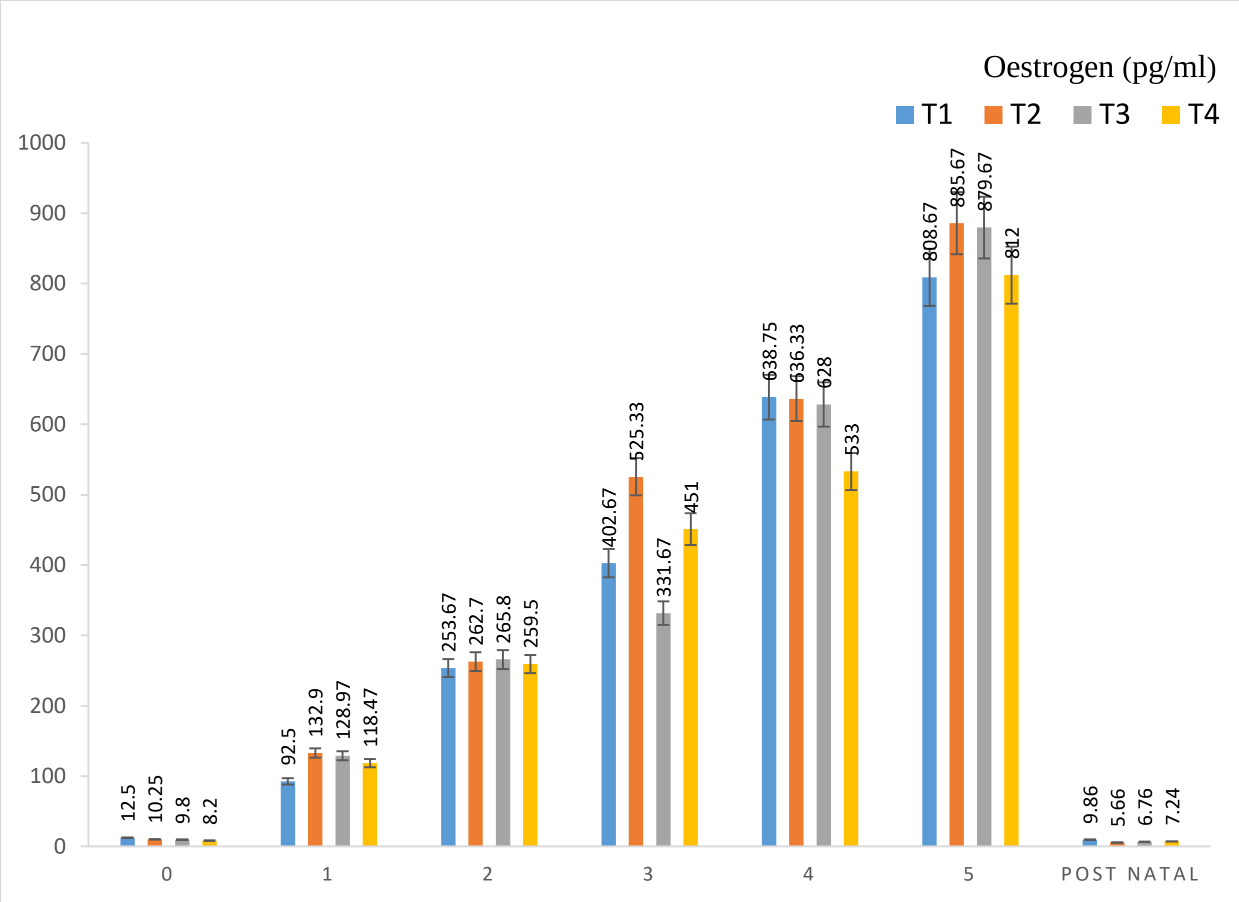


**Figure 4.2 Pattern of oestrogen levels of wattled and non-wattled does raised Semi intensively, before mating, during pregnancy and after kidding**

$T_1$= Non-wattled does mated with non-wattled bucks;
$T_2$ = Non-wattled does mated with wattled bucks;
$T_3$= Wattled does mated with non-wattled buck:
$T_4$= Wattled does mated with wattled bucks.

(628.00 pg/ml) and $T_4$ (633.00), respectively in the fourth month of pregnancy. In the fifth month, $T_2$ (885.67 pg/ml) and $T_3$ (879.67 pg/ml) does had statistically ($p<0.05$) higher oestrogen levels than $T_1$ (808.67 pg/ml) and $T_4$ (812.00 pg/ml) does. After paturition, does in $T_1$ (9.86 pg/ml) had the highest ($p<0.05$) oestrogen level compered to those in $T_2$ (7.27 pg/ml), $T_3$ (6.76 pg/ml) and $T_4$(5.66 pg/ml), respectively.

## 4.8. Effect of Wattle on the Rectal Temperature of the Red Sokoto Does Raised Semi-Intensively

Table 4.6. shows the effect of wattle on the rectal temperature ($^{O}C$) of the Red Sokoto does raised semi-intensively. The Table shows significant ($p<0.05$) difference in average rectal temperature before mating, average rectal temperature in the first and second month only. The average rectal temperature for the third, fourth and fifth months and the mean showed no significant ($p>0.05$) difference. The average rectal temperature of does in $T_4$ was observed to be significantly ($p<0.05$) higher than in does found in $T_1$ (39.30). $T_2$ (39.10) and $T_3$ (38.98) who were statistically similar before mating. In the first month of gestation, does in $T_2$ (39.28) had significantly ($p<0.05$) higher average rectal temperature than those in $T_1$ (38.93). Does in $T_3$ (39.10) and $T_4$ (39.15) had intermediate values ($p>0.05$) between the extremes. The highest ($p<0.05$) average rectal temperature in the second month of gestation was found in $T_1$ (38.92) does and the least ($p<0.05$) was found in $T_2$ (38.63) does. $T_3$ (38.88) and $T_4$ (38.85) also had intermediate values as in the first month of gestation.

## 4.9 Effect of Wattle on Mean Udder Measurements and Milk Yield of Red Sokoto Does kept Semi Intensively

The effect of wattle on mean udder parameters and milk yield of Red Sokoto does kept semi intensively is presented in Table 4.7. The Table revealed a significant ($p<0.05$) difference in all the parameters measuered except in teat length before milking and the last test day milk yield. Non-wattled does mated with wattled bucks ($T_2$) and wattled does mated with non-wattled bucks ($T_3$) were statistically ($p>0.05$) the same in udder circumference values (31.99 and 32.34 cm) before milking, while non-wattled does mated with non-wattled bucks ($T_1$) had significantly ($p<0.05$) lower values (29.34 cm). Does in $T_3$ (29.22 cm) had statistically ($p<0.05$) higher udder circumference after milking than those in other treatments. Does in $T_1$, $T_2$ and $T_3$ had statistically similar ($p>0.05$) values (8.40, 9.13 and 8.53 cm) ($p<0.05$) in the distance between teat before milking and differs significantly ($p<0.05$) from does in $T_4$ (7.36). After milking, does in $T_3$ (8.63) had the largest ($p<0.05$) distance between teats compared to does in other treatments. Does in $T_1$ (3.03) had the highest ($p<0.05$) values in teat length after milking while does in $T_2$, $T_3$ and $T_4$ (2.57, 2.63 and 2.44 cm) had similar values ($p>0.05$). Does in $T_2$, $T_3$ and $T_4$ had (141.64, 139.28 and 154.53 ml) and (283.28, 278.56 and 309.06 ml respectively) similar ($p<0.05$) and higher total quantity of milk yield and average daily milk yield than those in $T_1$ (120.13 ml and 190.25 ml respectively). Does in $T_3$ had significantly ($p<0.05$) higher first test day milk yield than does in $T_1$, $T_2$ and $T_4$. Does in $T_3$ and $T_4$ had significantly ($p>0.05$) higher peak yield values (440 ml and 520 ml) over does in $T_1$ (210 ml and $T_2$ (298.33 ml), respectively. Does in $T_4$ recorded the highest ($p<0.05$) total milk yield (3709.00 ml), followed by does in $T_2$ (3399.00 ml), $T_3$ (3343.00 ml) and $T_1$ (2283), respectively.

### 4.10. Effect of Wattle on Colostrum Constituents of Red Sokoto Does Reared Semi Intensively

The effect of wattle on the proximate composition, vitamin and mineral content of colostrum of Red Sokoto does reared semi intensively and presented in Table 4.8 revealed a significant ($p<0.05$) difference in the moisture content, nitrogen free extract and the metabolizable energy of the colostrum. The colostrum of does in $T_4$ had the highest ($p<0.05$) moisture content (88.18

**Table 4. 6. Effect of wattle on the rectal temperature of the Red Sokoto does raised semi-intensively**

| Average rectal temperature ($^{O}C$) | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM | Normal range 38.5-39.7 ($^{O}C$) | Average temperature of the experimental Site (Geography Department) F.U.T, Minna, 2017) |
|---|---|---|---|---|---|---|---|
| Before mating | $38.50^{b}$ | $39.10^{b}$ | $38.98^{b}$ | $39.30^{a}$ | 0.12 | | 39.44 (April, 2017) |
| First month | $38.93^{b}$ | $39.28^{a}$ | $39.10^{ab}$ | $39.15^{ab}$ | 0.05 | | 33.31 (May, 2017) |
| Second month | $38.92^{a}$ | $38.63^{b}$ | $38.88^{ab}$ | $38.85^{ab}$ | 0.05 | | 32.11 (June, 2017) |
| Third month | 39.08 | 39.00 | 39.20 | 39.07 | 0.04 | | 29.98 (July, 2017) |
| Fourth month | 38.88 | 38.77 | 38.90 | 38.78 | 0.05 | | 31.8 (August, 2017) |
| Fifth month | 38.40 | 38.10 | 38.20 | 38.23 | 0.11 | | 29.55 (September, 2017) |
| After birth | 38.50 | 38.20 | 38.15 | 38.53 | 0.09 | | 33.26 (October, 2017) |
| Mean | 38.74 | 38.73 | 38.77 | 38.84 | 0.07 | | 32.78 (April-October, 2017) |

Merck manual, 2018

$^{abcd}$ Means within a row having different superscripts differed significantly ($p<0.05$);

**$T_1$**= Non-wattled does mated with non-wattled bucks;

**$T_2$** = Non-wattled does mated with wattled bucks;

**$T_3$**= Wattled does mated with non-wattled buck:

**$T_4$**= Wattled does mated with wattled bucks.

**SEM=** Standard error of mean

**Table 4.7. Effect of wattle on mean udder measurements and milk yield of Red Sokoto does kept semi intensively**

| Parameters (cm) | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| Udder circumference before milking | $29.34^{b}$ | $31.99^{a}$ | $32.34^{a}$ | $30.90^{ab}$ | 0.37 |
| Udder circumference after milking | $25.74^{c}$ | $28.00^{ab}$ | $29.22^{a}$ | $26.74^{bc}$ | 0.38 |
| Distance between teat before milking | $8.40^{a}$ | $9.13^{a}$ | $8.53^{a}$ | $7.36^{b}$ | 0.17 |
| Distance between teat after milking | $7.34^{bc}$ | $8.13^{ab}$ | $8.63^{a}$ | $6.85^{c}$ | 0.17 |
| Teat length before milking | 3.28 | 3.11 | 2.52 | 2.91 | 0.16 |
| Teat length after milking | $3.03^{a}$ | $2.57^{b}$ | $2.63^{b}$ | $2.44^{b}$ | 0.06 |
| Quantity of milk yield (ml) | $120.13^{b}$ | $141.64^{a}$ | $139.28^{a}$ | $154.53^{a}$ | 5.06 |
| Average daily milk yield (ml) | $190.25^{b}$ | $283.28^{a}$ | $278.56^{a}$ | $309.06^{a}$ | 13.84 |
| First test day milk yield (ml) | $176.67^{b}$ | $216.67^{b}$ | $440.00^{a}$ | $270.00^{b}$ | 14.07 |
| Peak yield (ml) | $210.00^{b}$ | $298.33^{b}$ | $440.00^{a}$ | $520.00^{a}$ | 14.93 |
| Last test day milk yield (ml) | 200.00 | 233.33 | 230.00 | 260.00 | 15.92 |
| Total milk yield (ml) | $2283^{d}$ | $3399^{b}$ | $3343^{c}$ | $3709^{a}$ | 16.07 |

$^{abcd}$ Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$**= Non-wattled does mated with non-wattled bucks;
**$T_2$** = Non-wattled does mated with wattled bucks;
**$T_3$**= Wattled does mated with non-wattled buck:
**$T_4$**= Wattled does mated with wattled bucks.
**SEM=** Standard error of mean

**Table 4.8. Effect of wattle on colostrum constituent of Red Sokoto does reared semi intensively**

| Parameters | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| **Proximate composition of colostrum** | | | | | |
| Moisture (%) | $85.56^{b}$ | $83.56^{b}$ | $83.25^{b}$ | $88.18^{a}$ | 0.68 |
| Crude protein (%) | 5.01 | 5.21 | 6.82 | 3.45 | 0.58 |
| Crude fibre (%) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ash (%) | 0.72 | 0.85 | 0.72 | 0.82 | 0.03 |
| Fat (%) | 3.29 | 3.58 | 4.33 | 3.04 | 0.29 |
| Nitrogen free extract (%) | $14.44^{a}$ | $16.44^{a}$ | $16.75^{a}$ | $11.82^{b}$ | 0.68 |
| Carbohydrate (%) | 4.94 | 6.80 | 4.88 | 4.51 | 0.70 |
| Metabolizable energy (Kcal) | $107.42^{ab}$ | $118.79^{ab}$ | $133.25^{a}$ | $88.40^{b}$ | 6.78 |
| Dry matter (%) | 14.44 | 16.44 | 16.75 | 11.82 | |
| **Vitamin content** | | | | | |
| Vitamin A (u/I) | 33.08 | 31.82 | 35.26 | 29.11 | 1.19 |
| Vitamin B (mg/g) | 56.17 | 55.76 | 57.00 | 55.11 | 0.61 |
| Vitamin C (mg/100g) | $2.63^{ab}$ | $2.92^{ab}$ | $3.55^{a}$ | $2.00^{b}$ | 0.23 |
| **Mineral content (Mg/100g)** | | | | | |
| Sodium | 12.10 | 10.60 | 12.90 | 13.74 | 0.87 |
| Potassium | 173.50 | 169.00 | 198.50 | 175.34 | 5.60 |
| Phosphorus | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Magnesium | 11.61 | 13.80 | 10.75 | 7.78 | 1.31 |
| Iron | 0.10 | 0.26 | 0.09 | 0.20 | 0.04 |
| Zinc | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Calcium | 139.50 | 131.00 | 133.00 | 111.66 | 6.71 |

$^{abcd}$ Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$**= Non-wattled does mated with non-wattled bucks;
**$T_2$** = Non-wattled does mated with wattled bucks;
**$T_3$**= Wattled does mated with non-wattled buck:
**$T_4$**= Wattled does mated with wattled bucks.
**SEM=** Standard error of mean

%) while does in $T_1$, $T_2$ and $T_3$ had lower and similar ($p>0.05$) moisture in their colostrum (85.5 %, 83.566 % and 83.25 %). The nitrogen free extract in the colostrum of does in $T_1$, $T_2$ and $T_3$. (14.44 %, 16.44 % and 16.75 %) were statistically similar ($p>0.05$) but higher ($p<0.05$) than does in $T_4$ (11.82 %). The metabolizable energy in the colostrum of does in $T_3$ (133.25 Kcal) was higher ($p<0.05$) than $T_4$ (88.40 Kcal) but statistically similar to $T_1$ and $T_2$. The Table also revealed a significant ($p<0.05$) difference only in the vitamin C content of the colostrum. Vitamins A and B showed no significant ($p>0.05$) difference. Colostrum from does in $T_3$ (3.55 mg/100g) had higher ($p<0.05$) vitamin C content over $T_4$ (2.00 mg/100g). The Table showed no significant ($p>0.05$) difference in the entire mineral content (sodium, potassium, phosphorus, magnesium, iron, zinc and calcium) evaluated for colostrum.

## 4.11. Effect of Wattle on Milk Constituents of Red Sokoto Does Reared Semi Intensively

Table 4.9 shows the effect of wattle on the mean proximate composition, vitamin and mineral content of the milk samples of Red Sokoto does reared semi intensively. The Table shows no significant ($p>0.05$) difference in the mean proximate components of milk except for moisture, fat, nitrogen free extract and the metabolizable energy. The milk samples in $T_1$ and $T_4$ had higher ($p<0.05$) moisture content (85.78 and 85.83 %) than $T_2$ and $T_3$ (83.84 and 84.21 %). For values of fat, nitrogen free extract and metabolizable energy composition of the milk, does in $T_2$ (4.32 %, 16.17 % and 125.69 kcal) and $T_3$ (5.23 %, 15.65 % and 136.75 Kcal) had statistically similar values ($p>0.05$) but higher than $T_1$ and $T_4$. The Table showed a significant ($p<0.05$) difference in the vitamin B content of the milk while there was no significant ($p>0.05$) difference in the vitamins A and C content of the milk. The milk samples from does in $T_1$, $T_2$ and $T_3$ had statistically similar ($p>0.05$) values of vitamin B content while vitamin B content

**Table 4.9. Effect of wattle on milk constituents of Red Sokoto does reared semi intensively**

| Parameters | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| **Proximate composition of milk** | | | | | |
| Moisture (%) | 85.78[a] | 83.84[b] | 84.21[b] | 85.83[a] | 0.32 |
| Crude protein (%) | 5.71 | 5.54 | 6.81 | 5.43 | 0.33 |
| Crude fibre (%) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ash (%) | 0.76 | 0.77 | 0.76 | 0.82 | 0.02 |
| Fat (%) | 3.74[b] | 4.32[ab] | 5.23[a] | 3.73[b] | 0.25 |
| Nitrogen free extract (%) | 14.21[b] | 16.17[a] | 15.65[ab] | 14.08[c] | 0.32 |
| Carbohydrate (%) | 3.86 | 5.55 | 3.36 | 4.11 | 0.52 |
| Metabolizable energy (Kcal) | 113.33[b] | 125.69[ab] | 136.75[a] | 119.29[b] | 3.33 |
| Dry matter (%) | 14.22 | 16.16 | 15.79 | 14.17 | 0.22 |
| | | | | | |
| **Vitamins content of milk** | | | | | |
| Vitamin A (u/I) | 34.03 | 33.26 | 35.05 | 32.13 | 0.67 |
| Vitamin B (mg/g) | 56.55[ab] | 56.24[ab] | 56.91[a] | 55.46[b] | 0.23 |
| Vitamin C (mg/100g) | 3.23 | 3.12 | 3.49 | 2.78 | 0.13 |
| | | | | | |
| **Mineral content of milk (Mg/100g)** | | | | | |
| Sodium | 12.87 | 13.39 | 12.20 | 12.00 | 0.60 |
| Potassium | 138.30 | 131.47 | 131.74 | 160.60 | 6.03 |
| Phosphorus | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Magnesium | 9.70[a] | 10.38[a] | 10.26[a] | 7.41[b] | 0.38 |
| Iron | 0.08[b] | 0.18[ab] | 0.24[ab] | 0.34[a] | 0.03 |
| Zinc | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Calcium | 119.70[ab] | 123.82[a] | 127.52[a] | 109.79[b] | 2.21 |

[abcd] Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$**= Non-wattled does mated with non-wattled bucks;
**$T_2$** = Non-wattled does mated with wattled bucks;
**$T_3$**= Wattled does mated with non-wattled buck:
**$T_4$**= Wattled does mated with wattled bucks.
**SEM=** Standard error of mean

of the milk from does in $T_4$ was loweest ($p<0.05$). The Table revealed a significant ($p<0.05$) difference in magnesium, iron and calcium content of milk only. Other minerals showed no significant ($p>0.05$) difference. Magnesium was the least in the milk samples obtained in $T_4$ does.

## 4.12. Pearson Correlation Coefficient between the Average Daily Milk Yield and Udder Parameters of Non-Wattled Does Mated with Non-wattled Bucks

The Pearson correlation coefficient between average daily milk yield and udder parameters (udder circumference before milking, udder circumference after milking, distance between teat before milking, distance between teat after milking, teat length before milking and teat length after milking) of Red Sokoto does in $T_1$ (non-wattled does mated with non-wattled bucks) is presented in Table 4.10. The Table show a positive non-significant ($p>0.05$) correlation between average daily milk yield and distance between teat before milking (0.63 cm), distance between teat after milking (0.38), teat length before milking (0.37) and teat length after milking (0.18 cm). The udder circumference before and after milking shows a negative non-significant ($p>0.05$) correlation with the average daily milk yield in $T_1$ (-0.33 and -0.66).

## 4.13 Pearson Correlation Coefficient between Average Daily Milk Yield and Udder Parameters Udder Parameters of Non-Wattled Does Mated with Wattled Bucks

Table 4.11 shows the Pearson correlation coefficient between average daily milk yield and udder parameters: udder circumference before milking, udder circumference after milking, distance between teat before milking, distance between teat after milking, teat length before milking and teat length after milking of Red Sokoto does in $T_2$ (non-wattled does mated with wattled bucks). The Table shows a positive non-significant ($p>0.05$) correlation between

**Table 4.10. Pearson correlation coefficient between average daily milk yield and udder parameters of non-wattled does mated with non-wattled bucks**

| | UCBM | UCAM | DBTBM | DBTAM | TLBM | TLAM | ADMY |
|---|---|---|---|---|---|---|---|
| UCBM | 1 | | | | | | |
| UCAM | 0.48ns | 1 | | | | | |
| DBTBM | -0.08ns | -0.77ns | 1 | | | | |
| DBTAM | 0.00ns | -0.48ns | 0.46ns | 1 | | | |
| TLBM | 0.020ns | -0.70ns | 0.069ns | 0.26ns | 1 | | |
| TLAM | -0.45ns | -0.67ns | 0.21ns | 0.11ns | 0.33ns | 1 | |
| ADMY | -0.33ns | -0.66 | 0.63ns | 0.38ns | 0.37ns | 0.18ns | 1 |

ns = Not significant (p>0.05)
UCBM= Udder circumference before milking
UCAM= Udder circumference after milking
DBTBM= Distance between teat before milking
DBTAM= Distance between teat after milking
TLBM= Teat length before milking
TLAM= Teat length after milking
ADMY= Average daily milk yield

**Table 4.11. Pearson correlation coefficient between average daily milk yield and udder parameters of non-wattled does mated with wattled bucks**

| | UCBM | UCAM | DBTBM | DBTAM | TLBM | TLAM | ADMY |
|---|---|---|---|---|---|---|---|
| UCBM | 1 | | | | | | |
| UCAM | 0.24ns | 1 | | | | | |
| DBTBM | 0.62ns | 0.28ns | 1 | | | | |
| DBTAM | 0.057ns | 0.47ns | 0.55ns | 1 | | | |
| TLBM | 0.50ns | -0.50ns | 0.55ns | 0.21ns | 1 | | |
| TLAM | -0.15ns | 0.42ns | -0.02ns | -0.16ns | -0.32ns | 1 | |
| ADMY | 0.77ns | -0.35ns | 0.22ns | -0.42ns | 0.40ns | -0.41ns | 1 |

ns = Not- significant (p>0.05)
UCBM= Udder circumference before milking
UCAM= Udder circumference after milking
DBTBM= Distance between teat before milking
DBTAM= Distance between teat after milking
TLBM= Teat length before milking
TLAM= Teat length after milking
ADMY= Average daily milk yield

average daily milk yield and udder circumference before milking (0.77), distance between teats before milking (0.22) and teat length before milking (0.40). The udder circumference after milking (-0.35), distance between teat after milking (-0.42) and teat length after milking (-0.41) showed a negative non-significant (p>0.05) correlation with average daily milk yield.

### 4.14 Pearson Correlation Coefficient between the Average Daily Milk Yield and Udder Parameters of Wattled Does Mated with Non-wattled Bucks

Table 4.12 shows the Pearson correlation coefficient between the average daily milk yield and the udder parameters: udder circumference before milking, udder circumference after milking, distance between teat before milking, distance between teat after milking, teat length before milking and teat length after milking of Red Sokoto does in $T_3$ (wattled does mated with non-wattled bucks). The teat length before milking (-0.38) and teat length after milking (-0.44) had a negative non-significant (p>0.05) correlation with average milk yield. Other parameters like the udder circumference before and after milking (0.35 and 0.20), distance between teat before and after milking (0.21 and 0.16) however, showed a positive non-significant (p>0.05) correlation with average daily milk yield.

### 4.15. Pearson Correlation Coefficient between the Average Daily Milk Yield and the Udder Parameters of Wattled Does Mated with Wattled Bucks

Table 4.13 shows the Pearson correlation coefficient between average daily milk yield and the udder parameters (udder circumference before milking, udder circumference after milking, distance between teat before milking, distance between teat after milking, teat length before milking and teat length after milking) of Red Sokoto does in $T_4$ (wattled does mated with wattled bucks). The average daily milk yield had a positive non-significant (p>0.05) correlation with udder circumference before milking (0.04), teat length before milking (0.55) and teat length after milking (0.33). The udder circumference after milking (-0.32), distance between

**Table 4.12 Pearson correlation coefficient between average daily milk yield and udder parameters of wattled does mated with non-wattled bucks**

| | UCBM | UCAM | DBTB | DBTA | TLBM | TLAM | ADMY |
|---|---|---|---|---|---|---|---|
| UCBM | 1 | | | | | | |
| UCAM | 0.81ns | 1 | | | | | |
| DBTB | 0.73ns | 0.36ns | 1 | | | | |
| DBTA | 0.69ns | 0.64ns | 0.05ns | 1 | | | |
| TLBM | 0.l7ns | 0.30ns | 0.02ns | -0.20ns | 1 | | |
| TLAM | -0.27ns | 0.25ns | -0.46ns | -0.30ns | 0.46ns | 1 | |
| ADMY | 0.35ns | 0.20ns | 0.21ns | 0.16ns | -0.38ns | -0.44ns | 1 |

ns = not-significant (p>0.05)
UCBM= Udder circumference before milking
UCAM= Udder circumference after milking
DBTBM= Distance between teat before milking
DBTAM= Distance between teat after milking
TLBM= Teat length before milking
TLAM= Teat length after milking
ADMY= Average daily milk yield

**Table 4.13. Pearson correlation coefficient between the average daily milk yield and the udder parameters of wattled does mated with wattled bucks**

| | UCBM | UCAM | DBTBM | DBTAM | TLBM | TLAM | ADMY |
|---|---|---|---|---|---|---|---|
| UCBM | 1 | | | | | | |
| UCAM | 0.56ns | 1 | | | | | |
| DBTBM | 0.42ns | 0.07ns | 1 | | | | |
| DBTAM | 0.40ns | -0.03ns | 0.85ns | 1 | | | |
| TLBM | -0.13ns | -0.21ns | -0.64ns | -0.80ns | 1 | | |
| TLAM | 0.24ns | -0.39ns | -0.08ns | 0.26ns | 0.17ns | 1. | |
| ADMY | 0.04ns | -0.32ns | -0.15ns | -0.16ns | 0.55ns | 0.33ns | 1 |

ns = not- significant (p>0.05)
UCBM= Udder circumference before milking
UCAM= Udder circumference after milking
DBTBM= Distance between teat before milking
DBTAM= Distance between teat after milking
TLBM= Teat length before milking
TLAM= Teat length after milking
ADMY= Average daily milk yield

teat before and after milking (-0.15 and -0.16) however had a negative non-significant ($p>0.05$) correlation with milk yield.

## 4.16. Effect of Wattle on the Weekly Body Weight of Red Sokoto Kids Raised Semi Intensively

Table 4.14. shows the effect of wattle on the weekly body weight of Red Sokoto kids raised semi intensively. The Table revealed a significant ($p<0.05$) difference in the weekly body weight gain of kids at birth, weeks 1, 2, 3, 7, 8, 9, 10,11 and 12. Weeks 4, 5, 6 showed no significant ($p>0.05$) difference in mean body weight. The mean body weight of kids for the twelve weeks showed no significant ($p>0.05$) difference across the treatments.

## 4.17. Effect of Wattle on the Weekly Body Length of Red Sokoto Kids Raised Semi Intensively

Table 4.15. shows the effect of wattle on the body length of Red Sokoto kids raised semi intensively**.** The table reveals a significant ($p<0.05$) difference in the body length from birth up to twelfth weeks after birth except for weeks 2, 7. The mean body length of the kids were also not significant ($p>0.05$) across the treatments.

## 4.18. Effect of Wattle on the Weekly Head Length of Kids Raised Semi Intensively

Table 4.16. presents the effect of wattle on the head length of kids raised semi intensively. The Table reveals a significant ($p<0.05$) difference in head length of the kids from birth to week 12 after birth except for weeks 2, 3, 4, 5 that showed no significant ($p>0.05$) difference. The mean head length of the kids showed no significant ($p>0.05$) difference across the treatments.

## 4.19. Effect of Wattle on the Weekly Head Width of Red Sokoto Kids Raised Semi Intensively

The Effect of wattle on the head width of Red Sokoto kids raised semi intensively is presented in Table 4.17. The Table reveals a significant ($p<0.05$) difference in head width of the kids in weeks 1, 2, 3, 6, 7, 8, 9, 10, 11, and 12. Weeks 4 and 5 showed no significant ($p>0.05$) difference across the treatments. The mean head width of the kids born to $T_1$ (9.11 cm), $T_2$ (10.01 cm), and $T_3$ (9.83 cm) had similar ($p>0.05$) values. No significant ($p>0.05$) difference were however observed in the head width of the kids born from non -wattled does mated to non-wattled bucks ($T_1$) and those born from wattle does mated to wattled bucks ($T_4$) (8.79 cm).

## 4.20. Effect of Wattle on the Weekly Height-at-Wither of Red Sokoto Kids Raised Semi intensively

Table 4.18 shows the effect of wattle on the height-at-wither of Red Sokoto kids raised semi intensively. The Table reveals a significant ($p<0.05$) difference in all the weeks 1, 2, 4, 5, 6, 7, 8, 9, 10, 11 and 12 among the treatment means. Wattle did not have any significant ($p>0.05$) influence on the Height-at-withers at birth, week 3 and the mean wither height of the kids.

## 4.21. Effect of Wattle on the Chest Girth of Red Sokoto Kids Kept Semi Intensively

The effect of wattle on the chest girth of Red Sokoto kids kept semi intensively (Table 4.19) revealed a significant ($p<0.05$) difference in the chest girth from the first day to week twelve except for weeks 3, 4 and the mean chest girth which showed no significant ($p<0.05$) difference among treatment.

**Table 4.14. Effect of wattle on the weekly body weight of Red Sokoto Kids raised semi intensively**

| WEEK | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| Birth Weight (kg) | $1.50^{bc}$ | $1.84^{a}$ | $1.70^{ab}$ | $1.27^{c}$ | 0.08 |
| WEEK 1 | $2.05^{ab}$ | $2.44^{a}$ | $2.23^{ab}$ | $1.80^{b}$ | 0.09 |
| WEEK 2 | $2.53^{ab}$ | $2.98^{a}$ | $2.71^{a}$ | $2.22^{b}$ | 0.12 |
| WEEK 3 | $3.00^{b}$ | $3.72^{a}$ | $3.20^{ab}$ | $3.00^{b}$ | 0.11 |
| WEEK 4 | 3.35 | 3.70 | 3.42 | 3.10 | 0.13 |
| WEEK 5 | 3.75 | 4.02 | 3.68 | 3.53 | 0.13 |
| WEEK 6 | 3.68 | 4.43 | 4.23 | 3.97 | 0.13 |
| WEEK 7 | $4.10^{b}$ | $4.85^{a}$ | $4.63^{ab}$ | $4.42^{ab}$ | 0.12 |
| WEEK 8 | $4.20^{b}$ | $5.25^{a}$ | $4.80^{a}$ | $4.90^{a}$ | 0.13 |
| WEEK 9 | $5.07^{c}$ | $6.28^{a}$ | $5.82^{ab}$ | $5.48^{bc}$ | 0.14 |
| WEEK 10 | $5.40^{c}$ | $7.00^{a}$ | $6.43^{b}$ | $6.22^{b}$ | 0.17 |
| WEEK 11 | $5.78^{c}$ | $7.68^{a}$ | $7.03^{b}$ | $7.00^{b}$ | 0.32 |
| WEEK 12 | $6.16^{c}$ | $8.36^{a}$ | $7.63^{b}$ | $7.22^{b}$ | 0.15 |
| Mean | 3.70 | 4.52 | 4.16 | 3.91 | 0.23 |

abcd Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$** = Kids resulting from mating non-wattled does with non-wattled bucks; **$T_2$**= Kids resulting from mating non-wattled does with wattled bucks; **$T_3$**= Kids resulting from mating wattled does with non-wattled buck: **$T_4$**= Kids resulting from mating wattled does with wattled bucks.**SEM=** Standard error of mean

**Table 4.15. Effect of wattle on the weekly body length of Red Sokoto kids raised semi intensively**

| WEEK | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| At birth (cm) | $22.93^{b}$ | $24.06^{ab}$ | $23.07^{b}$ | $25.43^{a}$ | 0.38 |
| WEEK 1 | $26.15^{c}$ | $29.06^{a}$ | $27.02^{bc}$ | $28.3^{ab}$ | 0.31 |
| WEEK 2 | 29.17 | 29.17 | 28.13 | 28.38 | 0.44 |
| WEEK 3 | $29.55^{b}$ | $32.30^{a}$ | $30.13^{ab}$ | $31.70^{ab}$ | 0.42 |
| WEEK 4 | $31.38^{b}$ | $33.37^{ab}$ | $32.70^{ab}$ | $34.26^{a}$ | 0.42 |
| WEEK 5 | $33.38^{b}$ | $36.04^{a}$ | $34.18^{ab}$ | $35.73^{a}$ | 0.36 |
| WEEK 6 | $32.77^{c}$ | $36.45^{a}$ | $35.00^{b}$ | $35.00^{a}$ | 1.90 |
| WEEK 7 | 33.57 | 29.15 | 30.13 | 36.40 | 0.40 |
| WEEK 8 | $31.77^{c}$ | $35.35^{ab}$ | $34.30^{b}$ | $36.27^{a}$ | 0.34 |
| WEEK 9 | $34.50^{c}$ | $37.95^{a}$ | $36.50^{b}$ | $37.72^{ab}$ | 0.37 |
| WEEK 10 | $35.48^{c}$ | $39.18^{a}$ | $37.70^{b}$ | $39.28^{a}$ | 0.49 |
| WEEK 11 | $35.48^{c}$ | $40.33^{a}$ | $38.84^{b}$ | $40.78^{a}$ | 0.74 |
| WEEK 12 | $36.46^{c}$ | $41.48^{ab}$ | $39.98^{b}$ | $42.28^{a}$ | 0.79 |
| Mean | 31.34 | 37.51 | 36.15 | 38.19 | 0.66 |

abcd Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$** = Kids resulting from mating non-wattled does with non-wattled bucks; **$T_2$**= Kids resulting from mating non-wattled does with wattled bucks; **$T_3$**= Kids resulting from mating wattled does with non-wattled buck: **$T_4$**= Kids resulting from mating wattled does with wattled bucks. **SEM=** Standard error of mean

**Table 4.16. Effect of wattle on the weekly head length of kids raised semi intensively**

| WEEK | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| At birth (cm) | $8.50^{a}$ | $8.28^{ab}$ | $8.50^{a}$ | $7.77^{b}$ | 0.13 |
| WEEK 1 | $9.20^{ab}$ | $9.02^{ab}$ | $9.67^{a}$ | $8.70^{b}$ | 0.15 |
| WEEK 2 | 8.87 | 9.05 | 9.43 | 9.00 | 0.14 |
| WEEK 3 | 9.10 | 9.66 | 9.87 | 9.47 | 0.15 |
| WEEK 4 | 10.01 | 10.25 | 10.38 | 10.36 | 0.14 |
| WEEK 5 | 10.00 | 10.18 | 10.34 | 9.75 | 0.14 |
| WEEK 6 | $9.96^{ab}$ | $10.35^{a}$ | $10.67^{a}$ | $9.53^{b}$ | 0.15 |
| WEEK 7 | $0.37^{ab}$ | $10.55^{ab}$ | $11.03^{a}$ | $9.82^{b}$ | 0.13 |
| WEEK 8 | $9.90^{c}$ | $10.75^{ab}$ | $10.97^{a}$ | $10.23^{bc}$ | 0.11 |
| WEEK 9 | $10.90^{bc}$ | $11.10^{b}$ | $11.55^{a}$ | $10.48^{c}$ | 0.11 |
| WEEK 10 | $11.10^{b}$ | $11.72^{a}$ | $11.98^{a}$ | $10.90^{b}$ | 0.14 |
| WEEK 11 | $11.10^{b}$ | $12.29^{a}$ | $12.39^{a}$ | $11.32^{b}$ | 0.18 |
| WEEK 12 | $11.30^{c}$ | $12.86^{a}$ | $12.80^{ab}$ | $11.74^{b}$ | 0.22 |
| Mean | 10.61 | 11.57 | 11.69 | 10.76 | 0.15 |

[abcd] Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$** = Kids resulting from mating non-wattled does with non-wattled bucks; **$T_2$**= Kids resulting from mating non-wattled does with wattled bucks; **$T_3$**= Kids resulting from mating wattled does with non-wattled buck; **$T_4$**= Kids resulting from mating wattled does with wattled bucks.
**SEM=** Standard error of mean

**Table 4.17. Effect of wattle on the weekly head width of Red Sokoto kids raised semi intensively**

| WEEK | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| At birth (cm) | $7.75^{ab}$ | $8.52^{a}$ | $8.27^{a}$ | $7.27^{b}$ | 0.17 |
| WEEK 1 | $8.23^{b}$ | $8.14^{b}$ | $9.15^{a}$ | $8.03^{b}$ | 0.14 |
| WEEK 2 | $9.13^{a}$ | $9.27^{a}$ | $9.58^{a}$ | $8.33^{b}$ | 0.19 |
| WEEK 3 | $8.65^{ab}$ | $9.64^{a}$ | $9.52^{a}$ | $8.43^{b}$ | 0.14 |
| WEEK 4 | 9.34 | 9.91 | 9.62 | 9.45 | 0.19 |
| WEEK 5 | 9.43 | 10.48 | 10.24 | 9.77 | 0.18 |
| WEEK 6 | $9.14^{b}$ | $10.38^{a}$ | $10.10^{a}$ | $8.83^{b}$ | 0.20 |
| WEEK 7 | $9.00^{b}$ | $10.42^{a}$ | $10.18^{a}$ | $8.60^{b}$ | 0.17 |
| WEEK 8 | $9.90^{b}$ | $11.03^{a}$ | $10.68^{ab}$ | $9.90^{b}$ | 0.20 |
| WEEK 9 | $9.30^{b}$ | $10.75^{a}$ | $10.48^{a}$ | $9.28^{b}$ | 0.49 |
| WEEK 10 | $10.05^{b}$ | $10.60^{a}$ | $10.08^{bc}$ | $8.80^{c}$ | 0.18 |
| WEEK 11 | $9.20^{b}$ | $10.41^{a}$ | $9.70^{b}$ | $8.32^{c}$ | 0.16 |
| WEEK12 | $9.40^{ab}$ | $10.60^{a}$ | $10.30^{ab}$ | $9.28^{b}$ | 0.18 |
| Mean | $9.11^{ab}$ | $10.01^{a}$ | $9.83^{a}$ | $8.79^{b}$ | 0.16 |

[abcd] Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$** = Kids resulting from mating non-wattled does with non-wattled bucks; **$T_2$**= Kids resulting from mating non-wattled does with wattled bucks; **$T_3$**= Kids resulting from mating wattled does with non-wattled buck: **$T_4$**= Kids resulting from mating wattled does with wattled bucks.
**SEM=** Standard error of mean

**Table 4.18. Effect of wattle on the weekly height-at-wither of Red Sokoto kids raised semi intensively**

| WEEK | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| At birth (cm) | 27.25 | 28.78 | 28.58 | 26.60 | 0.42 |
| WEEK 1 | $29.95^{bc}$ | $32.45^{a}$ | $31.92^{ab}$ | $29.43^{c}$ | 0.34 |
| WEEK 2 | $32.97^{a}$ | $33.92^{a}$ | $33.55^{a}$ | $31.13^{b}$ | 0.54 |
| WEEK 3 | 33.88 | 36.24 | 35.88 | 33.13 | 0.39 |
| WEEK 4 | $34.88^{b}$ | $37.25^{a}$ | $36.65^{ab}$ | $35.67^{ab}$ | 0.51 |
| WEEK 5 | $36.60^{b}$ | $40.67^{a}$ | $39.90^{a}$ | $37.53^{b}$ | 0.46 |
| WEEK 6 | $35.61^{b}$ | $39.56^{a}$ | $39.22^{a}$ | $36.83^{b}$ | 0.43 |
| WEEK 7 | $36.87^{a}$ | $39.18^{ab}$ | $39.55^{a}$ | $37.23^{ab}$ | 0.47 |
| WEEK 8 | $37.67^{c}$ | $42.00^{a}$ | $41.25^{ab}$ | $39.57^{bc}$ | 0.49 |
| WEEK 9 | $36.20^{b}$ | $41.13^{a}$ | $39.95^{a}$ | $37.60^{b}$ | 0.42 |
| WEEK 10 | $38.80^{b}$ | $42.87^{a}$ | $41.45^{a}$ | $39.02^{b}$ | 0.50 |
| WEEK 11 | $39.68^{b}$ | $44.51^{a}$ | $42.87^{a}$ | $40.39^{b}$ | 0.38 |
| WEEK 12 | $40.56^{b}$ | $46.15^{a}$ | $44.29^{a}$ | $41.76^{b}$ | 0.32 |
| Mean | 35.46 | 38.82 | 38.08 | 35.80 | 0.64 |

$^{abcd}$ Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$** = Kids resulting from mating non-wattled does with non-wattled bucks; **$T_2$**= Kids resulting from mating non-wattled does with wattled bucks; **$T_3$**= Kids resulting from mating wattled does with non-wattled buck; **$T_4$**= Kids resulting from mating wattled does with wattled bucks.
**SEM=** Standard error of mean

**Table 4.19. Effect of wattle on the weekly chest girth of Red Sokoto kids kept semi intensively**

| WEEK | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| At birth (cm) | $25.35^{b}$ | $28.26^{a}$ | $28.40^{a}$ | $24.80^{b}$ | 0.48 |
| WEEK 1 | $29.73^{ab}$ | $32.08^{a}$ | $31.55^{a}$ | $28.80^{b}$ | 0.41 |
| WEEK 2 | $32.40^{a}$ | $33.59^{a}$ | $34.10^{a}$ | $30.37^{b}$ | 0.57 |
| WEEK 3 | 32.82 | 35.60 | 35.73 | 34.87 | 0.41 |
| WEEK 4 | 34.04 | 35.60 | 35.45 | 34.53 | 0.51 |
| WEEK 5 | $35.03^{b}$ | $37.78^{ab}$ | $37.94^{a}$ | $35.12^{b}$ | 0.57 |
| WEEK 6 | $34.74^{b}$ | $39.52^{a}$ | $39.93^{a}$ | $36.33^{b}$ | 0.65 |
| WEEK 7 | $36.10^{b}$ | $41.08^{a}$ | $41.65^{a}$ | $37.60^{b}$ | 0.57 |
| WEEK 8 | $37.80^{b}$ | $42.53^{a}$ | $43.25^{a}$ | $41.83^{a}$ | 0.58 |
| WEEK 9 | $37.80^{b}$ | $42.93^{a}$ | $43.05^{a}$ | $39.20^{b}$ | 0.45 |
| WEEK 10 | $40.75^{b}$ | $44.25^{a}$ | $43.75^{a}$ | $40.59^{b}$ | 0.48 |
| WEEK 11 | $41.58^{b}$ | $45.53^{a}$ | $44.37^{a}$ | $41.91^{b}$ | 0.93 |
| WEEK 12 | $42.41^{b}$ | $46.81^{a}$ | $44.99^{a}$ | $43.23^{b}$ | 0.45 |
| Mean | 35.43 | 38.89 | 38.78 | 37.09 | 0.75 |

$^{abcd}$ Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$** = Kids resulting from mating non-wattled does with non wattled bucks; **$T_2$**= Kids resulting from mating non-wattled does with wattled bucks; **$T_3$**= Kids resulting from mating wattled does with non-wattled buck; **$T_4$**= Kids resulting from mating wattled does with wattled bucks.
**SEM=** Standard error of mean

## 4.22. Effect of Wattle on the Weekly Horn Length of Red Sokoto Kids Raised Semi Intensively upto Week Twelve

Table 4.20 (effect of wattle on the horn length of Red Sokoto Kids raised semi intensively up to week twelve) revealed a significant ($p<0.05$) difference from week six to week twelve in the horn length. At week six and seven, the kids of non-wattled does mated with wattled males in $T_2$ were significantly ($p<0.05$) higher in terms of horn length than all the other treatments. At week eight, $T_4$ had the highest ($p<0.05$) horn length while $T_1$, $T_2$ and $T_3$ which were lower and statistically similar ($p>0.05$). Kids in $T_2$ had the highest ($p<0.05$) horn length followed by kids in $T_3$ and $T_4$ who had similar horn length while the kids in $T_1$ had the shortest horn length from weeks 9 to 12.

## 4.23. Effect of Wattle on the Weekly Rump Length of Red Sokoto Kids Raised Semi Intensively

The Effect of wattle on the rump length of Red Sokoto kids raised semi intensively in Table 4.21 showed no significant ($p>0.05$) difference from birth to week 3 and in the mean rump length only, Weeks 4, 5, 6, 7, 8, 9, 10, 11 and 12 however revealed a significant ($p<0.05$) difference in the rump length.

## 4.24. Effect of Wattle on the Weekly Rump Width of Red Sokoto Kids Raised Semi Intensively

The effect of wattle on the rump width of Red Sokoto kids raised semi intensively in Table 4.22 revealed a significant ($p<0.05$) difference in the rump width of kids at birth and at weeks 5, 6, 7, 8, 9, 10, 11 and 12. Weeks 1, 2, 3, 4 and the mean rump width showed no significant ($p<0.05$) difference across the treatments.

**Table 4.20. Effect of wattle on the weekly horn length of Red Sokoto kids raised semi intensively up to week twelve**

| WEEK | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| At birth (cm) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| WEEK 1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| WEEK 2 | 0.00 | 0.05 | 0.03 | 0.00 | 0.02 |
| WEEK 3 | 0.05 | 0.03 | 0.02 | 0.00 | 0.07 |
| WEEK 4 | 0.07 | 0.07 | 0.28 | 0.00 | 0.02 |
| WEEK 5 | 0.23 | 0.32 | 0.26 | 0.23 | 0.04 |
| WEEK 6 | $0.50^b$ | $0.72^a$ | $0.46^b$ | $0.38^b$ | 0.06 |
| WEEK 7 | $1.20^b$ | $1.60^a$ | $1.30^b$ | $1.03^b$ | 0.07 |
| WEEK 8 | $1.30^b$ | $1.68^b$ | $1.34^b$ | $1.76^a$ | 0.03 |
| WEEK 9 | $1.70^c$ | $2.00^a$ | $1.90^b$ | $1.90^b$ | 0.07 |
| WEEK 10 | $1.35^c$ | $2.20^a$ | $1.90^b$ | $1.90^b$ | 0.11 |
| WEEK 11 | $1.40^c$ | $2.38^a$ | $1.94^b$ | $1.91^b$ | 0.70 |
| WEEK 12 | $1.45^c$ | $2.56^a$ | $1.98^b$ | $1.92^b$ | 0.48 |
| Mean | 0.71 | 1.05 | 0.88 | 0.85 | 0.11 |

$^{abcd}$ Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$** = Kids resulting from mating non-wattled does with non-wattled bucks;
**$T_2$**= Kids resulting from mating non-wattled does with wattled bucks;
**$T_3$**= Kids resulting from mating wattled does with non-wattled buck:
**$T_4$**= Kids resulting from mating wattled does with wattled bucks.
**SEM=** Standard error of mean

**Table 4.21 Effect of wattle on the weekly rump length of Red Sokoto kids raised semi intensively**

| WEEK | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| At birth (cm) | 6.73 | 7.66 | 7.05 | 7.50 | 0.12 |
| WEEK 1 | 8.40 | 8.78 | 8.43 | 8.67 | 0.18 |
| WEEK 2 | 8.73 | 8.72 | 8.16 | 8.40 | 0.18 |
| WEEK 3 | 9.58 | 10.10 | 9.32 | 9.52 | 0.17 |
| WEEK 4 | $9.95^{ab}$ | $10.16^{ab}$ | $9.22^{b}$ | $10.29^{a}$ | 0.19 |
| WEEK 5 | $10.05^{ab}$ | $10.98^{a}$ | $9.76^{b}$ | $10.37^{ab}$ | 0.18 |
| WEEK 6 | $9.54^{b}$ | $10.94^{a}$ | $10.12^{ab}$ | $10.33^{ab}$ | 0.20 |
| WEEK 7 | $9.63^{b}$ | $10.90^{a}$ | $10.33^{ab}$ | $11.07^{a}$ | 0.21 |
| WEEK 8 | $10.90^{c}$ | $12.15^{ab}$ | $11.63^{bc}$ | $12.87^{a}$ | 0.17 |
| WEEK 9 | $10.57^{b}$ | $11.83^{a}$ | $11.03^{ab}$ | $11.70^{a}$ | 0.13 |
| WEEK 10 | $11.45^{ab}$ | $12.10^{a}$ | $11.23^{b}$ | $11.80^{ab}$ | 0.15 |
| WEEK 11 | $11.88^{ab}$ | $12.32^{a}$ | $11.33^{b}$ | $11.82^{ab}$ | 0.22 |
| WEEK 12 | $12.31^{ab}$ | $12.54^{a}$ | $11.43^{b}$ | $11.84^{ab}$ | 0.18 |
| Mean | 9.98 | 10.71 | 9.93 | 10.48 | 0.21 |

$^{abcd}$ Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$** = Kids resulting from mating non-wattled does with non-wattled bucks;
**$T_2$**= Kids resulting from mating non-wattled does with wattled bucks;
**$T_3$**= Kids resulting from mating wattled does with non-wattled buck:
**$T_4$**= Kids resulting from mating wattled does with wattled bucks.
**SEM=** Standard error of mean

**Table 4.22. Effect of wattle on the weekly rump width of Red Sokoto kids raised semi intensively**

| WEEK | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| At birth (cm) | $7.13^{b}$ | $8.78^{a}$ | $7.75^{b}$ | $7.33^{b}$ | 0.13 |
| WEEK 1 | 8.70 | 9.20 | 9.00 | 9.12 | 0.12 |
| WEEK 2 | 10.20 | 9.61 | 10.04 | 10.19 | 0.15 |
| WEEK 3 | 9.90 | 10.50 | 10.40 | 10.28 | 0.14 |
| WEEK 4 | 10.67 | 10.98 | 10.21 | 10.56 | 0.17 |
| WEEK 5 | $11.10^{ab}$ | $11.82^{a}$ | $10.74^{b}$ | $10.97^{ab}$ | 0.19 |
| WEEK 6 | $10.57^{b}$ | $12.06^{a}$ | $11.31^{ab}$ | $11.13^{ab}$ | 0.19 |
| WEEK 7 | $10.47^{b}$ | $12.05^{a}$ | $11.22^{ab}$ | $10.90^{b}$ | 0.21 |
| WEEK 8 | $11.13^{b}$ | $12.90^{a}$ | $12.02^{ab}$ | $11.87^{ab}$ | 0.21 |
| WEEK 9 | $11.23^{c}$ | $13.20^{a}$ | $12.22^{b}$ | $11.92^{bc}$ | 0.19 |
| WEEK 10 | $11.60^{b}$ | $13.52^{a}$ | $12.22^{b}$ | $11.92^{b}$ | 0.21 |
| WEEK 11 | $11.60^{b}$ | $13.72^{a}$ | $12.18^{b}$ | $11.89^{b}$ | 0.27 |
| WEEK 12 | $11.90^{b}$ | $13.92^{a}$ | $12.26^{b}$ | $11.95^{b}$ | 0.26 |
| Mean | 10.48 | 11.71 | 10.89 | 10.77 | 0.21 |

$^{abcd}$ Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$** = Kids resulting from mating non-wattled does with non-wattled bucks;
**$T_2$**= Kids resulting from mating non-wattled does with wattled bucks;
**$T_3$**= Kids resulting from mating wattled does with non-wattled buck:
**$T_4$**= Kids resulting from mating wattled does with wattled bucks.
**SEM=** Standard error of mean

## 4.25. Effect of Wattle on the Weely Fore Leg of Red Sokoto Kids Raised Semi Intensively

Table 4.23 shows the effect of wattle on the fore leg of Red Sokoto kids raised semi intensively. The table revealed a significant ($p<0.05$) difference in all the weeks except for week 1. The mean fore leg however did not show any significant ($p>0.05$) difference across the treatments.

## 4.26. Effect of Wattle on the Weely Hind Leg of Red Sokoto Kids Raised Semi Intensively

Table 4.24 shows the effect of wattle on the hind leg of Red Sokoto kids raised semi intensively. The table shows a significant ($p<0.05$) difference in the hind leg of the kids in all the treatments from week one to week twelve and the mean hind leg. The Table revealed that kids in $T_1$ (34.99 cm), $T_2$ (38.08 cm) and $T_3$ (38.50cm) had higher ($p<0.05$) mean hind leg while kids of wattled does mated with wattled bucks in $T_4$ (33.20 cm) had the least ($p>0.05$) hind leg but was similar to the kids of non-wattled does mated with non-wattled bucks in $T_1$.

## 4.27. Effect of Wattle on the Weekly Shin Circumference of Red Sokoto Kids Raised Semi Intensively

The effect of wattle on the shin circumference of Red Sokoto kids raised semi intensively (Table 4.25) revealed significant ($p<0.05$) differences in the shin circumference from birth until twelve weeks of age except for weeks 1, 4, 5, 6, 7 that showed no significant ($p>0.05$) difference. The mean shin circumference for the twelve weeks showed no significant ($p>0.05$) difference across the treatments.

**Table 4.23. Effect of wattle on the Weely fore leg lof Red Sokoto kids raised semi intensively**

| WEEK | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| At birth (cm) | $21.65^{b}$ | $24.96^{a}$ | $23.78^{ab}$ | $22.07^{b}$ | 0.43 |
| WEEK 1 | 25.88 | 26.40 | 26.1 | 24.18 | 0.28 |
| WEEK 2 | $28.40^{ab}$ | $28.15^{ab}$ | $29.24^{a}$ | $27.40^{b}$ | 0.49 |
| WEEK 3 | $27.68^{b}$ | $30.62^{a}$ | $30.37^{a}$ | $27.12^{b}$ | 0.41 |
| WEEK 4 | $30.21^{ab}$ | $31.74^{a}$ | $29.97^{ab}$ | $28.84^{b}$ | 0.36 |
| WEEK 5 | $31.13^{b}$ | $33.16^{a}$ | $31.70^{b}$ | $29.07^{c}$ | 0.50 |
| WEEK 6 | $29.33^{b}$ | $33.98^{a}$ | $32.72^{a}$ | $29.50^{b}$ | 0.53 |
| WEEK 7 | $29.33^{b}$ | $34.83^{a}$ | $33.53^{a}$ | $30.77^{b}$ | 0.59 |
| WEEK 8 | $29.70^{c}$ | $36.23^{a}$ | $34.53^{ab}$ | $33.10^{b}$ | 0.46 |
| WEEK 9 | $33.37^{b}$ | $37.43^{a}$ | $36.63^{a}$ | $33.98^{b}$ | 0.39 |
| WEEK10 | $33.90^{b}$ | $36.70^{a}$ | $34.79^{b}$ | $31.69^{c}$ | 0.66 |
| WEEK 11 | $34.45^{b}$ | $37.08^{a}$ | $35.73^{b}$ | $32.81^{c}$ | 0.43 |
| WEEK12 | $35.45^{b}$ | $37.46^{a}$ | $36.67^{b}$ | $33.93^{c}$ | 0.54 |
| Mean | 29.59 | 32.61 | 31.60 | 29.21 | 0.58 |

$^{abcd}$ Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$** = Kids resulting from mating non-wattled does with non wattled bucks; **$T_2$**= Kids resulting from mating non-wattled does with wattled bucks; **$T_3$**= Kids resulting from mating wattled does with non-wattled buck; **$T_4$**= Kids resulting from mating wattled does with wattled bucks.**SEM=** Standard Error of Mean

**Table 4.24. Effect of wattle on the weekly hind leg of Red Sokoto kids raised semi intensively**

| WEEK | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| At birth (cm) | $25.80^{b}$ | $29.02^{a}$ | $28.90^{a}$ | $23.80^{c}$ | 0.68 |
| WEEK 1 | $27.93^{b}$ | $30.44^{ab}$ | $32.07^{a}$ | $27.06^{b}$ | 0.49 |
| WEEK 2 | $32.10^{c}$ | $34.03^{b}$ | $35.91^{a}$ | $30.54^{d}$ | 0.67 |
| WEEK 3 | $33.63^{b}$ | $36.94^{a}$ | $37.57^{a}$ | $31.76^{b}$ | 0.58 |
| WEEK 4 | $34.78^{ab}$ | $37.39^{a}$ | $35.71^{a}$ | $32.12^{b}$ | 0.67 |
| WEEK 5 | $34.23^{b}$ | $37.85^{a}$ | $36.82^{ab}$ | $32.49^{c}$ | 0.72 |
| WEEK 6 | $34.44^{b}$ | $39.16^{a}$ | $39.44^{a}$ | $33.13^{b}$ | 0.71 |
| WEEK 7 | $36.17^{b}$ | $40.03^{a}$ | $40.80^{a}$ | $34.67^{b}$ | 0.73 |
| WEEK 8 | $34.07^{b}$ | $39.73^{a}$ | $39.67^{a}$ | $37.00^{ab}$ | 0.66 |
| WEEK 9 | $39.07^{b}$ | $42.73^{a}$ | $43.80^{a}$ | $38.00^{b}$ | 0.60 |
| WEEK10 | $40.88^{b}$ | $42.57^{ab}$ | $43.27^{a}$ | $37.00^{c}$ | 0.65 |
| WEEK11 | $40.00^{b}$ | $42.31^{a}$ | $42.65^{a}$ | $35.91^{c}$ | 0.43 |
| WEEK12 | $41.76^{b}$ | $42.83^{a}$ | $43.89^{a}$ | $38.09^{c}$ | 0.59 |
| Mean | $34.99^{ab}$ | $38.08^{a}$ | $38.50^{a}$ | $33.20^{b}$ | 0.70 |

$^{abcd}$ Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$** = Kids resulting from mating non-wattled does with non wattled bucks; **$T_2$**= Kids resulting from mating non-wattled does with wattled bucks; **$T_3$**= Kids resulting from mating wattled does with non-wattled buck; **$T_4$**= Kids resulting from mating wattled does with wattled bucks.**SEM=** Standard error of mean

### 4.28. Effect of Wattle on Weaning Traits of Red Sokoto Kids Raised Semi Intensively

Table 4.26 shows the effect of wattle on the weaning traits of Red Sokoto kids raised semi intensively. Kids in $T_2$ (kids of non-wattled does mated to wattled bucks) had the highest ($p<0.05$) final body weight at weaning, survival rate and weaning weight gain (8.36, 6.52 kg) followed by those in $T_3$ (7.63, 5.93 kg) and $T_4$ (7.22, 5.95 kg) that had similar values ($p<0.05$) while $T_1$ had the least value in the weaning weight and weaning weigth gain (7.22, 4.66 kg). Kids in $T_2$ had the highest survival rate (100 %) followed by those in $T_1$ (75 %), $T_3$ (66.7 %) and $T_4$ (33.3 %), respectively. $T_1$ and $T_3$ had 50 % male and 50 % female (i.e. sex ratio of 1:1), $T_2$ had 75 % male and 25 % female (ratio 3: 1) and $T_4$ had 33.3 % male and 66.7 % female (ratio 1: 2).

### 4.29. Effect of Wattle on the Haematological Parameters of Red Sokoto Does before Mating

The effect of wattle on the haematological parameters of Red Sokoto does before mating (Table 4.27) reveal significant ($p<0.05$) differences in the haemoglobin concentration, packed cell volume, eosinophil, mean corpuscular volume and mean corpuscular haemoglobin. The Table showed no significant ($p>0.05$) difference in the white blood cell count, red blood cell count, neutrophil, lymphocytes, monophil, basophil and mean corpuscular haemoglobin concentration. Does in $T_4$ had the highest haemoglobin concentration (10.11g/dl) and Packed cell volume (29.10 %). This was followed by does in $T_3$ (8.53g/dl, 24.05 %) while does in $T_1$ (6.56 g/dl, 17.42 %) and $T_2$ (6.21 g/dl, 17.71 %) had lower but similar ($p>0.05$) values. Does in $T_1$ (2.00 %) had the highest ($p<0.05$) eosinophil values, but does in $T_2$ (0.92 %), $T_3$ (0.61 %) and $T_4$ (0.00 %) had statistically similar ($p>0.05$) eosinophil values. Does in $T_1$ (37.44 fl) were not significantly ($p>0.05$) different from those in $T_2$ (37.44 fl) in terms of mean corpuscular volume values; the two treatments however had higher ($p<0.05$) values than does in $T_3$ (36.44

**Table 4.25. Effect of wattle on the shin circumference of Red Sokoto kids raised semi intensively**

| WEEK | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| At birth (cm) | $5.60^{a}$ | $5.84^{a}$ | $5.77^{a}$ | $5.13^{b}$ | 0.13 |
| WEEK 1 | 6.40 | 5.82 | 6.33 | 6.26 | 0.26 |
| WEEK 2 | $7.37^{ab}$ | $6.73^{b}$ | $8.63^{a}$ | $8.00^{ab}$ | 0.08 |
| WEEK 3 | $6.58^{a}$ | $6.42^{ab}$ | $6.43^{ab}$ | $6.00^{b}$ | 0.09 |
| WEEK 4 | 6.65 | 6.45 | 6.44 | 6.25 | 0.11 |
| WEEK 5 | 6.40 | 6.40 | 6.40 | 6.07 | 0.09 |
| WEEK 6 | 6.14 | 6.26 | 6.26 | 5.87 | 0.09 |
| WEEK 7 | 6.13 | 6.23 | 6.23 | 5.83 | 0.07 |
| WEEK 8 | $6.40^{b}$ | $6.85^{a}$ | $6.63^{ab}$ | $6.27^{b}$ | 0.09 |
| WEEK 9 | $6.33^{b}$ | $6.98^{a}$ | $6.73^{a}$ | $6.22^{b}$ | 0.09 |
| WEEK10 | $6.23^{b}$ | $7.00^{a}$ | $6.73^{a}$ | $6.30^{b}$ | 0.08 |
| WEEK11 | $6.30^{b}$ | $7.01^{a}$ | $6.77^{a}$ | $6.40^{b}$ | 0.07 |
| WEEK12 | $6.37^{b}$ | $7.02^{a}$ | $6.81^{a}$ | $6.50^{ab}$ | 0.09 |
| Mean | 6.38 | 6.54 | 6.63 | 6.24 | 0.08 |

[abcd] Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$** = Kids resulting from mating non-wattled does with non-wattled bucks;
**$T_2$**= Kids resulting from mating non-wattled does with wattled bucks;
**$T_3$**= Kids resulting from mating wattled does with non-wattled buck:
**$T_4$**= Kids resulting from mating wattled does with wattled bucks.
**SEM=** Standard error of mean

**Table 4.26. Effect of wattle on weaning trait of Red Sokoto kids raised semi intensively**

| Parameters | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| Final Body weight at weaning (kg) | $6.16^{c}$ | $8.36^{a}$ | $7.63^{b}$ | $7.22^{b}$ | 0.15 |
| Weaning weight gain (kg) | $4.66^{c}$ | $6.52^{a}$ | $5.93^{b}$ | $5.95^{b}$ | 0.25 |
| Survival rate (%) | $75.00^{b}$ | $100^{a}$ | $66.70^{b}$ | $33.33^{c}$ | 7.31 |
| Mortality rate (%) | $25.00^{c}$ | $0.00^{d}$ | $33.30^{b}$ | $66.7^{a}$ | 7.20 |
| Male (%) | $50.00^{b}$ | $75.00^{a}$ | $50.00^{b}$ | $33.33^{c}$ | 4.49 |
| Female (%) | $50.00^{b}$ | $25.00^{c}$ | $50.00^{b}$ | $66.70^{a}$ | 4.49 |
| Twin (%) | $0.00^{c}$ | $0.00^{c}$ | $25.00^{b}$ | $50.00^{a}$ | 6.25 |
| Single (%) | $100.00^{a}$ | $100.00^{a}$ | $75.00^{b}$ | $50.00^{c}$ | 6.25 |

[abcd] Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$** = Kids resulting from mating non-wattled does with non wattled bucks;
**$T_2$**= Kids resulting from mating non-wattled does with wattled bucks;
**$T_3$**= Kids resulting from mating wattled does with non-wattled buck:
**$T_4$**= Kids resulting from mating wattled does with wattled bucks.
**SEM=** Standard error of mean

**Table 4.27. Effect of wattle on the haematological parameters of Red Sokoto does before mating**

| Parameters | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM | *Normal range |
|---|---|---|---|---|---|---|
| RBC ($x10^6$/dl) | 10.64 | 10.37 | 10.74 | 10.86 | 0.17 | 9.2 -13.5 |
| Hb (g/dl) | $6.56^c$ | $6.21^c$ | $8.53^b$ | $10.11^a$ | 0.39 | 7 – 15 |
| PCV (%) | $17.42^c$ | $17.71^c$ | $24.05^b$ | $29.10^a$ | 1.32 | 21- 35 |
| MCV (fl) | $37.44^a$ | $37.44^a$ | $36.44^b$ | $36.44^b$ | 0.32 | 16-25 |
| MCH (pg) | $6.10^b$ | $7.16^a$ | $5.56^b$ | $6.14^b$ | 0.40 | 5.2-8.0 |
| MCHC (g/dl) | 37.96 | 37.59 | 35.48 | 35.01 | 0.80 | 30 – 36 |
| WBC (x $10^3$/l) | 13.31 | 10.53 | 12.84 | 10.25 | 0.75 | 6.8 -20.1 |
| **WBC differentials** | | | | | | |
| Lymphocytes (%) | 63.27 | 66.52 | 68.15 | 68.54 | 1.31 | 47 – 82 |
| Neutrophils (%) | 31.68 | 32.81 | 30.99 | 32.62 | 0.98 | 17 – 52 |
| Eosinophils (%) | $2.00^a$ | $0.92^b$ | $0.61^b$ | $0.00^b$ | 0.41 | 1 – 7 |
| Monocytes (%) | 0.82 | 0.00 | 0.25 | 1.31 | 0.14 | 0-4 |
| Basophils (%) | 0.24 | 0.00 | 0.00 | 0.00 | 0.15 | 0-1 |

*Daramola *et al.* (2005)

$^{abcd}$ Means within a row having different superscripts differed significantly ($p<0.05$);

**$T_1$**= Non-wattled does mated with non-wattled bucks;

**$T_2$** = Non-wattled does mated with wattled bucks;

**$T_3$**= Wattled does mated with non-wattled buck:

**$T_4$**= Wattled does mated with wattled bucks.

**SEM=** Standard error of mean

RBC = Red blood cell count

Hb = Haemoglobin concentration

PCV = Packed cell volume

MCV = Mean corpuscular volume

MCH = Mean corpuscular haemoglobin

MCHC = Mean corpuscular haemoglobin concentration

WBC = White blood cell

fl) and $T_4$ (36.44 fl) which showed statitically ($p>0.05$) equal values in the mean corpuscular volume values. Does in $T_2$ (7.16 pg) had significantly ($p<0.05$) higher mean corpuscular haemoglobin values than does in $T_1$ (6.10 fl), $T_3$ (5.56 fl), and $T_4$ (6.14 fl).

### 4.30. Effect of Wattle on the Serum Biochemistry of Red Sokoto Does before Mating

Table 4.28 shows the effect of wattle on the serum biochemistry of Red Sokoto does before mating. The Table revealed significant ($p<0.05$) differences in the sodium, potassium, calcium, chloride, phosphorus, cholesterol, and total bilirubin components of the blood serum of the does used before mating. The urea, total protein, creatinine, glucose, high density lipoprotein, low density lipoprotein, albumin, triglyceride, conjugated bilirubin, alanine aminotransferase, aspartate aminotransferase and Alkaline Phosphatase showed no significant ($p>0.05$) differences. Does in $T_2$(156.65 mmo/l), $T_3$(159.35 mmo/l) and $T_4$(163.00 mmo/l) showed similarities ($p>0.05$) in the values of sodium but were significantly ($p<0.05$) higher than that observed in does in $T_1$(147.40 mmo/l). Does in $T_1$(5.97 mmo/l) had higher ($p<0.05$) potassium while $T_3$ had the least (4.57 mmo/l). Calium was higher in does in $T_4$ (2.61mmo/l) compared to does in $T_2$ (2.49 mmo/l) $T_3$(2.52 mmo/l) and $T_1$(2.37 mmo/l) repectively. Does in $T_2$ had higher chloride (78.68 mmo/l) than in the other treatments. Does in $T_4$(1.95 mmo/l) had higher ($p<0.05$) phosphorus while the least was found in $T_3$(1.55 mmo/l). Does in $T_1$(4.10 mmo/l) and $T_4$(4.60 mmo/l) had the highest ($p>0.05$) cholesterol level and in the serum followed by does in $T_3$(3.35 mmo/l) and $T_2$(2.55 mmo/l), respectively. Finally, the Table showed that does in $T_4$(4.73 mg/dl) had the highest ($p<0.05$) total bilirubin while those in $T_1$(3.11 mg/dl), $T_2$(2.76 mg/dl) and $T_3$(mg/dl) had the least values.

**Table 4.28. Effect of wattle on the serum biochemistry of Red Sokoto does before mating**

| **Parameters** | **$T_1$** | **$T_2$** | **$T_3$** | **$T_4$** | **SEM** | ***Normal Range** |
|---|---|---|---|---|---|---|
| Sodium (mmo/l) | $147.40^{b}$ | $156.65^{a}$ | $159.35^{a}$ | $163.00^{a}$ | 3.66 | 124 – 155 |
| Potassium (mmo/l) | $5.97^{a}$ | $4.97^{ab}$ | $4.57^{b}$ | $5.58^{ab}$ | 0.38 | 3.0 – 6.0 |
| Calcium (mmo/l) | $2.37^{c}$ | $2.49^{b}$ | $2.52^{b}$ | $2.61^{a}$ | 0.11 | 1.15 – 3 |
| Chloride (mmo/l) | $78.68^{ab}$ | $78.68^{a}$ | $57.26^{ab}$ | $50.39^{b}$ | 1.43 | 99– 120 |
| Phosphorus (mmo/l) | $1.60^{bc}$ | $1.85^{ab}$ | $1.55^{c}$ | $1.95^{a}$ | 0.22 | 0.58 – 4.5 |
| Urea (mmo/l) | 7.49 | 6.05 | 5.20 | 5.63 | 0.81 | 0.8 – 9.7 |
| Creatinine (mg/dl) | 0.85 | 0.53 | 0.52 | 0.59 | 0.23 | 0.9 - 1.8 |
| Cholesterol (mmo/l) | $4.10^{a}$ | $2.55^{c}$ | $3.35^{b}$ | $4.60^{a}$ | 0.71 | 2.07-3.37 |
| Glucose (mmo/l) | 1.62 | 2.31 | 1.66 | 1.53 | 0.60 | 2.78-4.16 |
| Total protein (g/100ml) | 3.86 | 4.78 | 5.18 | 5.70 | 0.45 | 6.3 – 8.5 |
| HDL (mmo/l) | 0.89 | 0.93 | 1.21 | 1.01 | 0.11 | 0.9-1.7 |
| LDL (mmo/l) | 1.25 | 1.40 | 2.15 | 2.30 | 0.27 | 0 - 4.1 |
| Albumin (g/100ml) | 1.480 | 1.715 | 2.285 | 2.050 | 0.32 | 2.8 – 4.3 |
| Triglyceride (mmo/l) | 0.47 | 1.13 | 0.71 | 0.45 | 0.24 | 0.16 – 1.6 |
| Total bilirubin (mg/dl) | $3.11^{b}$ | $2.76^{b}$ | $2.74^{b}$ | $4.73^{a}$ | 0.35 | 0 - 0.9 |
| Conjugated bilirubin (mm/l) | 2.26 | 2.02 | 1.88 | 1.54 | 0.12 | 0-1.7 |
| (ALT) (IU/L) | 14.30 | 13.75 | 12.70 | 13.80 | 0.10 | 12-38 |
| AST (IU/L) | 6.94 | 16.95 | 11.70 | 5.34 | 0.89 | 2 – 22 |
| ALP (IU/L) | 23.55 | 24.54 | 31.49 | 41.37 | 2.14 | 1.4-25.7 |

*Daramola *et al.* (2005)

[abcd] Means within a row having different superscripts differed significantly ($p<0.05$);

**$T_1$**= Non-wattled does mated with non-wattled bucks;

**$T_2$** = Non-wattled does mated with wattled bucks;

**$T_3$**= Wattled does mated with non-wattled buck:

**$T_4$**= Wattled does mated with wattled bucks.

**SEM=** Standard error of mean

HDL= High density lipoprotein

LDL = Low density lipoprotein

ALT= Alanine aminotransferase

AST= Aspartate aminotransferase

ALP= Alkaline phosphatase

### 4.31. Effect of Wattle on the Haematological Parameters of Red Sokoto Does after Birth

The effect of wattle on the haematological parameters of Red Sokoto does after birth (Table 4.29) revealed no significant ($p>0.05$) difference in most of the haematological parameters measured for all the does except for white blood cell count, MCH and MCHC that showed some level of significance ($p<0.05$). Does in $T_3$ had the highest ($p<0.05$) MCH values (63.50 mmo/l) while those in $T_1$ (23.00 mmo/l), $T_2$ (33.00) and $T_4$ (34.00) had similar ($p>0.05$) but lower ($p<0.05$) values of MCH compared to does in $T_3$ (63.50). The values of MCHC of does in $T_2$ (38.00) were higher ($p>0.05$) than in the other treatments. Does in $T_4$ (17.75) had the highest ($p<0.05$) white blood cell count compared to does in other treatments.

### 4.32. Effect of Wattle on the Serum Biochemistry of the Red Sokoto Does after Birth

The Effect of wattle on the serum biochemistry of the Red Sokoto does after birth (Table 4.30) showed significant ($p<0.05$) difference in the sodium, potassium, calcium, phosphorus, cholesterol, total protein, low density lipoprotein and total bilirubin components of the blood serum of the does after parturition. The chloride, urea, creatinine, glucose, high density lipoprotein, albumin, triglyceride, conjugated bilirubin, alanine aminotransferase, aspartate aminotransferase and Alkaline phosphatase showed no significant ($p>0.05$) difference across treatments. Does in $T_2$ (160.10 mmo/l), $T_3$ (162.04 mmo/l) and $T_4$ (164.37 mmo/l) had significantly ($p<0.05$) higher sodium content in blood serum than does in $T_1$ (144.13 mmo/l). Does in $T_1$ had the highest ($p<0.05$) potassium content (6.04 mmo/l) while the least was in $T_2$ (4.53 mmo/l). Does in $T_2$ (2.54 mmol), $T_3$ (2.56 mmol/l) and $T_4$ (2.61 mmo/l) had similar ($p>0.05$) calcium content in the blood serum, but the three had higher ($p<0.05$) levels of calcium than does in $T_1$ (2.29 mmo/l). Phosphorus content in $T_4$ (1.93 mmo/l) was significantly ($p<0.05$) higher while the least was found in $T_3$ (1.57 mmo/l). The cholesterol level of wattled does mated with wattled bucks ($T_4$) was significantly ($p<0.05$) higher (4.67 mmo/l) than non-wattled does mated with non-wattled bucks in $T_2$ (2.60 mmo/l). Does in $T_2$ however, had cholesterol values similar ($p>0.05$) to the values obtainable for does in $T_1$ (3.77 mmo/l) and $T_3$ (3.23 mmo/l). Does in $T_4$ had higher (5.63 g/100ml) total protein in the blood serum than other treatments. Does in $T_3$ (2.03 mmo/l) and $T_4$ (2.40 mmo/l) had equal but higher ($p<0.05$) levels of low density lipoprotein than does in $T_1$ (1.10 mmo/l) and $T_2$ (1.23 mmol). Does in $T_4$ (4.81 mmo/l) equally had significantly ($p<0.05$) higher levels of total bilirubin than does in $T_1$ (3.08 mmo/l), $T_2$(2.74 mmo/l) and $T_3$(2.75 mmo/l), respectively.

### 4.33. Effect of Wattle on the Haematological Parameters of Weaned Red Sokoto Kids Raised Semi Intensively

Table 4.31 revealed the effect of wattle on the haematological parameters of weaned Red Sokoto kids raised semi intensively. The Table showed no significant ($p>0.05$) difference in red blood cell count, haemoglobin concentration, packed cell volume, mean corpuscular volume, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration, White blood cell count, lymphocytes, neutrophils, eosinophils, monocytes and basophils of the weaned kids.

### 4.34. Effect of Wattle on the Serum Biochemistry of Weaned Red Sokoto Kids Raised Semi Intensively

The effect of wattle on the serum biochemistry of weaned Red Sokoto kids raised semi Intensively (Table 4.32) revealed no significant ($p>0.05$) differences in potassium, calcium, chloride, phosphorus, urea, creatinine, cholesterol, glucose, total protein, high density lipoprotein, low-density lipoprotein, albumin, triglyceride, total bilirubin, alanine aminotransferase, aspartate aminotransferase and Alkaline phosphatase among the treatments.

**Table 4.29. Effect of wattle on the haematological parameters of Red Sokoto does after birth**

| Parameters | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM | *Normal range |
|---|---|---|---|---|---|---|
| RBC ($x10^{12}$/L) | 10.35 | 10.50 | 10.95 | 10.75 | 1.34 | 8.0 -18.0 |
| Hb (g/dl) | 10.40 | 9.40 | 9.75 | 9.70 | 0.55 | 8.0-12.0 |
| PCV (%) | 23.00 | 23.00 | 25.50 | 25.50 | 1.54 | 22 – 38 |
| MCV (fl) | 71.00 | 28.00 | 57.50 | 66.00 | 6.01 | 16-25 |
| MCH (pg) | $23.00^b$ | $33.00^b$ | $63.50^a$ | $34.00^b$ | 5.86 | 5.2-8.0 |
| MCHC (g/dl) | $30.50^b$ | $38.00^a$ | $32.00^b$ | $30.00^b$ | 1.52 | 30 – 36 |
| WBC ($x10^9$/L) | $9.20^b$ | $14.20^{ab}$ | $9.00^b$ | $17.75^a$ | 0.27 | 4.0 -13.0 |
| **WBC differentials** | | | | | | |
| Lymphocytes (%) | 73.50 | 64.00 | 66.5 | 65.5 | 3.09 | 50-70 |
| Neutrophils (%) | 13.50 | 15.00 | 21.5 | 26.35 | 4.55 | 30-48 |
| Eosinophils (%) | 8.40 | 21.00 | 7.6 | 5.5 | 2.09 | 1-8 |
| Monocytes (%) | 3.60 | 0.00 | 3.45 | 2.15 | 0.57 | 0-4 |
| Basophils (%) | 1.00 | 0.00 | 0.95 | 0.5 | 0.11 | 0-1 |

*Daramola *et al.* (2005)

[abcd] Means within a row having different superscripts differed significantly ($p<0.05$);

**$T_1$**= Non-wattled does mated with no wattled bucks;

**$T_2$** = Non-wattled does mated with wattled bucks;

**$T_3$**= Wattled does mated with no wattled buck:

**$T_4$**= Wattled does mated with wattled bucks.

**SEM=** Standard error of mean

RBC = Red blood cell count

Hb = Haemoglobin concentration

PCV = Packed cell volume

MCV = Mean corpuscular volume

MCH = Mean corpuscular haemoglobin

MCHC = Mean corpuscular haemoglobin concentration

WBC = White blood cell

**Table 4.30. Effect of wattle on the serum biochemistry of the Red Sokoto does after birth**

| **Parameters** | **$T_1$** | **$T_2$** | **$T_3$** | **$T_4$** | **SEM** | ***Normal range** |
|---|---|---|---|---|---|---|
| Sodium (mmo/l) | $144.13^{b}$ | $160.10^{a}$ | $162.4^{a}$ | $164.37^{a}$ | 1.33 | 124 – 155 |
| Potassium (mmo/l) | $6.04^{a}$ | $4.53^{c}$ | $4.80^{bc}$ | $5.66^{ab}$ | 0.14 | 3.0 – 6.0 |
| Calcium mmo/l) | $2.29^{b}$ | $2.54^{a}$ | $2.56^{a}$ | $2.61^{a}$ | 0.02 | 1.15 – 3 |
| Chloride (mmo/l) | 65.93 | 89.80 | 47.38 | 46.32 | 6.36 | 105 – 120 |
| Phosphorus (mmo/l) | $1.73^{ab}$ | $1.73^{ab}$ | $1.57^{b}$ | $1.93^{a}$ | 0.04 | 0.58 – 4.5 |
| Urea (mmo/l) | 6.80 | 6.00 | 5.29 | 5.79 | 0.36 | 0.8 – 9.7 |
| Creatinine (mg/dl) | 0.76 | 0.53 | 0.55 | 0.60 | 0.04 | 0.9 - 1.8 |
| Cholesterol (mmo/l) | $3.77^{b}$ | $2.60^{c}$ | $3.23^{bc}$ | $4.67^{a}$ | 0.09 | 2.07 – 3.37 |
| Glucose (mmo/l) | 1.65 | 2.02 | 1.19 | 1.32 | 0.18 | 2.78-4.16 |
| Total Protein (g/100ml) | $4.08^{b}$ | $4.85^{ab}$ | $5.19^{ab}$ | $5.63^{a}$ | 0.19 | 6.3 – 8.5 |
| HDL (mmo/l) | 0.76 | 1.01 | 0.95 | 0.95 | 0.08 | 0.9-1.7 |
| LDL (mmo/l) | $1.10^{b}$ | $1.23^{b}$ | $2.03^{a}$ | $2.40^{a}$ | 0.10 | 0 - 4.1 |
| Albumin (g/100ml) | 2.14 | 2.22 | 2.22 | 2.61 | 0.23 | 2.8 – 4.3 |
| Triglyceride (mmo/ litre) | 0.38 | 1.04 | 0.57 | 0.37 | 0.09 | 0.16 – 1.6 |
| Total Bilirubin (mg/dl) | $3.08^{b}$ | $2.74^{b}$ | $2.75^{b}$ | $4.81^{a}$ | 0.04 | 0 - 0.9 |
| Conjugated Bilirubin (mm/l) | 2.01 | 1.70 | 1.55 | 1.58 | 0.03 | 0 – 1.7 |
| ALT (IU/L) | 14.61 | 14.33 | 19.87 | 13.92 | 1.59 | 12-38 |
| AST (IU/L) | 8.75 | 13.46 | 9.65 | 5.16 | 1.25 | 2 – 22 |
| ALP (IU/L) | 28.83 | 23.54 | 23.67 | 23.54 | 4.00 | 14-25.7 |

*Daramola *et al.* (2005)

[abcd] Means within a row having different superscripts differed significantly ($p<0.05$);

**$T_1$**= Non-wattled does mated with non-wattled bucks;

**$T_2$** = Non-wattled does mated with wattled bucks;

**$T_3$**= Wattled does mated with non-wattled buck:

**$T_4$**= Wattled does mated with wattled bucks.

**SEM=** Standard error of mean

HDL= High density lipoprotein

LDL = Low density lipoprotein

ALT= Alanine aminotransferase

AST= Aspartate aminotransferase

ALP= Alkaline phosphatase

**Table 4.31. Effect of wattle on the haematological parameters of weaned Red Sokoto kids raised semi intensively**

| **Parameters** | **$T_1$** | **$T_2$** | **$T_3$** | **$T_4$** | **SEM** | ***Normal range** |
|---|---|---|---|---|---|---|
| RBC ($x10^{12}$/L) | 5.60 | 5.80 | 5.50 | 5.75 | 0.46 | 8.0 -18.0 |
| Hb (g/dl) | 10.20 | 10.70 | 10.45 | 11.30 | 0.57 | 8.0-12.0 |
| PCV (%) | 30.50 | 31.50 | 30.00 | 33.00 | 1.22 | 22 – 38 |
| MCV (fl) | 57.50 | 56.00 | 38.00 | 51.00 | 1.31 | 16-25 |
| MCH (pg) | 13.00 | 14.00 | 32.50 | 13.50 | 3.21 | 5.2-8.0 |
| MCHC (g/dl) | 35.50 | 37.00 | 35.00 | 37.50 | 7.95 | 30 – 36 |
| WBC ($x10^9$/L) | 13.55 | 14.00 | 13.55 | 13.55 | 1.43 | 4.0 -13.0 |
| **WBC differentials** | | | | | | |
| Lymphocytes (%) | 51.05 | 49.55 | 45.55 | 47.55 | 1.20 | 50-70 |
| Neutrophils (%) | 40.95 | 42.45 | 45.95 | 44.95 | 2.58 | 30 – 48 |
| Eosinophils (%) | 6.50 | 6.50 | 7.00 | 6.00 | 0.62 | 1-8 |
| Monocytes (%) | 3.50 | 3.80 | 3.45 | 3.30 | 0.50 | 0-4 |
| Basophils (%) | 1.30 | 1.30 | 1.25 | 1.30 | 0.22 | 0-1 |

*Daramola *et al.* (2005)
**$T_1$**= Non-wattled does mated with non-wattled bucks;
**$T_2$** = Non-wattled does mated with wattled bucks;
**$T_3$**= Wattled does mated with non-wattled buck:
**$T_4$**= Wattled does mated with wattled bucks.
**SEM=** Standard error of mean
RBC = Red blood cell count
Hb = Haemoglobin concentration
PCV = Packed cell volume
MCV = Mean corpuscular volume
MCH = Mean corpuscular haemoglobin
MCHC = Mean corpuscular haemoglobin concentration
WBC = White blood cell

**Table 4.32. Effect of wattle on the serum biochemistry of weaned Red Sokoto kids raised semi intensively**

| Parameters | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM | *Normal range |
|---|---|---|---|---|---|---|
| Potassium (mmo/l) | 6.30 | 6.53 | 6.99 | 7.27 | 0.20 | 3.0 – 6.0 |
| Calcium mmo/l) | 3.00 | 3.20 | 3.40 | 3.10 | 0.34 | 1.15 – 2.4 |
| Chloride (mmo/l) | 99.00 | 101.30 | 98.80 | 105.00 | 1.25 | 105 – 120 |
| Phosphorus (mmo/l) | 2.90 | 2.30 | 3.40 | 2.21 | 082 | 0.58 – 4.5 |
| Urea (mmo/l) | 7.26 | 7.26 | 8.39 | 9.52 | 0.87 | 0.8 – 9.7 |
| Creatinine (mg/dl) | 1.40 | 1.40 | 3.40 | 1.65 | 0.45 | 0.9 - 1.8 |
| Cholesterol (mmo/l) | 8.20 | 8.63 | 8.20 | 10.33 | 0.84 | 64.6 - 136.4 |
| Glucose (mmo/l) | 4.79 | 6.66 | 6.58 | 5.62 | 0.78 | 6 – 10 |
| Total protein (g/100ml) | 6.08 | 6.17 | 6.93 | 7.31 | 0.40 | 6.3 – 8.5 |
| HDL (mmo/l) | 0.72 | 0.68 | 0.59 | 0.83 | 0.09 | 0.9-1.7 |
| LDL (mmo/l) | 1.78 | 1.92 | 1.91 | 3.60 | 0.70 | 0 - 4.1 |
| Albumin (g/100ml) | 2.88 | 3.18 | 3.07 | 3.18 | 0.21 | 2.8 – 4.3 |
| Triglyceride (mmo/ litre) | 2.54 | 4.20 | 2.54 | 3.58 | 0.72 | 0.16 – 1.6 |
| Total bilirubin (mg/dL) | 1.60 | 1.62 | 1.63 | 1.945 | 0.51 | 0 - 0.9 |
| ALT (IU/L) | 19.09 | 19.09 | 19.09 | 19.09 | 7.15 | 12-38 |
| AST (IU/L) | 11.03 | 11.03 | 11.03 | 11.03 | 4.14 | 2 – 22 |
| ALP (IU/L) | 23.60 | 23.60 | 44.85 | 27.88 | 7.25 | 1.4-25.7 |

*Daramola *et al.* (2005)
**$T_1$**= Non-wattled does mated with non-wattled bucks;
**$T_2$** = Non-wattled does mated with wattled bucks;
**$T_3$**= Wattled does mated with non-wattled buck:
**$T_4$**= Wattled does mated with wattled bucks.
**SEM=** Standard error of mean
HDL= High density lipoprotein
LDL = Low density lipoprotein
ALT= Alanine aminotransferase
AST= Aspartate aminotransferase
ALP= Alkaline phosphatase

## 4.35. Effect of Wattle on the Haematology of Red Sokoto Bucks Raised Semi Intensively

Table 4.33 shows the effect of wattle on the haematology of Red Sokoto bucks raised semi intensively. The results revealed significant ($p<0.05$) difference in the white blood cells count, neutrophils and lymphocytes. Wattle had no significant ($p>0.05$) effect on red blood cell count, haemoglobin concentration, packed cell volume, monocytes, eosinophils, basophils, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration of the bucks used for the experiment. Non-wattled does in $T_1$ had higher ($p<0.05$) white blood cells (15.58 x $10^3$/l) and lymphocytes (65.53 %) than $T_2$ with (12.53 x $10^3$/l and 60.41 %). Bucks in $T_2$ had higher ($p<0.05$) nuetriphils (37.05 %) than $T_1$ (32.30 %)

## 4.36 Effect of Wattle on the Serum Biochemistry of Red Sokoto Bucks Raised Semi Intensively

The effect of wattle on the serum biochemistry of Red Sokoto bucks raised semi intensively is presented in Table 4.34. The Table shows that wattle did not significantly ($p>0.05$) influence the sodium, potassium, calcium, chloride, phosphorus, urea, creatinine, cholesterol, glucose, total protein, low-density lipoprotein, albumin, triglyceride, total bilirubin, conjugated bilirubin, alanine aminotransferase, aspartate aminotransferase and alkaline phosphatase among the treatments but affected the ($p<0.05$) high-density lipoprotein of the Red Sokoto bucks used for the experiment. Bucks in $T_2$ had higher ($p<0.05$) high density lipo protein (1.00 mmo/l) than $T_1$(0.45 mmo/l)

## 4.37. Effect of Wattle on the Scrotal and Semen Parameters of Red Sokoto Bucks Raised Semi Intensively

The effect of wattle on the scrotal and semen parameters of Red Sokoto bucks raised semi intensively (Table 4.35) revealed no significant ($p>0.05$) difference in all the parameters measured. The parameters include, scrotal circumference, right testis length, right testis width, left testis length, left testis width, semen volume, semen pH and the mean rectal temperature of the bucks.

**Table 4.33. Effect of wattle on the haematology of Red Sokoto bucks raised semi intensively**

| Parameters | $T_1$ | $T_2$ | SEM | *Normal range |
|---|---|---|---|---|
| RBC ($x10^6$/dl) | 10.20 | 10.19 | 0.17 | 9.2 -13.5 |
| Hb (g/dl) | 8.85 | 9.79 | 0.39 | 7 – 15 |
| PCV (%) | 29.58 | 31.47 | 1.32 | 21- 35 |
| MCV (fl) | 37.20 | 37.40 | 0.32 | 16-25 |
| MCH (pg) | 6.55 | 6.43 | 0.40 | 5.2-8.0 |
| MCHC (g/dl) | 36.81 | 37.22 | 0.80 | 30 – 36 |
| WBC (x $10^3$/l) | $15.58^a$ | $12.53^b$ | 0.76 | 6.8 -20.1 |
| WBC Differentials | | | | |
| Lymphocytes (%) | $65.53^a$ | $60.41^b$ | 1.31 | 47 – 82 |
| Neutrophils (%) | $32.30^b$ | $37.05^a$ | 0.98 | 17 – 52 |
| Eosinophils (%) | 2.00 | 1.20 | 0.41 | 1 – 7 |
| Monocytes (%) | 0.47 | 0.32 | 0.14 | 0-4 |
| Basophils (%) | 0.20 | 0.40 | 0.15 | 0-1 |

***Daramola *et al.* (2005)
$^{abcd}$ Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$=** Non-wattled bucks
**$T_2$**= Wattled bucks
**SEM=** Standard error of mean
RBC = Red blood cell count
Hb = Haemoglobin concentration
PCV = Packed cell volume
MCV = Mean corpuscular volume
MCH = Mean corpuscular haemoglobin
MCHC = Mean corpuscular haemoglobin concentration
WBC = White blood cell

**Table 4.34 Effect of wattle on the serum biochemistry of Red Sokoto bucks raised semi intensively**

| Parameters | $T_1$ | $T_2$ | SEM | *Normal range |
|---|---|---|---|---|
| Sodium (NA) (mmo/l) | 153.55 | 160.53 | 3.66 | 124 – 146 |
| Potassium (K) (mmo/l) | 6.21 | 5.72 | 0.38 | 3.0 – 6.0 |
| Calcium (CA)(mmo/l) | 2.70 | 2.81 | 0.11 | 1.15 – 2.4 |
| Chloride (Cl) (mmo/l) | 66.52 | 72.44 | 11.43 | 105 – 120 |
| Phosphorus (mmo/l) | 2.35 | 2.30 | 0.22 | 0.58 – 4.5 |
| Urea (mmo/l) | 7.73 | 8.00 | 0.81 | 0.8 – 9.7 |
| Creatinine (mg/dl) | 1.20 | 1.19 | 0.23 | 0.9 - 1.8 |
| Cholesterol (mmo/l) | 5.025 | 5.38 | 0.71 | 64.6 -136.4 |
| Glucose (mmo/l) | 2.59 | 2.66 | 0.60 | 6 – 10 |
| Total Protein (g/100ml) | 6.14 | 6.33 | 0.45 | 6.3 – 8.5 |
| HDL (mmo/l) | $0.47^{b}$ | $1.00^{a}$ | 0.11 | 0.9-1.7 |
| LDL (mmo/l) | 1.30 | 1.75 | 0.28 | 0 - 4.1 |
| Albumin (g/100ml) | 2.85 | 2.72 | 0.32 | 2.8 – 4.3 |
| Triglyceride (mmo/ l) | 0.93 | 1.07 | 0.23 | 0.16 – 1.6 |
| Total Bilirubin (mg/dl) | 2.90 | 3.83 | 0.35 | 0 - 0.9 |
| Conjugated Bilirubin (mm/l) | 1.20 | 1.37 | 0.12 | 0 – 1.7 |
| ALT (IU/L) | 31.37 | 26.41 | 4.10 | 12-38 |
| AST (IU/L) | 15.49 | 13.82 | 2.89 | 2 – 22 |
| ALP (Iu/ml) | 312.1 | 261.5 | 52.14 | 1.4-25.7 |

***Daramola** *et al.* (2005)
$^{abcd}$ Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$=** Non-wattled bucks
**$T_2$**= Wattled bucks
**SEM=** Standard error of mean
HDL= High density lipoprotein
LDL = Low density lipoprotein
ALT= Alanine aminotransferase
AST= Aspartate aminotransferase
ALP= Alkaline phosphatase

**Table. 4.35 Effect of wattle on the scrotal and semen parameters of Red Sokoto bucks raised semi intensively**

| **Parameters** | **T1** | **T2** | **SEM** |
|---|---|---|---|
| Body weight (kg) | 15.71 | 15.46 | 0.33 |
| Scrotal circumference (cm) | 17.60 | 18.20 | 0.24 |
| Right test length (cm) | 10.35 | 10.05 | 0.18 |
| Right test width (cm) | 3.70 | 3.80 | 0.04 |
| Left test length (cm) | 9.60 | 10.00 | 0.30 |
| Left test width (cm) | 3.80 | 3.75 | 0.03 |
| **Semen evaluation** | | | |
| Semen volume (ml) | 1.49 | 1.11 | 0.26 |
| Semen pH | 6.76 | 6.80 | 0.087 |
| Motility | | | |
| Active (%) | 80.25 | 82.75 | 4.40 |
| Sluggish (%) | 15.50 | 13.50 | 3.64 |
| Non-motile (%) | 4.25 | 3.75 | 0.82 |
| Colour (%) | Cream | Cream | |
| Mean rectal temperature ($^{O}C$) | 38.77 | 39.01 | 0.08 |

**$T_1$=** non-wattled bucks
**$T_2$**= Wattled bucks
**SEM=** Standard error of mean

# CHAPTER FIVE

## 5.0 DISCUSSION

### 5.1 Effect of Wattle on the Initial Body Weight and Morphometric Parameters of Red Sokoto Does

The wider head width of 11.88±0.38 with large effect of upto 0.62 (Eta-value) in wattled does is in agreement with the findings of Adedeji *et al.* (2012) who reported that wattle significantly ($p<0.05$) influenced the body weight of the West African Dwarft goat. Also the presence of wattles is said to be associated with heavier body weights from 18 month of age onward in Longling Yellow goats of China (Leng *et al.*, 2010). Odubote (1994) also observed that wattle significantly ($p<0.05$) influenced yearling weight of West African dwarf goats and concluded that bilaterally wattled goats were heavier than non-wattled goats. Osinowo *et al.* (1990) observed better ($p<0.05$) weaning weight in wattled Yankasa lambs than in non-wattled lambs. Goats with wattle had longer body length, stood higher at wither and had better chest depth in Longling Yellow Goats of China (Leng *et al.*, 2010). Adedeji *et al.* (2012) reported that chest girth, body length and scrotal length were significantly ($p<0.05$) influenced by presence of wattle in West African dwarf goat. This result was not in line with the findings of Ijomanta (2012) and Stultz (2016) who found no significant influence ($p>0.05$) of wattle in goats.

### 5.2 Effect of Wattle on the Body Weight and Morphometric Parameters of Red Sokoto Does Post-Partum

The results obtained from this study on the body weight of Red Sokoto does after parturition (Table 4.2) revealed that females (does) with wattle mated to wattled bucks had the lowest body weight. The the result obtained in the body weight of does post-partum and the non significant difference in the morphometric parameters is not in line with the findings of Ozoje and Kadir (2001) who reported that wattle gene had significant influence on body measurements such as body length, heart girth and height- at-withers in West African Dwarf Sheep. The results from this study however confirms the findings of Kolo *et al.* (2016) who stated that wattle had no significant difference on the body weight and morphometric parameters of goats in a recent study in Niger State, Nigeria. Ijomanta (2012) also observed no difference in the body conformation traits between Red Sokoto goat having wattle and those without wattle.

### 5.3 Effect of Wattle on the Average Body Weight and Morphometric Parameters of Red Sokoto Bucks Raised Semi Intensively

The superiority of the non wattled bucks in body weight, and head width with the gene having a large effect (0.92 and 0.78 Eta values) on the parameters agree with the findings of Stultz (2016) who concluded that wattle had no significant influence ($p>0.05$) in dairy goats. Ijomanta (2012) observed no difference ($p>0.05$) in body conformation traits between Red Sokoto goats having wattle and those without wattle in Kastina State, Nigeria. This result however is not in line with the findings of Adedeji *et al.* (2012) who reported that wattle significantly ($p<0.05$) influenced the body weight of the West African Dwarft goat. Leng *et al.* (2010) discovered that the presence of wattles in Longling Yellow goats of China is associated with heavier body weights from 18 month of age onward, Odubote (1994) also observed that wattle significantly ($p<0.05$) influenced yearling weight of West African dwarf goats and concluded that bilaterally wattled goats were heavier than non-wattled goats.  Osinowo *et al.* (1990) observed better ($p<0.05$) weaning weight in wattled Yankasa lambs than in non-wattled lambs.

The superiority of the wattled bucks (T2) in the rump length and fore leg length with large effect ( 0.91 and 0.78) is in line with the findings of Adedeji *et al.* (2012); Leng *et al.* (2010):

Odubote (1994); Osinowo *et al.* (1990) who reported that wattle significantly ($p<0.05$) influenced the body weight and other morphometric parameters in goats with the wattled type having the best measurements, but was not inline with the findings of Stultz (2016) and Ijomanta (2012) who found no significant influence ($p>0.05$) of wattle in goats.

## 5.4 Effect of Wattle on the Reproductive Traits of Red Sokoto Does Raised Semi Intensively

The weight of does pre partum appeared to have been affected by the sex of the foetus (Table 4.4). Does where over 50 % of the foetuses resulted in male kids (Table 4.5) ($T_1$, $T_2$ and $T_3$) had heavier body weight pre and post-partum. Jones (2014) studied 68 million human births over the period of 23 years and found out that the less weight a mother gains during pregnancy, the less likely she is to have a male. The results obtained by Soundararajan and Sivakumar (2011) suggested that male kids weighed heavier at birth because male foetus grows faster during prenatal development than females foetus. McNamee (2014) also found out that males grow faster in the womb having greater body length and weight gain than females as a result of more efficient placenta of the male foetus. Chandra *et al.* (2009) documented that male foetuses grow faster than female foetus because of the anabolic effect of male hormones. Dovey (2014) stated that males grow faster from conception; this however puts them at a higher risk of lacking nutrients. If the female (mother) do not gain adequate amount of weight to support male foetus during pregnancy, there is bound to be a foetal loss (Jones, 2014).

The heavier weight of does post-partum in $T_1$, $T_2$ and $T_3$ confirms that the weigth of does before parturition could have been influenced by the sex of the foetuses. The development of larger body size or heavier body weight is a mechanism developed by females during pregnancy to support the growth and development of male foetus who happen to be very demanding nutritionally and could die if thier nutritional needs are not met (Dovey, 2014).

The birth weight of the kids (Table 4.4) falls within the range given by Osuhor *et al.* (2002); Oni (2003); Alaku (2010) and Garba *et al.* (2015) except for kids in $T_4$ where 50 % of the kids were twins. The results obtained could be due to any of these three reason: the first been that 75 % of the kids in $T_2$ are males, second reason is the 0 % twin birth recorded for the $T_2$ and thirdly, it may be because of the cross between the non-wattled does and the wattled bucks. The result is in line with the findings of Adama and Arowolo (2002); Hamayun *et al.* (2006); Alaku (2010); Semakula *et al.* (2010); Soundararajan and Sivakumar (2011); Alkire (2012); Singh *et al*., (2013); Meza-Herrera *et al*. (2014); Garba *et al*. (2015); Future beef, 2018; Ganesh *et al*. (2018); and Gikunju *et al.* (2018) who studied the effect of sex, type of birth and cross breed in goat (kids). The result obtained for the kidding loss most especially in $T_4$ (wattled does mated with wattled bucks) and $T_3$ (wattled does mated with non-wattled bucks) appeared to to have been affected by the litter size, although no material was found to support the statement.

## 5.5 Effect of Wattle on Conception Rate, Abortion Rate, Survival Rate, Type of birth and Sex Ratio of Red Sokoto Does Raised Semi Intensively

The conception rate appeared to have been affected by the rectal temperature (Table 4.5) of does before mating. Non-wattled does mated with non-wattled bucks ($T_1$), non-wattled does mated with wattled bucks ($T_2$) and wattle does mated with non-wattled bucks ($T_3$) which had the lower rectal temperature before mating had up to 50 % conception rate compared to wattled does mated to wattled bucks ($T_4$) that had 25 % conception rate. The results agree with the findings of Turner (2010) who observed a reduction in calving rate due to a 1°C increment in temperature in both British-breed and in Zebu-cross herds. The results obtained by Zakari *et* *al*. (2013) also indicates that elevated rectal temperature, mean maximum and minimum temperatures were detrimental to conception.

Abortion/foetal losses (Table 4.5) were observed in non-wattled does mated with non-wattled bucks ($T_1$) and wattled does mated with wattled bucks ($T_4$) with the highest in $T_4$ (up to 50 %). The foetal losses or abortion rate observed in $T_4$, is higher than the 40 % embryonic and foetal losses reported by Fonseca *et al*. (2005) for tropical environment due to the harsh environmental temperature and humidity which tend to increase the thermal stress of pregnant does. This is true for this experiment as the mean rectal temperature taken for the period of the pregnancy revealed that does in $T_4$ (wattled does mated with wattled bucks) had the highest rectal temperature (Table 4.6). The result obtained in this work however contradicts the earlier speculations of Odubote (1994) that the presence of wattle in goats could be for thermoregulation, as goats in $T_4$ in spite of possessing wattle could not properly regulate their body temperature as evidenced by their higher rectal temperature.

The survival rate of kids (Table 4.5) in $T_4$ (kids resulting from wattled does mated with wattled bucks) was lower than all the other treatments possibly because of the higher number of twins in the treatment. The twinning probably had an effect on birth weight also. Malik *et al*. (1990) found a significant litter size effect on mortality, and attributed this to a lower body weight due to multiple birth. Perez-Razo1 *et al*. (1998) stated that kids weighing more than 3 kg at birth had higher survival than those weighing 2 kg or less.

## 5.6 Pattern of Progesterone Levels of Wattled and Non-Wattled Does Raised Semi Intensively, before Mating, during Pregnancy and after Kidding

The progesterone levels rapidly (Figure 4.1) increased across the treatments a month after mating, this is due to pregnancy which usualy leads to elevation in the blood progesterone level. The result is similar with the findings of Tsutomu *et al*. (1994) who also observed an increase in the plasma progesterone level after mating. Although the result from this current study showed irregular pattern across the treatments, continuous increased in progesterone level was observed as the pregnancy proceeded uptil the fourth month after which there was a marked decrease in the level of serum progesterone in the fifth month. The pattern obtained in this work is similar to the pattern obtained by Katongole and Gombe (1984) in indigenous goats of Uganda where the plasma progesterone was observed to increase until the fourth month, but decreased in the fifth month of pregnancy. Tsutomu *et al*. (1994) also reported an increase in the plasma progesterone from the day 10 to day 140 after mating. The serum progesterone of does used in this work decreased rapidly after birth. This also agrees with the findings of Katongole and Gombe (1984) and Tsutomu *et al*. (1994) who observed a rapid fall in the plasma progesterone level after the does kidded; similar patterns from mating to after kidding or lambing was also observed in the serum progesterone of sheep and goats in Iraq by Alwan *et al*. (2010). The conception rate of the does in the study appeared to have been affected by the level of progesterone before mating because $T_1$ (non-wattle does mated with non wattle bucks) and $T_3$ (wattled does mated with non wattle bucks) had higher progesterone level before mating than other treatments. This agrees with the findings of Pobby (2015) and Baby2see.com, (2018) who stated that levels of progesterone affects fertility and implantation of babies. They also stated that many females with infertility or implantation failures or miscarriages produce low levels of progesterone and needs supplementation.

The decline in the level of serum progesterone in the fifth month in the does, may be due to the does way of preparing for the birth of the kids since higher levels of progesterone help to maintain pregnancy (Pobby, 2015). A critical look at the study reveals that $T_4$ (wattled does mated with wattled bucks) and $T_1$ (non-wattled does mated with non-wattled bucks) had lower progesterone levels on the fifth month; this could be the reason for the higher levels of abortions in the two treatments, with $T_4$ having the highest since 50 % of the pregnancy resulted in twins. Baby2see.com (2018) stated that higher levels of progesterone is needed during pregnancies involving twin or triplets. The low level of progesterone might have resulted from the conditions associated with the weather or pneumonia condition observed during the study, which resulted in many of the abortions. Pobby (2015) however, added that the birth of a healthy child is still possible despite low progesterone levels. Hartwig *et al*. (2013) associated lower levels of maternal progesterone in early stages of pregnancy with reduced birth weight observed in female kids. In sheep, low progesterone levels have also been associated with low lamb birth weight (Wallace *et al*., 1997 as cited by Hartwig *et al*., 2013). Their conclusion agrees with the findings of this work, since $T_4$ (wattled does mated with wattled bucks) that had low birth weight had lower progesterone in the early stages of pregnancy.

## 5.7 Pattern of Oestrogen Levels of Wattled and Non-Wattled Does Raised Semi Intensively, before Mating, during Pregnancy and after Kidding

The marternal oestrogen levels showed a steady increase in all the treatments from the first month after mating up to the fifth month and then declined rapidly after parturition. This agrees with the findings of Alwan *et al*. (2010) who reported had a similar trend in their research study. The rapid decline in oestrogen is to trigger the production of prolactin, the hormone responsible for milk production (Lee, 2019). A critical look at the Figure 4.2 (page 50). reveals that $T_2$ (non-wattled does mated with wattled bucks) and $T_3$ (wattled does mated with non-wattled bucks) had the highest oestrogen level at the fifth month. Wikipedia (2019) stated that breasts are a manifestation of higher levels of oestrogen in females. Lee (2019) opined that high oestrogen levels during pregnancy promotes the development of milk ducts in the breast. The high oestrogen in the two treatments ($T_2$ and $T_3$) before parturition (fifth month) could be responsible for the larger udder circumference and quantity of milk produced throughout the twelve weeks of the experiment (Table 4.7) since oestrogen is responsible for the development of female secondary sexual characters. Maternal hormones during pregnancy has become a useful tool for predicting the sex of the child. This may not be true for this work since $T_4$ (wattled does mated with wattled bucks) with the largest percentage of females at no point had higher levels of oestrogen during the period of the experiment.

## 5.8 Effect of Wattle on the Rectal Temperature of the Red Sokoto Does Raised Semi-Intensively

The rectal temperature of the does before mating in all the treatments fell within the range (38.5-39.7 $^{o}$C) given by Merck Manual. The result favoured all the does irrespective of the mating partners. The result confirms the report of Ozoje (2002) who stated that wattle gives no advantage to goats. This result however does not agree with the suggestions of Odubote (1994) that the possession of wattle in goats could be for thermoregulatory function which help the animal adapt to the environment as all the animals had similar mean rectal temperatures. Adedeji (2012) observed that West African Dwarf (WAD) goats with wattle had significantly lower rectal temperature and pulse rate than non-wattled goats, thus, it is expected that goats with wattle will adapt better to their environment than those without wattle. The lower rectal temperature in $T_1$ (non-wattled does mated with non-wattled bucks) before mating and the first month after mating may be the reason for the high conception rate of the does in the treatment.

## 5.9 Effect of Wattle on Mean Udder Parameters and Milk Yield of Red Sokoto Does kept Semi Intensively

The result obtained for the average udder circumference before and after milking in relation to the milk produced in $T_2$ (non-wattled does mated with wattled bucks), $T_3$ (wattled does mated with non wattled bucks) and $T_4$ (wattled does mated with wattled bucks) agrees with the findings of Sam *et al.* (2017) who observed a positive correlation between udder conformation traits and milk yield. This result also agrees with the findings of Merkhan and Alkass (2011), Moufida (2014) and Patel *et al*. (2016) who also observed positive relationship between udder conformation traits (udder height and udder circumference) and milk yield characteristics (initial yield, average daily yield, peak yield, total yield and lactation length). Strong relationship between udder size and milk yield have also been reported in sheep (Kukovics *et al*., 2006) and in cattle (Kilekoung *et al.,* 2017). This result therefore confirms that increase in udder size would increase milk yield. The higher milk yield obtained in does with wattle and does mated with wattle agrees with the finding of Shongjia *et al.* (1992) who observed significantly ($p<0.05$) higher milk yield in wattled Saanen does. The result is not in line with the works of Stutz (2016) who found no meaningful contribution of wattle in dairy goats.

The result obtained in $T_4$ (wattled does mated with wattled bucks) in relation to its udder circumference and distance between teat with the milk produced could however be attributed to the higher litter or twins obtained in the treatment. This agrees with the findings of Ijomanta (2012) that milk yield increase with increase in litter size. The distance between teat for does in $T_2$ (non-wattled does mated with wattled bucks) and $T_3$ (wattled does mated with non-wattled bucks) were wider which may be the reason why the milk yield in these treatments were among the highest. Upadhyay *et al*. (2014) observed that correlation between teat parameters (except for teat height from ground) and milk yield (average daily milk yield and total milk yield) were significant and positive. Ayadi *et al*. (2014) also reported that daily milk production is positively correlated to distance between teats. Siddik *et al*. (2005) observed a positive significant correlation between teat circumference and daily milk yield.

Presently, materials linking teat length to milk production are scarce. However, data obtained from this work suggest that teat length both before and after milking may have negative influence on milk yield as does in $T_1$ (non-wattled does mated with non-wttled bucks), which had the longest teat length, had the least milk production. $T_4$ (wattled does mated with wattled bucks) had the highest total milk yield of 3709.00 ml and this could be because of the quantity of milk obtained in the peak yield. The small udder circumference (before and after milking), longer teat length (before and after milking) and poor milk yield obtained in $T_1$ (non-wattled does mated with non-wattled bucks) could be because of the pendulous udders of the does in the treatment. This result is in agreement with the findings of Upadhyay *et al*. (2014) who obtained a similar result and attributed it to the pendulous nature of the udders, which was discovered to be inversely proportional to milk yield and therefore, should be considered as a serious factor for disqualification of goats for dairying.

### 5.10 Effect of wattle on colostrum constituent of Red Sokoto does reared semi intensively

The colostrum samples (Table 4.8) in $T_4$ (wattled does mated with wattled bucks) had higher moisture content than any other treatments, which directly affected the availability of other nutrients in the milk including; nitrogen free extract and metabolizable energy. The crude protein, fat and carbohydrates though not showing any significant difference, were also lower than amounts found in the other treatments. This result is in line with the reports of Isaac (2017) who mentioned that increased water content in milk reduces the protein and fat content in the milk. Dairy Foods (2018) reported that moisture content dramatically affect flavour, texture, physical and chemical properties of food as well as sensory perception of food. The moisture content is also an important component in determining the shelf life of food products. Safefood 360 (2014) observed that high moisture content in food encourages microbial growth, and supports chemical and enzymatic reactions as well as food spoilage processes. Other treatments were also affected by water content in the colostrum as the lower moisture contents translated into a better milk in terms of higher nitrogen free extract, metabolizable energy, crude protein and fat.

Wattled does mated with bucks without wattle ($T_3$) had higher vitamin C content in their colostrum compared to wattled does mated to wattled bucks ($T_4$). Vitamin C is regarded as one of the safest and most effective nutrients in milk. Its benefits include: protection against cardiovascular diseases, immune system deficiencies, eye disease and skin wrinkling and prenatal health problems (Zelman, 2018). Higher levels of vitamin C in blood may be the ideal nutrition marker for overall health (Zelman, 2018). According to Ambulance and Health (2016), vitamin C is essential for the synthesis and maintenance of collagen (the most abundant protein in the human body) and basement membrane synthesis (thin sticky layer that support the epithelial cell layer). Vitamin C serve as an essential co-factor for the synthesis of carnitine (an amino acid that is necessary for the transport of fatty acids into mitochondria). Vitamin C is directly involved in the synthesis of neurotransmitter (biological molecules that facilitate the electrical flow between neurons and nerve cells in the body and in the brain). Vitamin C promotes calcium incorporation into bone tissue, is responsible for immune system function and maintenance, acts a powerful antioxidant that neutralizes harmful free radicals and aid in neutralizing pollutants and toxins. Vitamin C is also able to generate other antioxidants such as vitamin E. Vitamin C in combination with zinc help in the healing of wound (Zelman, 2018).

Vitamin C contributes to the health of the teeth and gum, improves the absorption of iron, is needed for the metabolism of bile acids, which may have implication on blood cholesterol level and gall stone. Vitamin C also plays important role in the synthesis of several important peptide hormones, neurotransmitters and carnitine (Zelman, 2018).

## 5.11 Effect of Wattle on Milk Constituents of Red Sokoto Does Reared Semi Intensively

The average moisture content of milk samples obtained from does in $T_1$ (non-wattled does mated with non-wattled bucks) and $T_4$ (wattled does mated with wattled bucks) (Table 4.9) were higher during the twelve weeks of the experiment which also affected the availability of other nutrient (fat, nitrogen free extract, and metabolizable energy). This result agrees with Dairy Foods (2018) that moisture content dramatically affect flavour, texture, physical and chemical properties of food as well as sensory perception of food. The higher moisture content that directly affected the availability of other nutrients in $T_1$ (non-wattled does mated with non-wattled bucks) and $T_4$ (wattled does mated with wattled bucks) could also be one of the factors that contributed to lower body weight and body measurements of kids in the two treatments Mayo Clinic (2018) .

Wattled does mated with wattled bucks in $T_4$ had the lowest vitamin B content. Vitamin B is normally associated with cell health, growth of red blood cells, energy levels, good eye sight, healthy brain function, good digestion, healthy appetite, proper nerve function, proper hormones and cholesterol production, cardiovascular health and muscle tone (Cronkleton, 2018). According to the Mayo Clinic (2018), vitamin $B_{12}$ plays a significant role in nerve function, the formation of red blood cells, and the production of DNA. Vitamin $B_6$ (pyridoxine) is vital for normal brain development and for keeping the immune and nervous system working properly, and help reduce risk of heart disease. Folate (vitamin $B_9$) is in the forefront of mood management, prevent serious birth defects of the brain and spine such as spina bifida in children. B vitamins are tied to lower stroke risk. Vitamin $B_1$ is important for preventing beriberi. Riboflavin (Vitamin $B_2$) boosts the immune system. Vitamin $B_3$ (Niacin) breaks down food into energy. Vitamin $B_5$ is good for healthy hormones (Mayo Clinic, 2018).

Milk samples of does in $T_1$ (non-wattled does mated with non-wattled bucks), $T_2$ (non-wattled does mated with wattled bucks) and $T_3$ (wattled does mated with non-wattled bucks) had high magnesium content. The higher magnesium content in the three treatments could be because of the lower moisture in the milk collected from the does. Magnesium is a mineral that is crucial to the body's function. Magnesium helps keep blood pressure normal, bones strong, and the heart rhythm steady (WebMD, 2018). Magnesium is involved in hundreds of biochemical reactions in the body; it boosts exercise performance and fights depression. Magnesium has benefits against type-2-diabetes, helps to lower blood pressure; it has anti-inflammatory benefits and prevent migraines (Spritzler, 2018).  Magnesium is a cofactor in more than 300 enzyme systems that regulate diverse biochemical reactions in the body, including protein synthesis, muscle and nerve function, blood glucose control, and blood pressure regulation (Institute of Medicine, 1997). Magnesium is required for energy production, oxidative phosphorylation, and glycolysis. It contributes to the structural development of bone and is required for the synthesis of DNA, RNA, and the antioxidant glutathione. Magnesium also plays a role in the active transport of calcium and potassium ions across cell membranes; a process that is important to nerve impulse conduction, muscle contraction, and normal heart rhythm.

Milk samples from does in $T_4$ (wattled does mated with wattled bucks) had the highest iron content compared to non-wattled does mated with non-wattled bucks ($T_1$). One of the main roles of iron is to help red blood cells transport oxygen to all parts of the body. Iron also plays an important role in specific processes within the cell that produce energy for the body. It is for this reason that one of the first symptoms of low body iron stores is tiredness and fatigue (Nestle, 2018). Iron is an essential element for blood production. About 6 % of body iron is a component of certain proteins, and it is essential for respiration and energy metabolism, and also as a component of enzymes involved in the synthesis of collagen and some neurotransmitters. Iron is also needed for proper immune function (University of Califonia San Fransico Medical Center, 2018).

Milk samples collected from non-wattled does mated with wattled bucks ($T_2$) and wattled does mated with non-wattled bucks ($T_3$) had higher calcium than wattled does mated to wattled bucks ($T_4$). Calcium is an essential mineral needed for bone health (Bayer, 2018). Calcium performs two crucial functions in the body: regulating certain body processes and building of bones and teeth (Preserved Articles, 2018; Nemours Foundation, 2018). Calcium helps in building strong bones and teeth in sending and receiving nerve signals in clotting blood, releasing hormones and other chemicals, squeezing and relaxing muscles and keeping a normal heartbeat (Preserved articles, 2018).

The result obtained from correlation analysis between udder parameters and average daily milk yield (Table 4.10 to 4.13) suggest that the traits do not share a common genetic control; therefore, selection for udder parameters may possibly not lead to improvement in the milk yield. The udder parameters either before or after milking did not modify milk yield because their genetic correlations with milk yield were nil or at best low. The results obtained is similar to the findings of Akpa *et al.* (1998b) who discovered that udder circumference and udder height were low in variability in Red Sokoto goats. The result however did not agree with the finding of Ijomanta (2012) who observed that udder size characteristics were positively correlated; implying that improvement in one would lead to improvement in the others thereby leading to improvement in milk production.

## 5.12 Effect of Wattle on the Body Weight and Morphometric Parameters of Red Sokoto Kids Raised Semi Intensively

Kids resulting from crosses between wattled and non-wattled goats ($T_2$ and $T_3$; Table 4.14 to 4.25) showed outstanding results in mean head width and mean hind leg. This could be attributed to the crossing between the wattled and the non-wattled goats as the possession of wattle in goats has been considered as a qualitative trait that could be utilized during selection for productive purposes (Sabbioni *et al*., 2011).

However, head width and fore leg length are not among the parameters listed for genetic improvement in animals. Thiruvenkadan (2005) listed body weight and chest girth as traits worthy of selection and improvement. Hamayun *et al.* (2006) suggested height-at-withers, heart girth and body weight in Beetal goats. Akpa *et al*. (1998a) reported body length, height-at-withers and chest girth in Red Sokoto. Singh *et al*. (1992) listed body weight, body length, heart girth, and height-at-withers at the age of 3 months as traits which gave the highest expected genetic gain at 3 and 6 months of age, and therefore should be selected subsequently for improvement.

### 5.13 Effect of Wattle on Weaning Trait of Red Sokoto Kids Raised Semi Intensively

Kids resulting from $T_2$ (kids of non-wattle does mated with wattled bucks) had the best result in body weight at weaning and weaning weight gain (8.36 and 6.25 repectively; Table 4.26). The result obtained may be because 75 % of the kids in the $T_2$ are males Chandra *et al*. (2009). The survival rate of kids in $T_2$ were higher while those in $T_4$ were lower than those of other treatments. The high survival rate in $T_2$ could be attributed to the higher body weight since 75 % of the kids were males. $T_2$ also had 0 % twin, this contributed to the heavier body weight observed in the treatment while the higher mortality in $T_4$ could be because of the higher number of female and twins in the treatment which are commonly associated with lower weight. Malik *et al*. (1990) observed a significant litter size effect on mortality, and attributed this to a lower body weight due to multiple birth. Perez-Razo1 *et al*. (1998) stated that kids weighing above 3 kg at birth had higher survival rate than those weighing 2 kg or less. Non-wattled does crossed with wattled bucks in $T_2$ had the highest percentage of male (75 %) while crosses between wattled does and no-wattled bucks in $T_4$ had the largest percentage of females at weaning.

### 5.14 Effect of Wattle on the Haematological Parameters of Red Sokoto Does before Mating

The values for haemoglobin concentration before mating (Table 4.27) falls within the range given by Daramola *et al.* (2005). Haemoglobin is the iron-containing oxygen-transport metalloprotein in the red blood cells of all vertebrates (Maton *et al*., 1993). Increased levels of haemoglobin concentration have been linked with greater ability to fight disease infection and low level of haemoglobin is a sign of disease infection or poor nutrition (Tambuwal *et al*., 2002). Wattled does mated with wattled bucks ($T_4$) had the highest haemoglobin concentration. This suggest that they might have higher oxygen carrying capacity, greater ability to resist disease infection and good feed conversion efficiency (since the animals were given the same feed) than the other treatments.

The packed cell volume values in $T_3$ (wattled does mated with non-wattled bucks) and $T_4$ (wattled does mated with wattled bucks) were within the range given by Daramola *et al.* (2005) while those of $T_1$ (non-wattled does mated with non-wattled bucks) and $T_2$ (non-wattled does mated with wattled bucks) fell short of the range. Njidda *et al*. (2014) stated that higher levels of PCV values in sheep might be a sign of healthier sheep. Bishnu (2016) also stated that higher PCV values might likely be a sign of healthier goats. According to Wikihow (2013), the PCV of animals is used to determine their anaemia state. Decreased levels of PCV is usually found in conditions like malnutrition, liver and kidney infection, iron deficiency, diseases of vitamin $B_{12}$ and folic acid deficiencies and pregnancy among other factors (DeMoranville and Best, 2013). Therefore, the high levels of PCV in $T_4$ (wattled does mated with wattled bucks) might be that they are healthier than does in the other treatments. From the result of the haematology of the does, it can be inferred that females in $T_4$ might have higher feed conversion ratio than other treatments; this is because they have higher haemoglobin and PCV than does in the other treatments. Bentrick (1974) stated that haematological traits (PCV and Hb) were associated with the nutritional status of the animal.

The MCV though far above the range given by Daramola *et al.* (2005) showed a significant difference, with does in $T_1$ (non-wattled does mated with non-wattled bucks) and $T_2$ (non-wattled does mated with wattled bucks) having higher values. According to Wikipedia (2013), MCV and the red cell distribution width can be very helpful in assessing a lower than normal haematocrit (PCV), since haematocrit is simply a way of determining how much of the blood volume is made up of red blood cells. The above statement was confirmed in this study, as $T_1$

(non-wattled does mated with non-wattled bucks) and $T_2$ (non-wattled does mated with wattled bucks) showed lower PCV and higher MCV value than does in $T_3$ (wattled does mated with non-wattled bucks) and $T_4$ (wattled does mated with wattled bucks). This may be as a result of reduced capacity of the bone marrow to produce red blood cells or a case of anaemia, since MCV is among the haematological parameters considered aside MCHC and MCH in the diagnosis of anaemia. The three serve as a useful index of the capacity of the bone marrow to produce red blood cells (Awodi *et al*., 2005). Increased MCV may also be observed in regenerative anaemia due to haemolysis and haemorrhages (Cheesbrough, 2004). Higher MCV values indicates macrocytosis (Coles, 1980).

Does in $T_2$ (non-wattled does mated with wattle bucks) showed higher MCH values than does in the other treatments. This could be as a result of anaemia or reduced capacity of the bone marrows to produce red blood cells, since MCH is among the haematological parameters listed as index of the capacity of the bone marrow to produce red blood cells (Awodi *et al*. 2005).

The percentage of eosinophils fell short of the range given by Daramola *et al*. (2005) except for $T_1$ (non-wattled does mated with non-wattled bucks). Eosinophils, like neutrophils, are responsible for the release of protein cytokines and chemokines that produce inflammation but are able to kill invading organisms (Bishnu, 2016). Eosinophil, like neutrophils, are very effective killing machine (Ganong, 2005). They are especially abundant in the mucosa of the gastrointestinal tract where they defend against parasites; and in the mucosa of respiratory and urinary tracts (Devendra, 1977). The results from this study especially on Hb, PCV, MCV and MCH are in line with the reports of Adedeji *et al.* (2011) who observed that wattle had significant effect on RBC, WBC, Hb, and $K^+$ of West African Dwarf goats.

## 5.15 Effect of Wattle on the Serum Biochemistry of Red Sokoto Does before Mating

Serum electrolytes like sodium in does before mating (Table 4.28) is known to maintain membrane potentials, regulate osmotic pressure and acid base balance and transmit nerves impulses. Sodium deficiency affect kidney tubes resulting in inability to concentrate urine (Latimer *et al*., 2004). Common symptoms of low blood sodium include weakness, fatigue, headache, nausea, vomiting, muscle cramps, confusion and irritability, severe cases could cause loss of consciousness, seizures and coma ((Latimer *et al*., 2004). The sodium level in this experiment was observed to be above the level given by Daramola *et al.* (2005) for West African Dwarf goats; with $T_2$ (non-wattled does mated with wattled bucks), $T_3$ (wattled does mated with non-wattled bucks) and $T_4$ (wattled does mated with wattled bucks) having higher serum sodium concentration. This may be due to dehydration as the blood samples were collected during the heat season (April). James (2018) stated that high level of sodium in blood (hypernatremia) could be caused by dehydration, which could be due to different reasons which include not drinking enough liquid, diarrhoea and kidney dysfunction. This could cause the animals to be thirsty and in worse cases, may cause confusion, muscular twitches and seizures.

The serum potassium for all the treatments were within the range given by Daramola *et al.* (2005) with does in $T_1$ (non-wattled does mated with non-wattled bucks) having higher potassium levels. Serum potassium helps to maintain membrane potentials, regulate osmotic pressure, acid base balance and transmit nerve impulses. Potassium deficiency, like sodium, affects the kidney tubes; resulting in inability of the kidney to concentrate urine (Latimer *et al*., 2004). The results obtained from this study agrees with the results of Adedeji *et al.* (2011) who discovered that wattle had significant influence on potassium ($K^+$) of West African Dwarf.

Does in $T_4$ (wattled does mated with wattled bucks) had the highest calcium level of 2.61 mmo/l. Calcium is an essential mineral needed for bone and teeth health, regulating certain body processes such as squeezing and relaxing muscles, releasing hormones and other chemicals, sending and receiving nerve signals, keeping a normal heartbeat and clotting (Bayer, 2018; Preserved Articles 2018; Nemours Foundation, 2018).

Does in $T_2$ (non-wattled does mated with wattled bucks) had the highest chloride content of 78.68 mmo/l. Chloride is among the essential electrolytes in the blood as it helps to balance the amount of fluid in the cells. The chloride in the blood serum is however lower than the range as given by Daramola *et al.* (2005). This is probably because the samples were collected in the month of April, which is usually hot as this causes the animals to loose body fluids due to excessive sweating (Chemocare, 2019). Does in $T_4$ (wattled does mated with wattled bucks) had the highest phosphorus in their blood serum. The body requires phosphorus to build and repair teeth and bones; it helps the nerves to function properly and makes muscles to contract (Chemocare, 2019).

Does in $T_1$ (non-wattled does mated with non-wattled bucks) and $T_4$ (wattled does mated with wattled bucks) had higher levels of cholesterol than the recommended range and this puts the does in these treatments at a higher risk of heart diseases (Mayo clinic, 2019). The bilirubin levels in all the treatments were higher than normal but does in $T_4$ (wattled does mated with wattled bucks) had higher values of bilirubin, which is a sign that the red blood cells were breaking down at an abnormal rate or that the liver is not breaking down waste properly and clearing the bilirubin from the blood.

## 5.16 Effect of Wattle on the Haematological Parameters of Red Sokoto Does after Birth

The haematology of does after parturition (Table 4.29) shows that the MCH of does were far above the range given by Daramola *et al*., (2005) for West African Dwarf goats. The higher levels of MCH obtained in this study could be due to the age and breed difference between the Red Sokoto breeds used in this work and the West African Dwarf goats used by Daramola *et al.* (2005). Osinowo *et al*. (1988) suggested that breed difference appear to modify the effect of wattle. Arfuso *et al*. (2016) also stated that haematological indicies in healthy goats show some difference in relation to breed and age. The higher MCH of wattled does mated with non-wattled bucks ($T_3$) might probably be because of the increased activity of bone marrow and deficiency of some haemopoietic factors. MCH is one of the haematological parameters listed in the diagnosis of anaemia and also act as a useful guide to reveal the capacity of the bone marrow to produce red blood cells, aside MCV and MCHC (Awodi *et al*., 2005; Bishnu, 2016). The MCHC values obtained in this study agrees with those given by Daramola *et al.* (2005) for West African Dwarf goats except for non-wattled does mated with wattle bucks ($T_2$). This may be due to anaemia or an increase in the activity of the bone marrow. Awodi *et al*. (2005) and Etim (2013) listed MCHC as one of the important haematological parameters for the diagnosis of anaemia and serve as a useful index of the capacity of bone marrow to produce red blood cells.

The WBC in $T_1$ (non-wattled does mated with non-wattled bucks) and $T_3$ (wattled does mated with wattled bucks) were within the range given by Daramola *et al.* (2005) while those in $T_2$ (non-wattled does mated with wattled bucks) and $T_4$ (wattled does mated with wattled bucks) were not within the range. Does in $T_4$ (wattled does mated with wattle bucks) were observed to have the highest WBC (above the range). This may be due to the presence of infection or a toxic substance in the body of the does. Higher WBC is an indicator of immune response to illnesses or diseases or toxin in an organism (Bradbury *et al*., 1999). According to Etim (2013), over the upper limits of white blood cell (leukocytosis) indicates problem; these could include: stress, infection, allergy, inflammation, trauma, or certain diseases. Therefore, elevated levels of white blood cell count needs further investigation. Braun (2013) stated that high white blood cell count might be as a result from stress, disorder in the immune system, and infection. It was also reported in other studies that high number of leucocytes may be due to infectious diseases, bone marrow tumour, anaemia, severe physical stress, inflammatory disease or tissue damage (example, burns) (Bagby, 2007; Dugdale, 2011). The significant effect of wattle on haematological parameters (MCH, MCHC and WBC) is in line with the observations of Adedeji *et al.* (2011) who stated that wattle had significant influence on RBC, WBC, Hb, and $K^+$ of West African Dwarf goats.

## 5.17 Effect of Wattle on the Serum Biochemistry of the Red Sokoto Does after Birth

In serum biochemistry after parturition (Table 4.30). $T_2$ (non-wattled does mated with wattled bucks), $T_3$ (wattled does mated with non-wattled bucks) and $T_4$ (wattled does mated with wattle bucks) had higher and above the normal range values for sodium. This may be due to harmatan wind or the hot environmental temperature of Minna during October month. James (2018) stated that high level of sodium in blood (hypernatremia) could be caused by dehydration, which could be because of many reasons which includes: not drinking enough liquid, diarrhoea and kidney dysfunction. This could cause the animals to be thirsty and in worse cases, may cause confusion, muscular twitches and seizures.

Does in $T_1$ (non-wattled does mated with non-wattled bucks) had higher serum potassium while does in the other treatments were within the normal range given by Daramola *et al*. (2005). Mayo Clinic (2019) stated that hyperkalemia could be as a result of the rupture of blood cells in the blood samples shortly after blood collection. The ruptured cells leak their potassium into the sample, thereby raising the amount of potassium in the sample. Since kidney dysfunction was not suspected, focus is shifted to the rupture of blood cells in the samples collected.

Does in $T_2$ (non-wattled does mated with wattled bucks), $T_3$ (wattled does mated with non-wattled bucks) and $T_4$ (wattled does mated with wattled bucks) had the highest calcium levels. Calcium is an essential mineral needed for bone and teeth health, regulating certain body processes such as squeezing and relaxing muscles, sending and receiving nerve signals, keeping a normal heartbeat, releasing hormones and other chemicals, and clotting blood (Bayer, 2018; Preserved Articles 2018; Nemours Foundation, 2018; Medline Plus, 2018). Does in $T_4$ (wattled does mated with wattled bucks) had the highest phosphorus in the blood serum. The body requires phosphorus for proper nerve functioning, building and repairs of bones and teeth and helps muscluar contraction (Chemocare, 2019). Does in $T_4$ (wattled does mated with wattled bucks) and $T_1$ (non-wattled does mated with non-wattled bucks) had higher levels of cholesterol and this put the does in these treatments at a higher risk of heart diseases (Mayo Clinic 2019). Although the total protein was within the normal range given by Daramola *et al.* (2005), does in $T_4$ (wattled does mated with wattled bucks) had higher levels. This may be caused by a particular condition or symptom, as certain blood proteins elevates as the body fight infection or inflammations (Mayo Clinic, 2019). The total bilirubin levels in all the treatments had higher range of bilirubin than the ones given by Daramola *et al*. (2005) which indicates that the red blood cells are being breaken down at an abnormal rate or the liver is not breaking down waste properly and clearing the bilirubin from the blood.

### 5.18 Effect of Wattle on the Haematology of Red Sokoto Bucks Raised Semi Intensively

The white blood cells of the bucks (Table 4.33) were within the range given by Daramola (2005). The higher white blood cells in bucks without wattle might be due to higher rate of infection or a toxic substance in the body of the bucks. According to Veterinary Drug Handbook (2009), active viral infection encourages the immune system to generate higher levels of white blood cells. Higher WBC indicates immune system response to infections or toxins in an organism (Bradbury *et al*., 1999). Etim *et al*. (2013) stated that over the upper limits of white blood cell (leukocytosis) indicates problem: these could include; stress, infection, allergy, inflammation, trauma, or certain diseases.

Bucks without wattle ($T_1$) had higher lymphocytes. Although the values were within the range given by Daramola *et al.* (2005), it might be due to infection (viral) or toxic substance in the body of the bucks. According to Veterinary Drug Handbook (2009), active viral infection encourages the immune system to generate higher levels of lymphocytes. Lymphocytes are concerned with the protection of the body agaist viral infections. Higher levels may indicate viral-related infection (Goatlink.com, 2009). Lymphocyte count above normal range can be a temporary and harmless situation due to body’s normal response to infection or inflammatory condition. However, high level of lymphocytes could be a sign of lymphocytosis (a condition normally connected with chronic infection, severe blood cancer and some diseases such as inflammatory bowel diseases) which is a more serious condition (Silva, 2018). Cleveland Clinic (2018) stated that high lymphocyte values indicates that the body is infected or have some form of inflammation; sometimes lymphocyte level are elevated due to a serious condition like leukemia lymphocytosis.

Bucks with wattle had higher neutrophils values than bucks without wattle. This may be an indication of active infection regardless of the fact that the value was within the normal range. High levels of neutrophil is usually associated with infection. Neutrophil are also known as segmented neutrophils or granulocytes, and are the major defender of the body against antigens and infection. High levels may indicate an active infection (Goatlink.com, 20 09). High neutrophis may be due to medical conditions like infection, stress, leukaemia, arthritis, acute kidney failure, medication effects and others (Medline Plus, 2018).

The serum biochemistry of bucks (Table 4.34) shows that bucks with wattle had higher HDl (high-density lipoprotein) than those without wattle. HDL. HDL is a microscopic blob that consists of a rim of lipoprotein that surrounds a cholesterol center. The HDL cholesterol particle is dense compared to the other types of cholesterol particles; so it is called high-density. Experts believe HDL cholesterol helps to reduce the risk of heart disease (WebMD Medical Reference, 2018). They help to maintian the inner walls (endothelium) of blood vessels. Damage to the inner walls is the first step towards atherosclerosis, which results in heart attacks and strokes (WebMD Medical Reference, 2018). HDL is called 'good' cholesterol, as it prevents the buildup of cholesterol by removing excess cholesterol out of cells and the blood. This prevents poor circulation of blood, which may result to stroke, high blood pressure, kidney damage and other heart diseases (Waugh, 2008; MedlinePlus, 2018). Higher levels of HDL is better as people with high levels are reported to have  lower risk of heart attack and stroke (Mayo Clinic 2018).

# CHAPTER SIX

## 6.0 CONCLUSIONS AND RECOMMENDATIONS

### 6.1 Conclusions

Based on the results obtained from this study, the following conclusions were made:

1. Wattle had significant ($p<0.05$) effect on the initial body weight and linear body measurements of Red Sokoto does before mating. Non-wattled does mated with wattled bucks ($T_2$), had the shortest ($p<0.05$) body length before mating. Non-wattled does mated with non wattled bucks ($T_1$), had the smallest in head width. Wattled does mated with wattled bucks ($T_4$) and non-wattled does mated with non-wattled bucks ($T_1$) had the longest foreleg length.

2. Wattle significantly ($p<0.05$) affected the body weight of does after birth with wattled does mated with wattle bucks having the lowest body weight.

Wattle had significant ($p<0.05$) influence on the reproductive performance of Red Sokoto does. Wattled does mated with wattled buck ($T_4$) had the lowest weight of doe pre and post-partum and highest kidding loss and least in birth weight. Wattled does produced higher litter size (upto 50 % twins).

Females mated with non wattled bucks ($T_1$) and ($T_3$) had the highest conception rate of up to 62.5 %.

Mating between the wattled and non-wattled ($T_2$ and $T_3$) had 0 % abortion.

Mating between non-wattled does mated with wattled bucks ($T_2$) produced the highest number of males (up to 75 %) while mating between wattled does mated with wattled bucks ($T_4$) had the largest percentage of female kids (66.7 %).

3. Wattle had significant ($p<0.05$) influence on the milk and udder parameters examined.

Crosses between the wattled and the non wattled had the highest in terms of udder circumference before and after milking, in quantity of milk and average daily milking. Wattled does in $T_3$ and $T_4$ produced the highest peak yield. Wattled does mated with wattled bucks ($T_4$) had the highest total milk yield.

4. Wattle had significant ($p<0.05$) influence on the average body weight and morphometric parameters of Red Sokoto kids. Kids resulting from both parents having wattle had the least in the average head width and average hind leg.

5. Wattle had significant ($p<0.05$) effect on body weight, survival rate, sex of kids and type of birth of Red Sokoto kids at weaning. Non-wattled does mated with wattled bucks ($T_2$) had the highest body weight, survival rate (100 %) and number of male kids at weaning. Wattled does mated with wattled bucks ($T_4$) had the largest percentage of female (66.7 %) kids and up to 50 percentage twin.

6. Wattled does and bucks had higher HDL, which brought about lower blood cholesterol levels. Wattle had no significant ($p>0.05$) influence on haematology and serum biochemistry of the kids uptill weaning.

7. Wattle had no significant ($p>0.05$) influence on the semen and scrotal parameters of Red Sokoto bucks used.

## 6.2 Recommendations

The following recommendations are drawn from the results of this study.

i. attention should be focused on the mating between the wattled and the non-wattled strains of Red Sokoto as it gave best result in most parameters examined for the kids.

ii. research studies focused on body weight and morphometric parameters after weaning on haematology and serum biochemistry, reproduction and milk production should be carried out in crosses of Red Sokoto breeds. This may bring about the needed improvement in the areas listed above.

iii. deliberate efforts must be made to preserve the wattle gene to avoid the goats carrying the gene from going to extinction.

## REFERENCES


Abba, Y. & Igbokwe, I. O. (2015). Testicular and related size evaluations in Nigerian Sahel Goats with optimal cauda epididymal sperm reserve. *Veterinary Medicine International*, 23, 1-7.

Adama, T. Z. & Arowolo, I. O. (2002). Body weight and body condition of Yankasa lambs and Savanna Brown goat kids from birth to 100 days of life. *Journal of Agriculture, Science and Technology*, 2, 92-96.

Adebayo, J. O. & Chineke, C. A. (2009). Evaluation of West African dwarf goat for some qualitative traits in Southwestern Nigeria. *African Journal of Agricultural Research,* 6(28), 6204-6207.

Adedeji, T. A. (2012). Effect of some qualitative traits and non-genetic factors on heat tolerance attributes of extensively reared West African dwarf (WAD) goats. *International Journal of Applied Agricultural and Apicultural Research,* 8 (1), 68-81.

Adedeji, T. A., Ozoje, M.O., Peters, S.O., Sanusi, O.A., Ojedapo, L. O. & Ige, A. O. (2011). Coat pigmentation and Wattle Genes' effect on some Haematological Characteristics of Heat Stressed and Extensively Reared West African Dwarf Goats. *World Journal of Life Science and Medical Research*, 1(3), 48-55.

Adedeji, T. A. Ozoje, M. O. Otunta, T.A. Ojedapo, L. O. Ojediran, T. K. & Ige, A. O. (2012). Effect of Wattle Trait on Body Sizes and Scrotal Dimensions of Traditionally Reared West African Dwarf (WAD) Bucks in the Derived Savannah Environment. *Iranian Journal of Applied Animal Science,* 2(1), 69-72.

Adeyinka, I. A. & Mohammed, I. D. (2006). Relationship of live weight and linear body measurement in two breeds of goat of Northern Nigeria. *Journal of Animal Science*. *Veterinary Advances*, 5(11), 891-893.

Agrodok. (2015). Goat Keeping useful management practices for smallholder. CTA Publications Distribution Service, P.O. Box 173 6700 AD Wageningen. Netherlands. Pp: 53-63

Akpa, G. N., Duru, S. & Amos, T. T. (1998a). Influence of strain and sex on estimation of Within age group body weight of Nigerian Maradi goats from their linear body measurements. *Tropical Agriculture* (Trinidad), 75(4), 462-467.

Akpa, G.N., Duru, S., Dim, N. I., Alawa, J. P. & Jokthan, G. E. (1998b). Sources of variation in udder traits of Red Sokoto goats. *Proceedings: of the Silver Anniversary Conference of Nigeria Society for Animal Production.* 21 – 26, March. Abeokuta, Nigeria. Pp: 638 – 639.

Akpa, G. N. (1999). Evaluation of dairy characteristics and lactation curves of small-holder Red Sokoto (*Maradi*) goats.Ph.D. thesis, Ahmadu Bello University, Zaria, Nigeria.

Akpa, G. N., Asiribo, E. O., Oni O. O. & Alawa, J. P. (2001). The influence of non-genetic factors on the shape of lactation curves in Red Sokoto goats. *Animal Science*, 72, 233-239.

Akpa, G.N., Asiribo, O. E., Oni, O.O., Alawa, J. P., Dim, N. I., Osinowo, O. A. & Abubakar, B. Y. (2002). Milk production by agropasturalist Red Sokoto goats in Nigeria. *Tropical Animal Health Production,* 34(6), 525 – 533.

Akpa, G.N., Asiribo, O.E. & Oni, O.O. (2003). Relationships among udder and teat size characteristics with milk yield in Red Sokoto goats. *Tropical Agriculture and the Environment*, 5, 204 – 213.

Alaku, S. O. (2010). *Introduction to Animal Science*. Jee communication, Enugu. Nigeria. P: 170.

Alkire, D. (2012) Advantages of cross breed. www.nobel.org/news/publications/ag-news-and-news/2012/april/the-advantages-of-crossbreeding/. Retrieved 1 April, 2012.

Alwan, A. F., Amin, F. A. M. & Ibrahim, N. S. (2010). Blood progesterone and estrogen hormones level during pregnancy and after birth in iraqi sheep and goat. *Basrah Journal Veterinary Research*., 10 (2), 153-157.

Ambulance and Health (2018). The six important roles of vitamin C. www.abundancehealth.co.uk. Retrieved 15 January, 2019.

American Goat Society (2009). Polled Genetics. www.americangoatsociety.com/education/polled_genetics.php

Anonymous. (2011). Supernumerary Teats. 2011. calfology.com/../supernumerary-teats.

Arfuso, F., Fazio, F., Rizzo, M., Marafioti, S., Zanghì, E. & Piccione1, G. (2016). Factors Affecting the Hematological Parameters in Different Goat Breeds from Italy. *Annal of Animal Science,* 16(3), 743–757.

Awake Magazine South Africa (2004). July 22, 2004.

Awodi, S, Ayo, J. O, Atodo, A. D. & Dzende, T. (2005). Some Haematological Parameters and the Erythrocyte Osmotic Fragility in the Laughing Dove (*Streptopella senegalensis*) and the village weaver bird (*Ploceus scucullatus*). In: Chineke, C. A;

Ayadi, M., Abdelkarim, M. M., Riyadh, S.A. & Mohammed, A.A. (2014). Evolution of udder morphology, alveolar and cisternal milk compartment during lactation and their relationship with milk yield in Najdi sheep. *Spanish Journal of Agricultural Reseach,* 12(4), 1061-1070.

Baby2see.com (2018). Progesterone tests and levels in pregnancy. Pregnancy Information from: www.Baby2see.com. Retrieved 6 March, 2018.

Bagby, G. C. (2007). Leucopenia and leucocytosis. In: Goldman L. Ausiello D. (eds). Cecil Medicine, 23rd edition. Philadelphia. Pa: Saunders Elsevier, 173.

Barazandeh, A., Moghbeli, S.M., Vatankhah, M. &Mohammadabadi, M. (2012). Estimating non-genetic and genetic parameters of pre-weaninggrowth traits in Raini Cashmere goat. *Tropcal Animal Health Production*, 44, 811–817.

Bayer (2018) Importance of Calcium — Go Deeper for Bone Health. http://www.bayer.us/en/csr-and-sustainability/transparency-in-supply-chains/. Retrieved 12 December, 2018

Belanger, J. & Bredesen, S. T. (2010). Basic information about goats "Storey's Guide to RaisingDairy Goats",2nd edition. Storey Publishing, North Adams, pg 14.

Bencini, R., Knight, T. W. & Hartmann, P. E. (2003). Secretion of milk and milk component in sheep. *Australian Journal of Experimental Agriculture*, 43, 524- 532.

Bentrick, S. (1974). Haematology, Textbook of Veterinary Pathology. Publ. Williams and Co Baltimore, 217-224.

Berndtson, W. E. (1977). Methods for quantifying mammalian spermatogenesis: A review. *Journal of Animal Science*, 44 (5). 818–833.

Bishnu, C. P. (2016). Evaluation of haematological and biochemical parameters of goats of Central Odisha environment fed on natural grazing land of Odisha, India. *The Pharma Innovation Journal*, 5(5), 83-90.

Bounthavone, K., Vanthong, P. & Preston, T.R. (2010). Effects of fresh or sundried cassava ongrowth performance of goats fed basal diets of Gamba grass or sugar cane stalk. *Livestock Research for Rural Development*, 22 (202).

Boujenane, I. & El-Hazzab, A. (2008). Genetic parameters for direct and maternal effects on body weights of Draa goats. *Small Ruminant Research*, 80, 16–21.

Bradbury, M. G, Egan, S. V. & Bradbury, J. H. (1999). Determination of all forms of cyanogen in cassava roots and cassava products using picrate paper kits. Clinical cases of small ruminants in Zaria, Nigeria. *Bulletin of Animal Heath and Production in Africa*, 30, 111-116. 15

Bratte, A., Ari, J. & Ikhimioya, A.I. (1999). Age and body weight and their relationship with testicular and horn development in Yankasa. West Afraican Dwarf cross breed Rams. *Journal of Applied Animal Research* (India), 1971-2119

Braun, P. (2013). High white blood cell count. What you should know? Inside Tracker. Available at: Bunn, H. F. (2011). Approach to the anaemias. In: Goldman, L., Schaffer, A. I. eds. Cecil Medicine. 24th ed. Philadelphia, Pa: Saunders Elsevier, 161.

Casu, S., Boyazoglu J.G. & Lauvergne J. J. (1970). The Inheritance of wattles in the Sardinian breed of sheep. *Annales de Genetique et Selection Animale*., 2**,** 249-261.

Chandra, R., Karmkar, H. D., De, D., Kumar, S. and Rahman, H. (2009). Factor influencing birth weight of Sikkim local kids. *Indian Journal of Small Ruminants*, 15(1), 113-114.

Charon, K. M. (1990). Genetic Parameters of Morphological trait of sheep udder. *World Review of Animal Production*, 25, 73 – 79.

Chemocare (2019). Hypochloremia. chemocare.com/chemotherapy/sideeffects/ hypochloremia-low-chloride.aspx. retrieved 12 January, 2019.

Cheesbrough, M. (2004). District Laboratory Practice in tropical Countries, Part 2. UniversityPress Cambridge, United Kingdom, 9, 266-342.

Cisse, M. l., Nianogo, I., Sane, J.G., Sawodago, M., Ndiaye, C., Awad, A. J. & Fall, Y. (2002). Grazing behaviour and milk yield of Senegalese Sahel goat. *Small Ruminant Research*, 43(1), 85- 93.

Cleveland Clinic (2018). Lymphocytosis. https://my.clevelandclinic.org/health/diseases/ 17751-lymphocytosis. 12 January 2018

Coles, E. H. (1980). Veterinary Clinician Pathology 3rd Edn. W.B. Sanders Co Philadelphia. Pp: 10-20.

Coras, B., Hafner, C., Roesch, A., Vogt, T., Landthaler, M. & Hohenleutner, U. (2005). Congenital cartilaginous rests of the neck (wattles). *Dermatologic Surgery*, 31, 1349-50.

Cronkleton, E. (2018). Why Is Vitamin B Complex Important, and Where Do I Get It? https://www.healthline.com/medical-team. Retrieved 2 April 2018.

Daramola, J. O., Adeloye, A. A., Fatoba, T. A. & Soladoye, A. O. (2005). Haematological and serum biochemical parameters of West African Dwarf (WAD) goats. Livestock Research for Rural Development, 17(8). Available at: http://www.irrd.org/irrd17/8/dara17095.htm.

Dawson, L. J., (1999). Pregnancy Diagnosis in Goats. *in Proceedings of the 14th Annual Goat Field Day, Langston University, Langston, UK. Pp: 97-103.*

Dairy Foods (2018). Moisture, Ash Testing in Food Processing. Pp. 1-21 https://www.dairyfoods.com/directories/7376-dairy-plants-USA. Retrieved 30 June 2010

Demoranville, V. E. & Best, M. A. (2013). Haematocrit. Encyclopedia of Surgery: A guide for patients and caregivers. Available at: enwikipedia.org/wiki/haematology.

Devendra, C. (1977). Cassava as feed source for ruminants. In: Cassava as animal feed. In: B. Nestel and M. Grasham. (eds.) IDRC – 095e Guelph, 107-127.

Devendra, C. (2000). Animal production and rain fed agriculture in Asia. Potential opportunities for productivity enhancement. *Out Look Agriculture*, 29(3), 161-175.

Dovey (2014). The womb makes it easy being a girl: how the placenta protects a girls more than boys. Medical daily. https://www.medicaldaily.com/womb-makes-it-easy-being-girl-how-placenta-protects-girls-more-boys-285690. May 31, 2014

Dugdale, D. C. (2011). White Blood Cell Count. Medline Plus.

Egwu, G. O., Onyeyili, P. A., Chibuzo, G. A. & Ameh, J. A. (1995). Improved productivity of goats and utilisation ofgoat milk in Nigeria. *Small Ruminant Research*, 16, 195-201.

Etim, N. N., Enyenihi, G. E., Williams, M. E. Udo, M, D., & Offiong, E. E. A. (2013). Haematological Parameters: Indicators of the Physi ological Status of Farm Animals. *British Journal of Science*, 10 (1), 37 -47.

FAO (2012). Animal genetic resource data banks- 2. Descriptor lists for cattle, buffalo, pigs, sheep and goats. *Animal Production and Health Paper* (Rome, Italy), 59/2.

Federal University of Technology Minna (2018). Student Hand book. Produced by Office of the Vice Chancellor Student Affairs Division. P1.

Fiascofarm.com (2009). Teeth, life expectancy and how to estimate a goat's age. *http://fiascofarm.com/goats/age.htm*. Retrieved 30 May 2009.

Fonseca, J. F., Torres, C. A. A., Costa, E. P., Maffili, V. V., Carvalho, G. R., Alves, N. G. & Rubert, M. A. (2005). Progesterone profile and reproductive performance of estrous-induced Alpine goats given HCG five days after breeding. *Animal. Reproduction*, .2 (1), 54-59.

Future Beef (2018). Crossbreeding system for beef cattle. https://futurebeef.com.au/knowledge-centre/crossbreeding-systemss-for-beef-cattle/.

Gall, C. (1980). Relationship between body conformation and production in dairy goats. *Journal of Dairy Science*, 63 (10), 1768-1781.

Garba, Y., Muhammad, I. R., Muhammad, B. F. & Maigandi, S. A. (2015). Reproductive performance of Red Sokoto Goats from a semi-intensive management system in semi-arid zone, Nigeria. *International Journal of Scientific Research in Science and Technology*, 1(3), 56- 59.

Ganesh, R. J., Mahesh, D. Vinod, B. & Shankar L. F. (2018). Factors Affecting Birth Weight in Sirohi Goat Kids. *International Journal of Current Microbiology and Applied Science*, 7(5), 2627-2631.

Ganong, W. F. (2005). Review of Medical Physiology, 22nd edition. McGraw Hill Medical Publication Asias Pp. 459- 516-532.

Garcia, A. M. K., Neary, G., Kelly, R. & Pierson, R.A. (1993). Accuracy of ultrasonography in early pregnancy diagnosis in the ewe. *Theriogenology,* 39, 847-861.

Gikunju, M. M., Kabuage, L.W., Wachira, A., Oliech, G. W & Gicheha, M. G. (2018). Evaluation of purebreds, crossbreeds and indigenous chicken egg quality traits in Kenya. *Livestock research for rural development*. 30 (10). http://www.lrrd.org/lrrd30/10/giche30170.html

GoatLink.com (2009). Goat blood values. Pp113. http://goatlink.com/component/option,com_search/Itemid,5/. August, 05 2009.

Gonalez, F.C., Batista, M., Rodriguez, N., Alamo, D., Sulon, J., Beckers, J.F.& Gracia, A. (2004). A comparison of diagnosis of pregnancy in the goat via transrectal ultrasound scanning, progesterone and pregnancy-associated glycoprotein assays. *Theriogenology,* 62, 1108-1115.

Hamayun, K., Muhammed, F., Ahmad, R., Nawaz, G., Rahimullah, N. & Zubair, M. (2006). Relationship of body weight with linear body measurements in goats. *Journal of Agricultural and Biological Science,* 1(3), 51 – 54.

Hartwig, I.R., Pincus, M. K., Diemert, A., Hecher, K., & Arck, P.C. (2013) Sex-specific effect of first trimester maternal progesterone on birth weight. *Human Reproduction*, 28 (1),77-86.

Haenlein, G. F. W. (1992). Role of goat meat and milk in human nutrition. In: *Proceedings of the 5$^{th}$ Nenaional Conerence on Goats. New Delhi, India*. Pp: 575 – 580.

Hassan, A. & Ciroma, A. (1992). Body weight measurement relationship in Nigerian Red Sokoto Goats. *In: Proceedings of the First Biennial Conference, African Small Ruminant Research Network*, Nairobi, *Kenya, ILCA, Pp. 491 – 497.*

Hirst, K. & Kris. (2008). The History of the Domestication of Goats.*About.com*. Accessed August 18. http://archaeology.about.com/od/domestications/qt/goat.htm

Igbokwe, I. O., Abba, Y., Geidam, S. U. & Igbokwe, N. A. (2014). Sperm output from unilateral cryptorchid Sahel goats, *Comparative*. *Clinical Pathology*, 23(4), 819–822.

Ijomanta, O. E (2012). Genetic profile of morphological traits and their association with production capacity of the Red Sokoto goat in Katsina State of Nigeria. M.sc Thesis from Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria.

Imagawa, T., Kon, Y., Kitagawa, H., Hashimoto, Y., Uehara, M. & Sugimura, M. (1994) Anatomical and histological re-examination of appendices colli in the goat. *Annals of Anatomy,* 176, 175–179.

Institute of Medicine (1997). Food and Nutrition Board. Dietary Reference Intakes: Calcium, Phosphorus, Magnesium, Vitamin D and Fluoride. Washington, DC: National Academy Press.

Isaac, N. (2017) Are there any adverse effects to mixing milk with water**?** https://www.quora.com/MTE5OTI1OTI5NzIyOTQ5NzU5M3wyMTExMDYyMzM0NzMxNjd8MA**/luno-124. Retrieved 15 May 2017

Jafaroghli, M., Rashidi, A., Mokhtari, M.S. & Shadparvar, A. A. (2010). Co-variance components and genetic parameter estimates for growth trait in Moghani sheep. *Small Ruminant Reseach*, 91, 170–177.

James, I. J., Osinowo, O. A. & Ajeabile, L.T. (2005). Factors affecting milk yield in WestAfrican Dwaft Goats. *Proceedings of the 30th Annual Conference of Nigerian Society of Animal Production*, 20-24 March, University of Nigeria, Nsukka, 30, 19-21.

James, L. L. (2018). Hypertremia. MSD Manual Consumer version. https://www.msdmanuals.com/home/hormonal-and-metabolic-disorders/electrolyte-balance/hypernatremia-high-level-of-sodium-in-the-blood.

Jennes, P. (1980). Composition and characteristics of goat milk. Review 1968-1979. *Journal of Dairy Science*, 63, 1605-1630.

Jones, S. B. (2014). Pregnancy linked to the sex of a baby. Modern medicine network. Retrieved December 26, 2014. https://www.obgyn.net/weight-management

Kafi, M., Safdarian, M. & Hashemi, M. (2004). Seasonal variation in semen characteristics, scrotal circumference and libido of Persian Karakul rams. *Small Ruminant Reseach*, 53, 133-139.

Katongole, C. B. & Gombe, S. A. (1985). A study of the reproductive hormones of indigenous goats in Uganda. hppt://www.fao.org/wairdocs/ilri/x5464b/x5464b1a.gif

Keeton, L. L., Green, R. D., Golden, B. L. & Anderson, K. J. (1996). Estimation of variance components and prediction of breeding values for scrotal circumference and weaning weight in Limousin cattle. *Journal of Animal Science*, 74, 31-36.

Kebede, T., Haile, A., Dadi, H. & Alemu, T. (2012). Genetic and phenotypic parameter estimates for reproduction traits in indigenous Arsi-balegoats. *Tropical Animal Health Production*, 44, 1007–1015.

Kilekoung, J. P. M., Julius, A. N., Houinga, D. & Pagnah A. (2017). Effects of body conformation and udder morphology on milk yield of Zebu cows in North region of Cameroon. *Veterinary World*, 10(8): 901-905.

Kolo, P. S., Egena, S. S. A., Tsado, D. N. & Adisa-Shehu, M. (2016). Effect of sex, wattle, beard, hair type, and extra teats of extensively managed goats (*Capra aegagrrus*) population of Niger State, Nigeria. *Equity Journal of Science and Science*, 4(1), 14-23.

Kukovics, S., Andras, M., Maria, A., Timea, N. & Istvan K. (2006). Effect of udder traits on milk yield of sheep. *Archieves of Animal Breeding*, 49 (2), 165-175.

Labussiere, J. (1988). Review of physiological and anatomical factors influencing the milking ability of ewes and the organization of milking. *Livestock production Science*, 18, 253 – 361.

Latimer, K.S., Mahaffey, E. A. & Prasse, K. W. (2004). Clinical pathology: *veterinary Laboratory Medicine, 4th Edition,* Iowa State University press Ames, Iowa USA,.

Lauvergne, J. J., Renieri, C. & Audiot, A. (1987). Estimating erosion of phenotypic variation in a French goat population. *Journal of Heredity,* 78, 307.

Lee, M. (2019). High estrogen levels while breastfeeding. Livestrong.com. https://www.livestrong.com/article/500552-high-estrogen-levels-while-breastfeeding/

Leng, J. Zhu, R. Zhao, G. Yang, Q. & Mao, H. (2010). Quantitative and Qualitative Body Traits of Longling Yellow Goats in China. *Agricultural Sciences in China*, 9(3), 408-415.

Luka, J. S. & Kibon, A. (2014). Milk Production of Red Sokoto Goats Fed with Supplements in Bauchi State, Nigeria. *Discourse Journal of Agriculture and Food Science*, 2(8), 258 -263.

Machado, T.M., Chakir, M. & Lauvergne, J. J. (2000). Genetic distances and taxonomic trees between goats of Ceara State (Brasil) and goat of the mediteranean region (Europe and Africa). *Genetics and Moecular Biology*. 23: 121-125.

Malik, C. P., Kanaujia, A. S., Balaine, D. S. & Rathi, S. S. 1990. Mortality pattern in Beetal and Black Bengal goats and their reciprocal crosses. *Indian Journal of Animal Science*, 60, 228–232.

Maton, A., Hopkins, R. L. J., McLaughlin, C. W., Johnson, S., Warner, C. W., LaHart, D., & Wright, J. D. (1993). Human Biology and Health. Englewood Cliffs, New Jersey, USA: Prentice Hall.

Martínez, M. F., Bosch, P.& Bosch, R. A. (1998). Determination of early pregnancy and embryonic growth in goats by transrectal ultrasound scanning. *Theriogenology,* 49, 1555-1565.

Mather, X. & Vrayla – Anesti, F. (1994). An evaluation of milk yield and milking ability in French Rouge de Lowest ewes. *Small Ruminants Research*, 13. 1–7.

Mavrogenis, A. P., Papachristoforou, C., Lysandrides, P. & Rouchias, A. (1989). Environmental and genetic effects on udder characteristics and milk production in Damascus goats. *Small Ruminants Research,* 2, 333–343.

Mayo Clinic (2018). High-density lipoprotein. https://www.mayoclinic.org/diseases-conditions/high-blood-cholesterol/in-depth/hdl-cholesterol/art-20046388. October 24, 2018.

MedlinePlus (2018). The "Good" Cholesterol. https://medlineplus.gov/hdlthegoodcholesterol.html. 18 April, 2019.

Mel DeJarnette (2004). Estrus synchronization: a reproductive management tool. Select Sires Inc.11740 U.S. 42 NorthPlain City, OH 43064. Pp 1-8.

Merkhan, K. Y. & Alkass, J. E. (2011). Influence of udder and teat size on milk yield in Black and Meriz goats. *Reseach Opinions in Animal Veterinary Science*, 1(9), 601-605.

Meza-Herrera, C.A., Serradilla, J.M., Mu˜noz-Mejías, M.E., Baena-Manzano & F. Menendez-Buxadera, A. (2014). Effect of breed and some environmental factors on body weights till weaning and litter size in five goat breeds in Mexico. *Small Ruminant Research*, 1-6 article in press. 121(2-3). Pp 215-215.

Moghbeli, S.M., Barazandeh, A., Vatankhah, M. & Mohammadabadi, M. (2013). Genetic and non-genetic parameters of body weight for postweaning traits in Raini Cashmere goats. *Tropical Animal Health Production*, 45, 1519–1524.

Moufida, A. (2014). Caractéristiques AnatomoPhysiologiques de la Glande Mammaire Chez La Chamelle en Tunisie et son Aptitude à la Mécanisation de la Traite. Thèse de Docteur en Sciences Agronomiques/Sciences de la Vie, Institut National Agronomique de Tunisie, Spécialité Sciences de Production *Animale/Biologie et Agronomie*, p190.

Mouquet, M. (1895) Sur les pendeloques. *Bulletin et Memoires de la Societe Centrale de Medicine*, 49, 241–4.

Mohammed, M. M. Kandiela, G. W. C. & Kazuyoshi, T. C. (2015).Ultrasonographic assessment of foetal growth in miniature“Shiba” goats (*Capra hircus*). *Animal Reproduction Science*, 162, 1–10.

MSN Encarta (2009). Average Animal Gestation Periods and Incubation Times. Microsoft. Archived from the original on 2009-10-31.

Naderi-Rezaei, H. R., Pompanon, F., Blum, M. G., Negrini, R., Naghash, H. R.,Balkiz, O. & Mashkour, M. (2008). "The goat domestication process inferred from large-scale mitochondrial DNA analysis of wild and domestic individuals". *Proceedings of National Academy of Sciences*, 105 (46), 17659–17664.

National Farmers Information Service (2012). Production System, Republic of Kenya. http://www.fao.org/3/i8270en/I8270EN.pdf. Pp 1-17.

Nemours Foundation (2018). Calcium. https://kidshealth.org/en/teens/calcium.html.

Nestle (2018) Importance of Iron. https://www.nestle.co.nz/nhw/nutritionlifestage nutritionpregnancy/importanceofiron

Njidda, A. A., Shuai'bu, A. A. & Isidahomen, C. E. (2014). Haematological and Serum Biochemical Indices of Sheep in Semi-Arid Environment of Northern Nigeria. *Global Journal of Science Frontier Research,* 14(2), 2249-4626.

Nkungu, D. R., Kifero, G. C. & Mtenga, L. A. (1995). Performance of dairy goats in Mgeta. Morogoro, Tanzania. *SMOTNewsletter,* 28, 3-8.

Nolte, M. (2010). Goat Health and Husbandry. A web text at http://goatspots.com/articles/basic-goat-health-and-husbandry/.

Ochepo, G. O. & Momoh, M. (2010). Development of the dairy goat industry in Nigeria: A review. *Proceedings of the. 35th Conference of the Nigeria Society for Animal Production,* 14-17 March.University of Ibadan, Nigeria, Pp 530-532.

Odubote, I. K. (1994). Characterization of West African Dwarf goat for certain qualitative trait. *Nigerian Journal of Animal Production,* 21, 37-41.

Oliveira, J. Da Rocha, L. L., Ribeiro, M. N. & Gomes, F. M. A. (2006). Characterization and visible genetic profile of goats native to the State of Pernambuco. *Archivos de Zootecnia*, 55, 63-73.

Oluwatomi, O. (2010). Goat farming. *Nigerian Tribune* of Monday, 8th March 2010, Page 9

Omontese, B.O., Rekwot, P.I., Ate, I.U., Rwuaan, J. S., Makun, H. J. Mustapha, R. A. & Lawal, M. (2012). Use of ultrasonography for pregnancy diagnosis in Red Sokoto goats. *Scientific Journal of Biological Sciences,* 1(5), 101-106.

Oni, O.O. (2003). Breeds and Genetic improvement of small ruminants(sheep and goats). *A Paper Presented at the Training Workshop on Small Ruminant Production,* 16-18th January, NAPRI, ABU, Shika, Nigeria.

Osaer, S., Goossens, B., Kora, S., Gaye, M. & Darboe, L. (1999). Health and productivity of traditionally managed Djallonke sheep and West African dwarf goats under high and moderate trypanosomosis. *Veterinary Parasitology*, 82(2), 109-119.

Oseni, S., Sonaiya, B., Omotogun, G., Ajayi, A & Muritala, I. (2006). West African Dwarf goat production under village condition: characterization and the establishment of breed standards. *Conference on International Agricultural Research for Development,* 11-13 October, 2006. University of Bonn, Tropentag. Germany, Pp 5-10.

Oseni, S. O. & Ajayi, B. A. (2008). Body weight and morphological characteristics of WAD goats under backyard units in South Western Nigeria. *Proceedings of the 13th Annual Conference of the Animal Science Association of Nigeria (ASAN),* September, 15-19. ABU Zaria.

Osinowo, O. A., Buvanendram, V. & Koning, M. L. (1988). A study of coat type, pigmentation and wattle incidence in Yankasa sheep and their effects on fertility and weaning weight. Proceedings of the 13th *Annual Conference of the Nigerian. Society of Animal Productoin*, 18-23 March, 1988. University of Calabar, Nigeria.

Osinowo, O. A., Buvanendram, V. & Koning, M. L. (1990). The occurance and inheritance of wattle in Yankasa sheep. *Nigerian Journal of Animal Production,* 17(1/2), 63-64.

Osuhor, C. U., Alawa, J. P & Apka. (2002). Manure production by goats grazing native pasture in Nigeria. *Tropical Grassland*, 36(1),123-125.

Ozoje, M.O. (2002). Incidence and relative effects of qualitative traits in West African Dwarf goats. *Small Ruminant Research,* 43, 97-100.

Ozoje, M.O., & Kadir, O. A. (2001). Effects of coat colour and wattle genes on body measurement traits in the West African Dwarf Sheep. *Tropical Agriclture (Trinidad),* 78, 118 – 122.

Ozoje, M. O. & Mgbere, O. O. (2002). Coat pigmentation effects in West Africa Dwarf goats: Live weights and body dimensions. *Nigerian Journal of Animal Production*, 29(1), 5-10.

Ozung, P. O., Nsa, E. E., Ebegbulum, V. N. & Ubua, J. A. (2011). The potentials of small ruminant production in Cross River rain forest zone of Nigeria. *Continental Journal of Animal and Veterinary Research, 3*(1), 33-37.

Palasz, A.T., Cates, W. F., Barth, A. B. & Mapletoft, R. J. (1994). The relationship between scrotal circumference and quantitative testicular traits in yearling beef bulls. *Theriogenology*, 42, 715-726.

Patel, Y. G., Trivedi, M. M., Rajpura, R. M., Savaliya, F. P. & Monika, P. (2016). Udder and teat measurements and their relation with milk production in crossbred cows. *International Journal of Environmental. Science and Technology*, 5(5), 3048-3054.

Peter, J. C. & Lesile, B. (1980). Current therapy. In: *Theriognelogy*. W.B. Morrow and Co. Saunders. Eds. Phila-delphia. Pp: 330-335.

Perez-Razo1, M. A. Sánchez, G. F. & Meza H. C. (1998). Factors affecting kid survival in five goat breeds. *Canadian Journal of Animal Science, 407-411. Retrieved from www.nrcresearchpress.com*

Pobby. (2015). Six facts about progesterone levels in pregnancy. Retrieved from https://www.checkpregnancy.com/progesterone-levels-early-pregnancy/. August 17, 2015.

Preserved Article (2018). What is the importance of calcium in human body? Retrieved from http://www.preservearticles.com/articles/what-is-the-importance-of-calcium-in-human-body/5802.

Reber, I., Keller, I., Becker, D., Flury C., Welle, M. & Dr€ogem€uller, C. (2015). Wattles in goats are associated with the FMN1/GREM1 region on chromosome 10. *Animal Genetics*, 46, 316-320.

Reichenbach, H. D., Santos, M. H. B., Oliveira, M. A. L., Meinecke-Tillmann, S. & Bürstel, D. M., (2004). Sexagem fetal na cabra e na ovelha por ultra-sonografia. *In*: Santos MHB, Oliveira MAL, Lima PF (Eds.). *Diagnóstico de gestação na cabra e na ovelha*. São Paulo, Brasil: Varela, Pp.117-136.

Revol, B. & Wilson, P. R. (1991). Foetal ageing in farmed red deer using real-time ultrasonography. *Animal Reproduction. Science*, 25, 241-253.

Ruvuna, F., Kogi, J. K., Taylor, J. F. & Mkuu, S. M. (1995). Lactation curves among crosses of Galla and East African with Toggenburg and Anglo-Nubian goats. *Small Ruminant Research*, 16, 1-6.

Ruvuna, F., Cartwrigth, T. C. & Blackburn, H. (1988). Gestation length, birth weight, and growth rates of pure-bred indigenous goats and their crosses in Kenya. *Journal of Agricultural Sciences Cambridge, 111, 363-368.*

Sabbioni, A., Beretti, V., Paini, V. & Superchi, P. (2011). Occurrence and inheritance of wattles and effects of genotype at wattle locus on Gompertz growth curve parameters in “Nero di Parma” pigs. *Livestock Science*, 137, 226–230.

Safefood 360 (2014). Water Activity ($a_w$) in Foods. Part of Our Professional Whitepapers Series. Pp 1-7. https://safefood360.com/resources/Water-Activity.pdf.

Sam, M., Akpa, G. N. & Alphonsus, C. (2017). Factors Influencing Udder and Milk Yield Characteristics of Indigenous Goats in North - West Nigeria. *Asian Research Journal of Agriculture*, 3(2), 1-9.

Samuel, F., Fajemilehin, O. K. & Salako, A. E. (2008). Body measurement characteristics of the West African Dwarf (WAD) goat in deciduous forest zone of Southwestern Nigeria. *African Journal of Biotechnology*, 7 (14), 2521-2526.

Santos, M. H. B., Oliveira, M. A. L., Lima, P. F., Moraes, E. P. B. X., Chalhoub, M. & Bicudo, S. D. (2004). Diagnóstico de gestação por ultra-sonografia de tempo real. *In*: Santos, MHB, Oliveira, MAL, Lima, PF (Eds.). D*iagnóstico de gestação na cabra e na ovelha*. Varela. (pp 97-116). São Paulo, Brasil

SAS (2000). Statistical Analysis System. SAS Institute Inc, SAS Campus Drive. Carry, North Carolina 27513, U.S.A.

Semakula, J., Mutetikka, D., Donald, K. R. & Mpairwe, D. (2010). Variability in body morphometric measurements and their application in predicting live body weight of Mubende and Small East African goat breeds in Uganda. *Middle-East Journal of Scientific Research, 5 (2), 98-105.*

Shongjia, L., Xiangmo, L., Gangyl, X. & Shenov, C. (1992). Relationship between physical traits, litter size and milk yield in Saanen, Guanzhong and Crossbred goats. *Proceedings of the 5th International Conference of Goats.* Pp. 83 in New Delhi.

Shook, G. E. (1989). Selection for disease resistance. *Journal of Dairy Science*, 72, 1349 –1362.

Siddik, K., Kor, A., Karaca, S. & Mertagioglu, H. (2005). A study of relationships between milk yield and some udder traits by using of path analysis in Akkeci goats. *Journal of Animal Veterinary Advances*, 4, 547-550.

Siemens, H. W. (1921). Zur kenntnis der sogenannten ohr- und halsanh€ange (branchiogene Knorpelnaevi). *Archiv f€ur Dermatologie und Syphilis,* 132, 186–205.

Silanikove, N. (2000). The physiology basis in goats in harsh environments. *Small Ruminant Research*, 35 (3), 181-193.

Silva, J. C. (2018). What are lymphocytes and what are the healthy levels to have medical news today. Retrieved from www.medicalnewstoday.com

Singh, D. K., Singh, C. S. P. & Mishra, H. R. (1992). Selection indices for genetic advancement in black bengel goats. *Animal Breeding Abstract*, 60, 394.

Smith, M. C. (1994). Goat medicine. Lippincott Williams & Wilkins, p.7

Soundararajan, C. & Sivakumar, T. (2011). Factors affecting birth weight of Kanni kids and sex ratio of Boer x Kanni crossbred goats. *Tamilnadu Jornal of Veterinary and Animal Sciences*, 7 (3), 144-149.

Spritzler, F. (2018). Ten Evidence-Based Health Benefits of Magnesium. Newsletter. Pp 1-27. Retrieved from https://www.healthline.com/health/about-us#link-an_page

Stultz, J. (2016). What are wattles? *Dairy Goat Journal. Pp 1-3.* March 14 2019 *https://backyardgoats.iamcountryside.com/ownership/all-about-goat-wattles/*

Tambuwal, F. M., Agale, B. M & Bangana, A. (2002). Haematological and Biochemical values of Apparently Healthy Red Sokoto Goats. *In: Proceeding of 27th Annual Conference of the Nigerian Society of Animal Production (NSAP),* 17-21 March, Federal University of Technology Akure, Akure, Nigeria.

Taylor, R. E. (1998). *Scientific Farm Animal Production: An Introduction to Animal Science*. Upper Saddle River. 6th ed. p 12.

Taylor, R.E. & Field, T.G. (1999). Growth and Development". In Scientific Farm Animal Production: *An Introduction to Animal Science, 6th Ed*. Prentice-Hall Upper Saddle River. 321-324.

Thear, K. & Frazer, A. (1986). *The Complete Book of Raising Livestock and Poultry*. Smallholders Guide. University services Ltd., Yaba. Pp. 86-88.

TheFreeDictionary.com (2013). Estrus synchronization. [online] Available at: http://www.thefreedictionary.com/Estrus+synchronization . Accessed on 24 October, 2013.

Thiruvenkadan, A. K., Pannerselvan, S. & Kandasanny, M. (2000). Distribution characteristic and production performance in Kaani, Adu Goats of Tamil Wade, *Indian Journal of Animal Science*, 70, 723-727. https://www.researchgate.net/publication/273129396.

Thiruvenkadan, A. K. (2005). Determination of best fitted regression model for estimation of body weight in Kanni Adu kids under farmer's management system. *Livestock Research for Rural Development*, 17 (7), 1-11. Retrieved from https://www.researchgate.net/publication/283566399

Tropical Cattle Research Centre (1982). CSIRO Division of Animal Production, PO Box 545, North Rockhampton, Queensland 4701, Australia. Volume 35, Issue 3 December 1982, pp. 401-412.

Tsutomu, S. T., Nakatani, H. T. & Junichi, M. (1994) Secretion of progesterone and 20α-dihydroprogesterone during pregnancy in goats. *Elsevier*. Volume 59, Issue 8, Pages 468-471.
Retrieved from https://www.sciencedirect.com/science/article/pii/0039128X94900590

Turner H. G. (2010). Genetic variation of rectal temperature in cows and its relationship to Fertility. *Animal Science*. 35 (3) 1982. Pp 401- 412. Published online by Cambridge University Press: 02 September 2010. Retrieved from https://www.cambridge.org/core/services/aop-cambridge- core/content/view/S0003356100001094.

Upadhyay, D., Patel, B. H. M., Kerketta, S., Kaswan, S., Sahu, S., Bharat, B. & Dutt T. (2014) Morphology and its relationship with production parameters in local goats of Rohilkhand region of India. *Indian Journal Animal of Research*, 48(6), 615-619.

University of Califonia San Fransico Medical Center (2018). Hemoglobin and functions of Iron.

Plumb, D.C. (1999). *Veterinary Drug Handbook.* Iowa State University Press,

Vilson, B., Anila, H., Ylli, B. & Rexhep, B. (2012). Visible genetic profile and genetic distances of local goat populations in Albania. *Livestock Research for Rural Development,* 24(3), 2012. http://www.lrrd.org/lrrd24/3/hoda24049.htm

Wallace, J. M., Aitken, R. P., Cheyne, M. A. & Humblot, P. (1997). Pregnancy-specific protein B and progesterone concentrations in relation to nutritional regimen, placental mass and pregnancy outcome in growing adolescent ewes carrying singleton fetuses. *Journal of Reproductive Fertility,* 109, 53–58.

Wang, P. O. (1989). Udder Characteristics in Toggenburg dairy characteristics, milk yield and non-yield traits. *Journal of Dairy Science*, 58, 729.

Waugh, D.J. and Wilson, C. (2008). "The interleukin-8 pathway in cancer". *Clinical Cancer Research*, 14(21), 6735–41.

WebMD Medical (2018) High Density Lipo protein. Reference Reviewed by Suzanne R. Steinbaum, MD on July 17, 2018

Weissengruger, G. E. (2000). Appendices colli in the domestic pig (Sus scrofa f.domestica). Tierarztl. Prax. G. N. 28, 276–280.

Wikipedia. (2013). Mean corpuscular volume. Retrieved from https://en.wikipedia.org/wiki/Mean_corpuscular_volume. 10 December 2019

Wikipedia. (2014). Wattle. Retrieved from https://en.wikipedia.org/wiki/Wattle_(anatomy). 2 January 2020

Wikipedia. (2019). Secondary sex characteristic. Retrieved from https://en.wikipedia.org/wiki/Secondarysexcharacteristic#p-search. 11 December 2019

Wildeus, S. (2011). Current concepts in synchronization of estrus: Sheep and goats. *Journal of Animal Science*, 77, 1-14.

Wilson, R. T. (1991). Small ruminant production and the small ruminant genetic resource in Tropical Africa.*Food and Agriculture Organization of the United Nations Animal Production and Health paper. (1991) Pp. 99-104, Rome.*

Yakubu, A., Raji, A. O. & Omeje, J. N. (2010). Genetic and phenotypic differentiation of qualitative traits in Nigerian indeginous goat and sheep population. *Journal of Agricultural and Biological Science*, 5(2), Pp.58-66.

Zahradeen, D., Butswat, I. S. R. & Mbap S.T. (2008). Evalution of some factors influencing growth performance of local goats in Nigeria. *African Journal of Food, Nutrition and Development*, 8(3),1.

Zelman, K. M. (2018). Benefits of vitamin C. From web md archives. www.webmd.com.

Zakari, A. Y., Molokwu E. C. I and Osoric, D. I. K. (2013). Effects of rectal and ambient temperatures and humidity on conception rates. *Elsevier*, 79(2), pp. 299-305.

**Table 4.4b. Effect of wattle on the Reproductive traits of Red Sokoto Does Raised Semi I ntensively**

| Trt | Conception | N | % | Abortion rate | N | % | Survival rate | N | % | Type of bir |
|---|---|---|---|---|---|---|---|---|---|---|
| $T_1$ | Conception rate | 5 | 62.5 | Abortion | 1 | 20 | Survival rate of kids | 3 | 75 | Twin |
| | Failed conception | 3 | 37.5 | Paturition | 4 | 80 | Mortality of kids | 1 | 25 | Single |
| $T_2$ | Conception rate | 4 | 50 | Abortion | 0 | 0 | Survival rate of kids | 4 | 100 | Twin |
| | Failed conception | 4 | 50 | Paturition | 4 | 100 | Mortality of kids | 0 | 0 | Single |
| $T_3$ | Conception rate | 5 | 62.5 | Abortion | 0 | 0 | Survival rate of kids | 4 | 66.7 | Twin |
| | Failed conception | 3 | 37.5 | Paturition | 5 | 100 | Mortality of kids | 2 | 33.3 | Single |
| $T_4$ | Conception rate | 2 | 25 | Abortion | 0 | 50 | Survival rate of kids | 1 | 33.3 | Twin |
| | Failed conception | 6 | 75 | Paturition | 2 | 50 | Mortality of kids | 2 | 66.7 | Single |

**Table 4.1. Effect of wattle on the initial body weight and morphometric parameters of Red Sokoto does**

| Parameters | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM |
|---|---|---|---|---|---|
| Body weight (kg) | 10.18 | 11.30 | 11.33 | 11.26 | 0.33 |
| Body length (cm) | 47.83$^{a}$ | 43.58$^{b}$ | 48.60$^{a}$ | 48.83$^{a}$ | 5.04 |
| Head length (cm) | 13.91$^{a}$ | 13.23$^{ab}$ | 12.96$^{b}$ | 13.60$^{ab}$ | 0.22 |
| Head width (cm) | 11.26$^{b}$ | 11.90$^{a}$ | 12.04$^{a}$ | 11.88$^{a}$ | 0.22 |
| Height-at-wither (cm) | 46.41 | 46.80 | 46.60 | 47.89 | 0.78 |
| Chest girth (cm) | 50.91 | 51.28 | 50.50 | 51.46 | 1.49 |
| Horn length (cm) | 3.01 | 2.58 | 2.46 | 3.28 | 0.40 |
| Rump length (cm) | 13.90 | 13.29 | 14.10 | 11.91 | 0.24 |
| Rump width (cm) | 13.53 | 13.41 | 13.93 | 14.20 | 0.28 |
| Fore leg (cm) | 39.80$^{ab}$ | 39.08$^{b}$ | 37.79$^{b}$ | 41.40$^{a}$ | 0.87 |
| Hind leg (cm) | 45.10 | 44.33 | 44.49 | 46.61 | 1.66 |
| Shin circumference (cm) | 6.30 | 6.45 | 6.39 | 6.43 | 0.20 |
| Ear length (cm) | 11.28 | 11.02 | 10.51 | 10.51 | 0.39 |

$^{abcd}$ Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$**= Non-wattled does mated with non-wattled bucks; **$T_2$** = Non-wattled does mated with wattled bucks;
**$T_3$**= Wattled does mated with non-wattled buck:
**$T_4$**= Wattled does mated with wattled bucks.
**SEM=** Standard error of mean

The results for the initial morphometric parameters for female goats (Table 4.1) shows that the body length, head length, head width and fore leg were significantly ($p<0.05$) influenced by the presence of wattle. The body weight, height at wither, chest girth, horn length, rump length, rump width, hind leg, shin circumference and ear length were however not significantly ($p>0.05$) affected by the presence of wattle in the does used for the experiments. For body length, does in $T_1$ (non-wattled does mated with non-wattled buck), $T_3$ (wattled does mated with non-wattled bucks) and $T_4$ (wattled does matted with wattled buck) had similar ($p>0.05$) values. However the body lenght for the three treatments were higher ($p<0.05$) than does in $T_2$ (non-wattled does mated with wattled buck).

Does in $T_1$ (non-wattled does mated with non-wattled buck) were similar ($p>0.05$) to does in $T_2$ (non-wattled does mated with wattled bucks) and $T_4$ (wattled does matted with wattled buck) while does in $T_2$ and $T_4$ are statistically similar ($p>0.05$) to does in $T_3$ (wattled does mated with non-wattled buck) for the head length. The head width of does in $T_2$, $T_3$ and $T_4$ were statistically similar ($p>0.05$) but the three had wider ($p<0.05$) headwidth than the head width of does in $T_1$. Finally does in $T_4$ were statistically similar ($p>0.05$) to does in $T_1$, while does in$T_1$ had similar ($p>0.05$) values with $T_2$ and $T_3$ in the fore leg.

The effect of wattle on average body weight and morphometric parameters in Red Sokoto bucks raised semi intensively is presented in Table 4.3. The Table shows a significant ($p<0.05$) difference only in the head width and the fore leg of the males used for the experiment. Other parameters: body weight, body length, head length, height-at-wither, chest girth, horn length, rump length, rump width, hind leg and shin circumference revealed no significant ($p>0.05$) differences. Bucks in $T_1$ showed significant ($p<0.05$) higher head width than bucks in $T_2$. Bucks in $T_2$ shows significantly longer fore leg over bucks in $T_1$.

| **Parameters** | **$T_1$** | **$T_2$** | **SEM** |
|---|---|---|---|
| Body weight (kg) | 15.71 | 15.45 | 0.33 |

| | | | |
|---|---|---|---|
| Body length (cm) | 65.23 | 66.93 | 5.04 |
| Head length (cm) | 15.38 | 15.70 | 0.22 |
| Head width (cm) | 15.10$^{a}$ | 14.20$^{b}$ | 0.22 |
| Height-at-wither (cm) | 56.05 | 55.25 | 0.78 |
| Chest girth (cm) | 57.62 | 58.14 | 1.49 |
| Horn length (cm) | 9.05 | 8.35 | 0.40 |
| Rump length (cm) | 14.40 | 14.90 | 0.24 |
| Rump width (cm) | 13.97 | 14.90 | 0.28 |
| Fore leg (cm) | 43.73$^{b}$ | 47.08$^{a}$ | 0.87 |
| Hind leg (cm) | 53.58 | 51.28 | 1.66 |
| Shin circumference(cm) | 7.05 | 6.48 | 0.20 |

$^{abcd}$ Means within a row having different superscripts differed significantly ($p<0.05$);
**$T_1$=** Non-wattled bucks
**$T_2$**= Wattled bucks
**SEM=** Standard error of mean

The non significant difference obtained in some of the traits evaluated and the similarities in values of results that were significant between wattled and non wattled does in the initial body weight and morphometric parameters makes it hard in deciding which of the gene allele that gives an outstanding result in body weight and morphometric parameters. This confirms the report of Imagawa *et al*. (1994) as cited by Reber *et al.* (2015) that the function of wattle in mammals is still under debate. Sabbioni *et al*. (2011) also stated that the major effect of wattle on productive trait is still not fully known. Reber *et al.* (2015) concluded that wattles are just rudimentary developed extremities. The two reports are in line with the findings of Kolo *et al.* (2016) who stated that there is no yard stick for judgment between the morphometric parameters measured in goats with wattle and those without wattle in Niger State, Nigeria. Ijomanta (2012) observed no difference in body conformation traits between Red Sokoto goats having wattle and those without wattle in Kastina State, Nigeria. The above results however are not in line with the findings of Ozoje and Kadir (2001) who reported that wattle gene had significant influence on body measurements such as body length, heart girth and height at withers in West African Dwarf sheep. According to Leng *et al.* (2010), wattle trait has positive association with heavier body weight from 18 months of age onward, and also with longer height at wither, body length and chest depth in female goats of Chinese Yellow goat breed. Odubote (1994) observed that wattle had significant effect on yearling weight of West African Dwarf goats, with bilaterally wattled goats weighing heavier than the non-wattled goats. Sabbioni *et al*. (2011) discovered that wattled pigs grow faster in dimensions and reached maturity faster than the non-wattled pigs.

Bucks without wattle were superior to the wattled bucks in head width but not in fore leg (Table 4.3). This may be because wattle has no directional effect on the morphometric parameters of goats. The results obtained regarding head width of the bucks is in line with the findings of Stutz (2016) who carried out a study on dairy goats and concluded that the major function of wattle is to make the animals look attractive. Nolte (2010) however, claimed that wattle has no obvious significance to the physiology of goats. This result is however not in line with the findings of Leng *et al.* (2010), who stated that wattle trait has positive association with heavier body weights from 18 months of age onward. They also associated the presence of wattle with longer height-at-wither, body length and chest depth in female Chinese Yellow goats in the same study.

In this research study, bucks with wattle ($T_2$) had longer fore leg than the non-wattled bucks (Table 4.3). This brings to mind the assumption of Sabbioni *et al*. (2011) that wattle trait could be utilized when selecting for productive traits in sheep and goats. The result obtained on fore leg is in line with the earlier findings (Odubote, 1994; Ozoje and Kadir, 2001; Leng *et al* 2010) who reported on the superiority of wattled animals over non-wattled animals (body weight and morphometric parameters). The result for fore leg however does not tally with the findings of Nolte (2010) and Stutz (2016) who found no meaningful contribution of wattle in animals. Since the aim of any research is to bring about an improvement over what is originally available, various experiments have been conducted in various parts of the world to see the best parameters to consider for genetic improvement of animal, but head width and foreleg are not among the parameters listed as basis for selection. Thiruvenkadan (2005) for instance, listed body weight and chest girth as traits worthy of selection and improvement. Hamayun *et al.* (2006) suggested height-at-withers, heart girth and body weight in Beetal goats. Akpa *et al*. (1998a) reported body length, height-at-withers and chest girth in Red Sokoto goats while Singh *et al*. (1992), listed body weight, body length, height-at-withers, and heart girth at 3 months as traits, which gave the highest expected genetic gain at 3 and 6 months of age and hence should be selected for subsequent improvement.