MILK COMPOSITION OF INDIGENOUS SHEEP AND GOATS RAISED UNDER SMALL-HOLDER URBAN PRODUCTION SYSTEM IN NORTHERN ECOLOGICAL ZONES OF NIGERIA

BY

YOHANNA, Sarki

DEPARTMENT OF ANIMAL SCIENCE,
FACULTY OF AGRICULTURE
AHMADU BELLO UNIVERSITY,
ZARIA, NIGERIA

SEPTEMBER, 2021

MILK COMPOSITION OF INDIGENOUS SHEEP AND GOATS RAISED UNDER SMALL-HOLDER URBAN PRODUCTION SYSTEM IN NORTHERN ECOLOGICAL ZONES OF NIGERIA

BY

YOHANNA, Sarki

B. AGRIC. (HONS: ANIMAL PRODUCTION ADSU, MUBI (2014)

(P17AGAN8009)

A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF ANIMAL SCIENCE

DEPARTMENT OF ANIMAL SCIENCE,
FACULTY OF AGRICULTURE
AHMADU BELLO UNIVERSITY,
ZARIA, NIGERIA

SEPTEMBER, 2021

DECLARATION

I hereby declare that, this project topic ***MILK COMPOSITION OF INDIGENOUS SHEEP AND GOATS RAISED UNDER SMALL-HOLDER URBAN PRODUCTION SYSTEM IN NORTHERN ECOLOGICAL ZONES OF NIGERIA*** was carried out by me in the Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University Zaria, Kaduna State of Nigeria. Under the supervision of Prof. D. Zahraddeen and Dr. M. Abdulrashid. The information obtained from literature has been duly acknowledged in the text and a list of references provided. No part of this Dissertation has been previously presented for another degree or diploma at any University.

YOHANNA, Sarki

____________________	________________	______________
Name of Student	**Signature**	**Date**

CERTIFICATION

This Dissertation titled ‘‘**MILK COMPOSITION OF INDIGENOUS SHEEP AND GOATS RAISED UNDER SMALL-HOLDER URBAN PRODUCTION SYSTEM IN NORTHERN ECOLOGICAL ZONES OF NIGERIA** by YOHANNA, Sarki meets the regulations governing the award of the degree of Masters of Science in Animal Science of the Ahmadu Bello University, Zaria and is approved for its contribution to scientific knowledge.

Prof. D. Zahraddeen Chairman, Supervisory Committee	____________________ Signature	__________ Date
Dr. M. Abdulrashid Member, Supervisory Committee	____________________ Signature	__________ Date
Prof. M. Kabir Head, Department of Animal Science Ahmadu Bello University, Zaria	____________________ Signature	__________ Date
Prof. Sani A. Abdullahi Dean, School of Postgraduate Studies, Ahmadu Bello University, Zaria	____________________ Signature	__________ Date

DEDICATION

I dedicate this research to God Almighty, the source of my inspiration; and to my wife, children and my brothers especially Dr Joel Yohanna for their endless prayer and financial assistance to see that I became successful. God bless you.

ACKNOWLEDGEMENTS

My profound gratitude goes to God Almighty who has giving me the inspiration, sound health and strength. God is faithful. I must express my immeasurable appreciation to my able and dynamic supervisors, Prof. D Zahraddeen and Dr. M. Abdulrashid through whose expertise, guidance, positive correction, advice and suggestion this piece of dissertation was produced. I must have to say thank you so much for your tireless effort in making this research work successful. May the Lord God Almighty continue to bless and reward you endlessly.

My appreciation will not be complete without mentioning the role played by Dr (Mrs) O.M. Daudu and all lecturers and the staff in the Department of Animal Science under the headship of Prof. M. Kabir in shaping my future. Thank you, may God reward your contributions. I want to say a big thank you to my parents Mr. and Mrs. Retired Rev. Yohanna Abbaya who considered my education a must, and a responsibility they had to take even in difficult moments of their lives, thank you for your support, prayers and encouragement in life, you are wonderful. To my wife who considered my education a must and a responsibility they had to take even in difficult moments of their lives and children.

To my brother, Dr Joel Yohanna and family thank you for your support, prayers and encouragement, you are wonderful (financially, morally and prayerfully). You made much effort just to see that I have become important in future, only God can reward you for your sacrifices

I have to recognize some very special people; my brothers, Hassan Abbaya, Gambo, Chipalai, Habila, Saminu, Yunusa and Hossainni. Thank you for your prayers, encouragement and support in kind and cash.

I say a big thank you to my roommate Abel Yarima, Monday Philimon, Raymon Bakodo, Maxwel Gurnugushi and to my classmates and senior colleagues for the encouragement and support in this journey. Space will not be enough to thank all those who are not mentioned here. May the good God bless you all abundantly, Amen.

ABSTRACT

The study was conducted to evaluate the influence of location on milk parameters of indigenous sheep and goats managed under small-holder husbandry system. Two seasons; wet (August- early October) and dry (late October – December) of 2019 were considered. The four locations are Jalingo in Southern Guinea Savannah, Mubi in Northern Guinea Savannah, Gwale in Sudan Savannah and Maiduguri in Semi-Arid/ Arid. The result showed that location significantly influenced (P<0.01) all the milk parameters of sheep and goats. SGS had the highest values of crude protein, fat, pH, solid non-fat and total solid with the highest values of 5.57, 5.59, 6.69, 8.40 and 14.39% respectively while NGS recorded the lowest values of lactose, calcium, phosphorus was higher in SAA zone with the value of 4.91, 196.88 and 145.22%, respectively. The influence of species in SGS on milk parameters showed that sheep milk was significantly (P< 0.01) higher in fat, pH, lactose, ash, and calcium (5.99, 6.69, 4.99, 0.75 and 124.81%) respectively than that of goats which had (4.64, 6.58, 4.28, 0.53, and 107.42%) respectively. In the NGS also species significantly (P<0.01) affected milk parameters with sheep having higher values of crude protein, phosphorus and total solids (5.15, 111.12 and 12.08% respectively) than goats with values (3.83, 91.60 and 11.22%) respectively. The influence of species of sheep in the SS and arid/ SAA on milk parameters showed that sheep was significantly (P<0.05) higher in all parameters measured. The influence of breed of sheep on milk parameters showed that there was significant (P<0.01) difference in all the parameters except fat and ash. WAD had higher crude protein, pH, and solid non-fat with the values of 6.04, 6.81 and 8.45% respectively. Uda and Balami had the highest value of phosphorus, calcium, and solid non-fat with the values of 136.80, 186.56, and 8.21% respectively. The influence of breed of goats on milk parameters showed significant (P<0.01) differences in all the parameters. Crude protein, fat, pH ash, solid non-fat and total solid were highest in West Africa Dwarf, Goats. However, Lactose, phosphorus, calcium was high in Sahel than Sokoto red and WAD. Seasonal effect on sheep milk parameters only affected ($P<0.05$) solids non-fat with dry season higher value (11.96%) than wet season (11.23. %). Season significantly ($P<0.01$) influenced fat, solids non-fat and total solids in goats with the wet season having significantly highest($P>0.01$) in the affected parameters. There were positive and negative correlations matric in both when sheep ($P<0.05$-0.01; r = -0.25-0.88) and goat ($R<0.05$-0.01; r = -0.77-0.67). It concluded that location, species and season had influence in milk parameters in sheep and goats in all breed. This study recommends that these factors be considered in production of milk from sheep and goats for human consumption.

TABLE OF CONTENTS

CHAPTER THREE

CHAPTER SIX

LIST OF TABLES

Title **Page**

LIST OF FIGURE

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Milk is a complex mixture consisting of an emulsion of fat and colloidal dispersion of protein, together with the milk sugar (lactose). In true solution these major constituent are phosphorus, vitamin, enzymes, and various minor organic compound such as cystic acid (Adebarimo, 1990). Milk has long been recognized as an valuable food of pastoralist diets in all the world, also it is a nutrient food and is recognized to contribute a high proportion of the nutrients, such as micronutrients, include calcium, phosphorus, vitamins like B and D, high quality protein such as casein protein, also fatty acid composition of milk fat has relation to its potential health benefits and impact on the human health (Frelich *et al*., 2012). Ruminant serve multitude of functions ranging from food to fertilizer-that are essential for human and plan life in both developed and under developed countries (Gatenby, 2002). The distribution of sheep and goats population by ecological zones of the tropical Africa as obtained from Jahnke (1982) shows that 71.5% of sheep and goat are from savannah zone and the estimated population of 22.1 million sheep and goat in Nigeria (Rim, 1992).

Milk is an important source of mineral substances especially calcium, phosphorus, sodium, chloride, iodine, magnesium and small amount of iron of these mineral constituent, calcium and phosphorus constitute a large fraction which is needed for bone growth and proper development of the new born (Al-Wabel, *et al.* 2008). The Webster's Dictionary defined milk as a whole yellowish liquid consisting of small fat globules suspended in solution' (Biswas, 2006). While Hellen (1994) defined milk as the white liquid produced in the udder of mammals in small clusters called alveoli under the influence of oxytocin a hormone that release from the pituitary gland near the brain after stimulus when suckling or milking. It is often described as nature's most perfect food because of its nutritive values and rich flavour (Hellen, 1994).

Milk has long been recognized as the most complete single food available in nature for maintenance of health, protection and promotion of growth of the mammals (Biswas, 2006). It supplies body building protein, bone forming minerals, health giving vitamins energy, lactose and milk fat (Biswas, 2006). The substantial improvement in the milk composition of the Indigenous goats can be made through improved management practices and cross- breeding with higher-yielding Indigenous or exotic goats (Zahraddeen *et al.,* 2007).

Caprine milk appears to be more ideal for farmers interested in butter production because it contains the highest fat percentage. The fact that goat, sheep and cow milk contain the same or similar percentages of protein implies that any of them can adequately serve as a nutritional source of protein for human consumption (Aduli *et al*., 2001).

Goat milk on the other hand, provide about 25% of market milk in some African countries and has proven to have special attribute compared to cow or human milk due to its higher digestibility, distinct alkalinity, higher buffering and higher therapeutic values in human medicine. Despite all these attribute of goat milk, its consumption is not a tradition in Nigeria, probably due to the characteristic "goat" flavour (Ngele, 1997).

Sheep and goat milk is white in colour compared with cow milk, which is yellowish because of the presence of carotene (Saini and Gill, 1991). Goat milk has a stronger flavour than sheep milk. This might be due to the liberation of short-chain fatty acids during rough handling, which give off a goaty smell (Babayan, 1981; Haenlein, 1992).

Although milk consist of 80-90% water, it also contain vital nutrient minerals, vitamins, fat, sugar, which are very important in human diet as a source of protein for the body growth, tissue repairs and other vital function of the body (Mathewman,1995).

Indigenous breeds0f sheep in Nigeria have the potential to supply a significant portion of the milk deficit in the country because sheep numbers far exceed cattle numbers in both rural and urban communities (RIM, 1992, Adewumi, 2005). They are also more affordable to resource poor families and produce more milk in relation to body size than cattle (Nuru, 1985). Sheep milk has been found to be richer in critical nutrients, except lactose, than milk of humans, cattle and goats (Buffano *et al*., 1996). The high content of vitamin D and calcium helps in fighting against osteoporosis. Sheep milk showed less susceptibility to mastitis than other ruminants and with a higher retail price than cow's milk (Chamberlain, 1989; Adewumi *et al* 2001). Sheep milk also generally has higher lactose content than milk from cows, buffaloes and goats. The high protein and overall solid contents of sheep milk make it particularly appropriate for cheese and yoghurt making. Milk from sheep is important in the Mediterranean region, where most of it is processed into cheeses such as *pecorino, caciocavallo* and *feta* (FAO, 2015).

1.2 Justification

Sheep produces around 16% of the total milk produced in Sub-Saharan countries (Kisza *et al.,* 1994). Compared to cow milk, sheep milk contain higher dry matter, fat, protein, unsaturated fatty acids, calcium, phosphorus, iron, magnesium, and vitamins (Kizsa *et al.,* 1994; Borys and Pisculewski, 2001). In in addition to its chemical composition, sheep milk is an excellent raw material for processing into fermented drinks and cheese.

Sheep milk is appreciated and processed into products characterized by taste and nutritional value (Molik *et al.,* 2004; Caballero *et al.,* 2007). However, in spite of the important attribute of sheep and goat milk, cow has been the principal source of milk neglecting the small ruminant these could probably be as a result of preference for other sources of milk, lack of awareness about their nutritional composition, odour, and quantity of milk produced (Molik *et al.,* 2004). Goats produce only about 2% of the world's total annual milk supply (FAO, 1988). However, their global contribution to the nutritional and economic well-being of humanity is tremendous. Worldwide, more people drink the milk of goats than the milk of any other single species. Goat milk has advantages over cow or human milk in having higher digestibility of protein and fat, alkalinity, buffering capacity, and certain therapeutic values in medicine and human nutrition (Park, 1990).

Milk form an important quality protein for humans, its composition and quality are important attribute that determine the nutritive value and acceptability (Zahraddeen *et al.,* 2007). Despite the knowledge of its importance, it is still absent in the diet of most Nigerian (Otaru, 2002) and consume far less than the recommended minimum daily animal protein requirement (Awotwi and Fynn, 1992).

It is believed that this study will sensitize producers toward producing sheep and goat milk and also enlighten consumers on the importance of the composition and nutritive value as well as a means of comparing between the two sources of milk hence an opportunity for making a choice based on preference. In addition for researchers it will serve as a reference for making further research considering the fact that these small ruminant sheep have the potential to supply a significant portion of milk deficit in the country because their number exceed that of cattle, this will greatly lead to exploiting their potential optimally (Rim, 1992 ; Adewumi, 2005).

1.3 Problem Statement

Nigerian population is growing at 3% per annum, urbanization at 4% and average increase in dairy consumption is 5% (Gatenby, 2002). Nigeria's market for imported dairy products is established at 240,000 metric tonnes, valued about $600 million (Economist, 2005). In view of this, the supply of dairy product has consistently failed to meet up with demand over the last decade. Nigeria remains a net importer of dairy product due to growing population, urbanization and wider use of dairy products ingredients. More emphasis has been placed on cow milk. Supply from other animals such as sheep, goat and camels have being neglected (Ibeawuchi and Dalyop, 1995). Moreover various cultures eg Fulani in northern region used different animals as source of milk for food (Hellen, 1994).

The desire to undertake the study is as a result of overdependence on cow for milk production neglecting other sources of milk production. More so breed variation do exist in milk production, therefore determining the milk composition of specific genotype would provide vital information on dairy farming in small ruminant, which will go a long way in improving the protein demand of the teeming population which is lacking and insufficient. It was shown by several authors that the protein intake of an average Nigerian still fall below the recommended average intake, this in turn contribute to the major problem facing children in developing countries pertaining to protein-energy malnutrition (Khalid *et al.*, 2013). Owing to the fact that children in these countries do not consume adequate amount of animal protein which is rich and easily digested.

1.4 Objectives of the study

This study was designed and aimed of investigating the milk composition of sheep and goats under small-holder husbandry system in four locations

The specific objectives were as follows:-

a- To determine the effect of species and breed on milk composition of sheep and goats

b- To determine the effect of season on milk composition of sheep and goats

c- To determine the effect of location on milk composition of sheep and goats

1.5 Research hypotheses

Ho**:** Breed and species has no significant effects on milk composition of sheep and goats reared under small-holder husbandry system

Ha**:** Breed and species has significant effect on milk composition of sheep and goats reared under small-holder husbandry system

Ho: Season has no significant effect on milk composition of sheep and goats reared under small-holder husbandry system

Ha: Season has significant effect on milk composition of sheep and goats reared under small-holder husbandry system

Ho: locations has no significant effect on milk composition of sheep and goats reared under small-holder husbandry system

Ha: location has significant effect on milk composition of sheep and goats reared under small-holder husbandry system.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 History and Importance of Milk

The history of milk begins in the Neolithic period when hominids made the transition from nomadic hunting to gathering societies. With the establishment of a fixed dwelling place, it was possible to gather and domesticate animals for work and food, thus developing agricultural practices. The 1st animals to be domesticated were goats and sheep in the Middle East because of their size, ruggedness, adaptation, behaviour, and social nature, which facilitates management by humans. For a long time, goats and sheep were a source of food (meat and milk) and clothing (wool). Over the many centuries, milk has become a desired and valuable source of nutrients; thus, herds were formed and dairy breeds were selected (Yildiz, 2010; Barłowska *et al.*, 2011).

Worldwide, cow milk is the most commonly consumed milk, dominating the world milk production with 782 million tons in 2013. Thus, 85% of the world milk production is derived from cattle, followed by milks from other species such as buffalo (11%), goat (2.3%), sheep (1.4%), and camel (0.2%) (FAO, 2015). However, sheep milk-producing farms represent a significant part of the agrarian economies in many countries, especially those bordering the Mediterranean Sea and in the Middle East. The world's largest producer of sheep milk is China (12.2%), and the leading producer in Europe is Greece (8.7%), followed by Romania (7.2%), and Italy (6.1%) (Barłowska *et al.*,2011). Sheep milk is also important in the Near East and North Africa, with 7.5% production, and somewhat less important in sub-Saharan Africa (5.6%) and East and Southeast Asia (3.9%). Milk production by small ruminants, including sheep and goats, has grown over the years and is now in search of new consumer markets (Selvaggi et al., 2014). In

Europe, sheep milk production was approximately 9.1 million tons in 2009, but its consumption in liquid form is rare (Tamime *et al*., 2011). Currently, sheep milk is considered a delicacy in many countries, including the United States. Therefore, sheep dairy products have gained market size due to the product's quality, high yield, and nutritional value; the high nutritional value is due to the higher concentrations of proteins, fats, vitamins, and minerals when compared to the milks from other domesticated mammals (Park et al., 2007; Milani and Wendorff, 2011). Sheep milk is mainly used for the production of fine cheese varieties, yogurt, and whey cheeses (Haenlein and Wendorff, 2006).

The high levels of protein, fat, and calcium by casein unit make it an excellent matrix for cheese production (Moatsou et al., 2004; Barłowska et al., 2011). Even though sheep milk production is booming, from the livestock point of view, sheep milk does not have as high a production yield as cow and goat milk due to seasonality (Albenzio et al., 2016). Thus, medium and small-sized sheep milk farms freeze the raw milk as a way to accumulate enough amount milk for processing into dairy products (Milani and Wendorff, 2011). Sheep milk frozen at −27 °C preserves protein stability for up to 12 month of storage. However, to maintain the high quality of sheep milk, it must be rapidly frozen and stored at temperatures below −20 °C (Wendorff, 2001)

Goat milk is similar to cow milk in its basic composition. Caprine milk, on the average, contains 12.2% total solids, consisting of 3.8% fat, 3.5% protein, 4.1% lactose, and 0.8% ash (FAO 1988). It has more fat, protein, and ash and less lactose than cow milk. Goat milk contains slightly less total casein, but higher non protein nitrogen than the cow counterpart. Goat milk and cow milk have 3 to 4 times greater levels of protein and ash than human milk. Total solids and caloric values of goat, cow, and human milks are similar (FAO 1988).

2.2 Small Ruminant Animals

Small ruminant animals are animals having four compartment stomach namely; rumen, reticulum, omasum and abomasum. They are capable of ruminating or chewing curd (CDevendra *et al*., 1988). They have specially adapted digestive tracts that help them survive on coarse herbage that cannot be digested by simple stomach (monogastric) animals. The presence of micro-organisms (bacteria, protozoa and fungi) in the rumen and reticulum also helps in breaking down the B-links of the cellulose materials to release energy in the form of volatile fatty acids (King, 1978; Jeffrey and Stevenson, 2001; Linda *et al*., 2004).

There are about 150 species of ruminant animals including cow, goat, deer, buffalo, sheep, giraffe, moose, and elk. Ruminant species can further be classified as grazers, browsers or intermediate. Grazers such as sheep, cattle and buffalo consume mostly lower quality grasses while browsers such as moose and mule deer stay in the woods and eat highly nutritious twigs and shrubs. Intermediates, such as goats and white tailed deer, have nutritional requirements midway between grazers and browsers (CDevendra and Mcleroy, 1980; Barnet and Federick, 2003).

2.3 Management Systems in Sheep and Goats Production

Sheep and goats production systems in Africa are as numerous as the socio-economic and varied agricultural situations in the continent. The terms 'production' and 'management' systems can be used interchangeably to refer to means by which livestock are reared. There are three basic systems of sheep and goat production. They are:

- Extensive system

- Semi-intensive system
- Intensive system (Payne, 1990).

2.3.1 Extensive system

This is a system of production where animals are allowed to graze or browse on large areas of land that are marginal in nature and not suitable for agricultural use. Usually, large numbers (50-200) of animals are involved of the land and what the animals benefit from grazing depends on the carrying capacity of the land (Wilson, 1991). The carrying capacity may be defined as the amount of forage available to sustain a set number of animals in a given area, or the number of animals that can live on an area of land with given types of biomass (or forages) over a set time period. In this type of system, houses are not provided for the animals and they sleep in the open at night (Wilson, 1991). Owing to the fact that they depend completely on the rangeland they are migratory, moving from one part of the country to another in search of places with better vegetation to graze on. This migratory movement is of two types: - Nomadism and Transhumance. Nomads (Pastoralists – the Tauregs in West Africa, Masai in East Africa and Fulani in Nigeria) are people without permanent homes and move from one place to another with their herds and flocks (Wilson, 1991). Transhumant are those with permanent homes or settlements to which they return every year after spending a large proportion of the year elsewhere with their animals in search of feeds and water. This system is under threat because of increasing human population and urbanization (Wilson, 1991)

2.3.2 Semi-intensive system

In this system of production, the animals are released for grazing or scavenging on rubbish dumps, unguarded gardens, and when they return in the evening to their owner's homes, they are fed household wastes. The number of animals kept is usually small, less than 10. During cropping seasons, the movement of the animals is restricted to prevent damage to crops. They are kept in an enclosure (corrals) or tethered to a tree or peg and fed on cut and carry basis with cut grasses and browse supplemented with household wastes. This system is common among villages in most parts of Nigeria where the flock owners keep them to supplement their main or primary occupation usually crop farming. The attention given to the animals in terms of housing, feeding and veterinary care is poor, but better than what obtains in the extensive system (Otaru and Iyiola-Tunji, 2015)

2.3.3 Intensive system

This is system of sheep and goat production where the animals are confined and not allowed to search for food by themselves. Good housing and veterinary care are usually provided for them and are fed cut grasses and legumes, grass hay and purchased concentrates, vitamins and minerals. Intensive system of production usually involves increase in one or more inputs of production so as to increase the total output from system (Otaru and Iyiola-Tunji, 2015). This system is usually associated with high costs of inputs (e.g. high labour cost, expensive quality feeds, high cost of land and cost of good foundation stock). It can only be successful i.e. profitable if high output is achieved or the product produced is highly valued with high price. Generally, management of animals in intensive system of production is better than in the other two systems (Otaru and Iyiola-Tunji, 2015). Due to confinement of large numbers of animals in an area, meticulous health care is, of necessity, required or given to prevent diseases and problems of parasites. Increase in human population and urbanization with a decreasing or shrinking area available for grazing either in extensive or semi-intensive system of production, is gradually making the intensive system as an option for the future (Otaru and Iyiola-Tunji, 2015).

2.4 Importance of Small Ruminant Animals

2.4.1 Source of Meat

Generally, ruminant animals contribute about 85% of the total natural meat supply, sheep and goats contribute about 14% of the total meat supply (Butswat *et al*., 2002). In Nigeria, the contribution of small ruminants (sheep and goats) to the nation's meat supply is much higher than this representing about 35% of the nation's meat supply (Charray *et al.*, 1992; Devendra and Burns, 1997).

In most parts of Nigeria, small ruminants, especially goats are slaughtered for consumption almost routinely while premium is put on sheep (ram) for meat during the Muslim Eid-el-Kabir festival (Otaru and Iyiola-Tunji, 2015) Africa is said to produce about 10-30% of this amount. Out of this amount, 14% comes from sheep and goats (Shearer *et al*., 1999; Barnet and Federick 2003)

2.4.2 Source of milk

It is estimated that there are about 220 million dairy cows in the world producing 340 million tonnes of milk per year (King, 1978). Africa is said to produce about 10-30% of this amount. Out of this amount, 14% comes from sheep and goats. In some countries, sheep and goats milk are the major source of milk supply for consumption (Shearer *et al*., 1999; Barnet and federick 2003) In terms of milk supplies from small ruminants, the breeds of goats we have in Nigeria produce more milk than the breeds of sheep (Park, 2006). Again, the quantity of milk produced is smaller in volume compared to that of cattle, and is used to augment supplies from cattle in some parts of northern Nigerian to increase the volume available for sale (Otaru and Iyiola-Tunji, 2015).

2.4.3 Hide and skin

Apart from food supply, ruminants also provide hides and skin. Leather from ruminants in the past was major source of foreign exchange. The famous Moroccan leather is obtained from the skin of Red Sokoto goat. Africa produces about 37,000 tonnes of greasy wool per year. Sheep skin is used for clothing in highland area of Ethopia and Nigeria (Charray *et al*., 1992; Rege *et al*., 2001). They produce wool, hair and skin and manure. Sheep and goats produce fibre (wool or hair) which is used in fabric industries. Sheep are the only species of animal known to produce wool. Goats, rabbits and others produce similar high quality fibre, but not wool. In Nigeria the breeds of sheep and goats we have are the hairy types which do not produce wool like the woolled sheep (*Awasi, Masai, Berbef, Blackhead, Boran, Merino, Criollo*) (F.A.O. 2015), and Mohair or Cashmere (Pashmina) goats like Angora and Kashmiri goats, respectively. Skins are by-products after slaughter, and are used in making shoes and other leather products. The skin from the Red Sokoto goats popularly known as “Moroco” leather is highly sought after in the leather trade in the international market. It earns Nigeria some foreign exchange (Otaru and Iyiola-Tunji, 2015).

2.4.4 Source of Manure

Ruminants as well as other animals help in improving/preserving soil fertility. Farm manure which consists of animals faecal materials are used to fertilize farm lands. Manure from tethered sheep and goats is collected and spread in crop fields as fertilizer. The Faecal droppings from sheep and goats are used as manure to enrich the soil of its nutrients content. The scarcity and high cost of inorganic fertilizer have made the demand for sheep and goat manure to increase. (Payne, 1990).

2.4.5 Form of investment.

Small ruminants serve as a form of investment; some farmers prefer to store their wealth in the form of livestock. Sheep and goats can be converted into cash quickly by being sold when the need arises. Given the absence of diseases and mortality, investment in sheep and goats can protect against losses due to high inflation rates characteristic of unstable economies of many developing nations like Nigeria (Rege *et al.*, 2001).

2.4.6 Medicinal purposes

The symptoms like gastrointestinal disturbances, vomiting, colic, diarrhoea, constipation and respiratory problems can be eliminated when goat milk is fed to infants. Pasteurized goat milk is well tolerated by the infants with gastro intestinal or respiratory symptoms. Fermented goats milk forms a soft curd when compared to cow's milk and hence helps in easy digestion and absorption. Regular intake of goat milk significantly improves the body weight gain, improve mineralization of skeleton, increase blood serum vitamin, mineral and haemoglobin levels. (Morgan *et al.*, 2012).

2.5 Breeds of Sheep

There are four main breeds of sheep in Nigeria. The breeds are Balami, Uda, West African Dwarf Sheep and Yankasa. Balami is most predominant in the North eastern part of Nigeria as described by Adu and Ngere, (1979) and Devendra (1997).

2.5.1 Balami. This breed is a native of Borno State and is predominantly found in North Eastern part of Nigeria. It is predominantly white and hairy with a convex head and dull expression. Males have horns while horns are absent in females. Matured males have dewlap. Balami is a fast growing animal with a good potential for milk production of 28-33kg/lactation. They attain maturity at the weight of 45-70kg in rams and 45-60kg in ewes (Devendra 1997).

2.5.2 Uda breed occurs throughout the Sahel-Sudan vegetation zone of Nigeria. It is a large and long-lopped breed with a convex facial profile. The coat colour is entirely brown or black from the forehead anterior to the limber-abdominal girth line and white posterior. The ears are long large and pendulous. The rams have large wide and spiral horns, which are usually absent in the ewes. The breed appears to thrive in hot, dry environment and suffers from poor survival outside this ecological zone; it is particularly adapted to extensive grazing and is renowned for its trekking ability. Mature weights range from 35 - 45kg for ewes and 45 – 55kg for rams (Adu and Ngere, 1979).

2.5.3 Yankasa breed is widely distributed in the northern part of Nigeria. In size it is intermediate between Uda and the West African Dwarf sheep. The coat colour of Yankasa is typically white with black patches around the eyes, ear, muzzle and sometimes the feet. The rams have curved horns and heavy hairy white mane. Some of the ewes have tassels on the neck. Mature weights are 25 – 40 kg for ewes and 35 – 50 kg for rams (Adu and Ngere, 1979).

2.5.4 West African Dwarf Sheep is widely distributed in the southern Nigeria, the breed is small compact hardy breed with a wide range of coat-colour which may be all white, black or brown or spotted black or brown on a white coat. The breed is considered to be tolerant to trypanosomiasis. Mature weights are 20 – 25kg for ewes and 25 – 30 kg for rams (Adu and Ngere, 1979).

2.6 Breed of Goats

There are three main Indigenous breeds of goats which are most adapted to Nigerian as described by Ngere *et al*. (2011).

2.6.1 Sahelian Goats: This breed is characterized by a short fine coat that could be black, red, white or spotted. They can have medium or large body size. The goats have short ears possessed horizontally, the horns drop down. Both male and female have horns, these animals well adapted for long-distance trekking, and can survive in desert areas of the country. The goats have long legs that make them adapted for nomadic life. The weight of a mature goat is 25 - 30 kg (Ngere *et al*., 2011)

2.6.2 Sokoto Red Goats. This breed of goats mostly used for meat. They are also called "Ogufe" especially in the South-west of the country. Maradi or Sokoto Red is spread mostly in the Sokoto area. This type is considered as one of the best defined among African breeds. The colour of the skin coat is red, and it is very valued for leather production. There is also a strain of such goats called Kano brown and Borno white. The goats have horns and horizontally positioned short ears. Mature animals have 20-30 kg of weight.

3.6.3 West African Dwarf Goats .This is a different breed of goat in Nigeria. Such a type of goats can be founded in forest areas of the country. The animal has a small size of body and short legs. Such characteristics allow them to move easily through thick vegetation of the forest. The colours can be different from black to white or gray or even multi-coloured. The height of a mature goat is 40 or 50 cm, and the weight is from 18 to 20kg. The breed is resistant to trypanosome and very hardy. This is another small-size type of goats. They are short and slightly chubby. The life span is ten years on average. They are characterized as very smart animals and can be great pets. They can easily adapt to different climate conditions (Ngere *et al*., 2011).

2.7 Comparative Advantages of Sheep and Goats over other Domestic Animals

The cost of acquiring or buying sheep and goats is cheaper than that of cattle. Five goats are considered to be equivalent to one cow or buffalo. Farmers can easily acquire goats than acquiring a cow. The amount used to acquire one heifer can be used to acquire several ewes or does. Therefore, more people keep sheep and goats than cattle. A programme to improve sheep and goats will help more people than the one to improve cattle owned by fewer (rich) people (Park *et al*., 2006).

The cost of feeding and maintaining sheep and goats is lower than the one to maintain cattle. They can be kept on a limited area of land (too small for cattle) and sheep and goats need very small amount of purchased animals feeds because they can thrive on poor quality roughage if situations compel them to do so, and thus help in converting poor quality feeds into valuable products at minimal cost. The quantities of products under such situations do not, however, meet the potentials of the animals (Park *et al*., 2006).

Owing to the fact that sheep and goats are ruminants and can eat food which is not suitable to human beings, the competitions for food between them and human beings is reduced compared to the competition between poultry and pigs on one hand, and human beings on the other (Park *et al*., 2006).

Sheep and goats give outputs (meats, milk, fibre, skin) in quantities that are enough for subsistent consumption by families or that can be sold in a day in the Indigenous market, thus the farmer does not suffer much from the lack of storage facilities on long term basis (Park *et al*., 2006).

Sheep and goats are more prolific than cattle. When conditions are favourable, sheep and goats can give birth eight months, and the generation interval (i.e the time between when a female animal is borne and the animal itself becoming a mother) is less than two years, about 18 to 21 months. In cattle, the calving interval is about two years and the generation interval is about four years (Park *et al*., 2006)

Their inherent ability to have multiple births, especially goats, make them to increase in number over a short period of time compared to cattle, given favourable environment (Park *et al*., 2006).

If there were 10 or 15 sheep and goats in a flock, for an example, they may not be all wiped out if there was an outbreak of disease. But with the same amount of money invested in acquiring one or two cows, the loss of capital is more and total if the two cows are wiped out by an outbreak of disease (Park *et al*., 2006).

There are no cultural or religious barriers against keeping of sheep and goats or eating their meat. Muslims and Jews for example, do not keep pigs nor eat pork while Hindus do not slaughter cattle (Park *et al*., 2006).

2.8 Basic Composition of Goat and Sheep Milk

Compositions of goat, sheep, cow and human milks are different , but vary with diet, breed, individuals, parity, season, feeding, management, environmental conditions, Indigenousity, stage of lactation, and health status of the udder (Parkash and Jenness, 1968; Schmidt, 1971; Linzell and Peaker, 1971; Larson and Smith, 1974; Posati and Orr, 1976; Underwood, 1977; Jenness, 1980; Haenlein and Caccese, 1994; Ju`arez and Ramos, 1986; Park, 1994,). Sheep milk contains higher total solids and major nutrient contents than goat and cow milk. Sheep colostrum in the early post-partum period is also higher in basic nutrients than cow colostrum: fat 13.0% and 5.1%, protein 11.8%

and 7.1%, lactose 3.3% and 3.6%, minerals 0.9% and 0.9%, total solids 28.9% and 15.6%, respectively (Anifantakis, 1986).

2. 9 Milk Composition

Milk is a colloidal suspension of solids in liquid. Fluid whole milk is approximately 88% water, 8.6% solid Non-fat (SNF) and 3-4% milk fat. The SNF is the total solid minus the milk fat and it contains protein, lactose and minerals (USDA, 2007). The first milk a female produces after the young is born is called colostrum (Ontsouka *et al*., 2003). For the next several milking, the milk is called transitional milk and it is not legally stable until the 11th milking (Miller *et al*., 1995). Colostrum is higher in protein, minerals and milk fat than milk, but it contains less lactose. The most remarkable difference between colostrum and milk produced latter is the extremely high immunoglobulin content of colostrum (Miller *et al*., 1995).

2.9.1 **Milk Fat**

In whole milk, the approximate 3-4% of fat is a mixture of lipids existing as microscopic globules suspended in the milk (Van Neuwenhove *et al*., 2009). Milk derives most of its distinctive properties from lipid fraction. The average total fat content of goat milk is similar to that found in other ruminant species (Keenan and Patton, 1995). Although there are reports that the percentage of goat fat exceeds those of a cow, such misconception is most likely derived from the fact that the average per cent fat of goats and cow milk is a variable components often ranging between 3.0 and 6.0 per cent (Barnet and Federic, 2003). Fatty acids in goats, sheep and cows milk fat are arranged in the triglycerides in accordance with a pattern that appears to be universal among ruminants (USDA, 2007). A major difference between the milk fat of ruminants is the percentage distribution among specific short chain fatty acids. The fat in goats

Table 2.1. **Mean and Standard Error of Milk Composition (%) in Goats as Influenced by Breed, Stage of Lactation, Season and Parity**

Factor	N	Crude protein	Fat	Total solid	Ash	pH	Lactose
Overall	100	3.52 ±0.02	4.77±0.01	11.53 ±0.07	0.87±0.12	6.25 ±0.06	4.55 ±0.02
Breed		***	***	*	NS	NS	***
Red Sokoto	40	3.84 ± 0.03^{a}	4.38 ± 0.02^{c}	11.30 ± 0.09^{b}	0.84 ±0.16	6.32 ±0.08	4.90 ± 0.03^{a}
Sahel	32	3.45 ± 0.03^{b}	5.16 ± 0.02^{a}	11.67 ± 0.11^{a}	1.08 ±0.19	6.21 ±0.09	4.46 ± 0.04^{b}
West African Dwarf	28	3.27 ± 0.04^{c}	4.74 ± 0.03^{b}	11.63 ± 0.12^{a}	0.70 ±0.21	6.21 ±0.10	4.29 ± 0.004^{c}
Lactation stage		***	***	NS	NS	NS	***
Colostrum	25	3.85 ± 0.04^{a}	5.35 ± 0.03^{a}	11.59 ±0.12	0.73 ±0.21	6.18 ±0.10	5.02 ± 0.04^{a}
Early lactation	25	3.66 ± 0.04^{b}	4.97 ± 0.03^{b}	11.43 ±0.12	0.79 ±0.21	6.36 ±0.10	4.72 ± 0.04^{b}
Mid lactation	25	3.38 ± 0.04^{c}	4.62 ± 0.03^{c}	11.51 ±0.12	1.12 ±0.21	6.33 ±0.10	4.40 ± 0.04^{c}
Late lactation	25	3.20 ± 0.04^{d}	4.13 ± 0.03^{d}	11.61 ±0.12	0.79 ±0.21	6.11 ±0.10	4.07 ± 0.04^{d}
Season		NS	***	NS	NS	NS	***
Dry	56	3.52 ±0.03	4.49 ± 0.12^{b}	11.56 ±0.10	0.66 ±0.17	6.26 ±0.08	4.25 ± 0.03^{b}
Wet	44	3.53 ±0.03	5.04 ± 0.02^{a}	11.50 ±0.11	1.09 ±0.18	6.23 ±0.09	4.85 ± 0.03^{a}
Parity		NS	***	NS	NS	NS	***
1	60	3.49±0.03	4.39 ± 0.02^{c}	11.58 ±0.08	0.97 ±0.13	6.32 ±0.07	4.03 ± 0.02^{c}
2	20	3.55 ±0.04	4.73 ± 0.03^{b}	11.68 ±0.15	1.00 ±0.26	6.28 ±0.13	4.85 ± 0.04^{b}
3	20	3.57 ±0.05	5.54 ± 0.03^{a}	11.35 ±0.15	0.65 ±0.27	6.14 ±0.13	5.30 ± 0.05^{a}

*n = sample size, NS = Not significant, * $P < 0.05$, *** $P<0.001$, [a,b,c]Mean in the same column within a subset having different superscripts are significantly different*

Source: (Zahradeen, 2007).

milk has more short-chain fatty acids than cow milk (Nicolos *et al*., 2004). Table 2.2 shows the average per cent milk fat of different ruminant animal species as reported by various authors.

2.9.2 Milk protein

Milk contains approximately 3.3-6.0% protein. Protein accounts for about 38% of total Solid and solid non-fat and about 22% of the calories of whole milk (USDA, 2007). The two classes of protein in milk are casein and whey protein. The casein amount for an approximately 80% of the total protein content while whey account for about 20% (USDA, 2007). Casein occurs in milk as a calcium salt and it is probably dispersed as a colloidal complex (physical or chemical) with calcium phosphate. The whey proteins that remain in solution or suspension after precipitation of the casein by acid may be salted out by various combination of salt (Anon, 1990). The milk protein has a high biological value and therefore a good source of essential amino acids (Clare and Swaisgood, 2000).Table 2.3 shows the average per cent milk protein of different ruminant animal species as reported by various authors.

2.9.3 Ash

The total ash (calcium, phosphorus etc.) content constitutes 0.6-0.8% of the total weight in the analysis of milk, this fraction occurs as the ash (the residue left after the milk has been Incinerated) (Wong *et al.,* 1988). The total ash content of goat and cow's milk which ranges from 0.78mg to 1mg per 100g milk is a little lower than that found in sheep milk (Insel *et al*., 2004), however the relative percentage of the ash components appear to be comparable (Lindmark *et al*., 2000).

As nutritional value of milk is often evaluated in terms of a variable calcium and phosphorus, it must be realized that concentrations of the various elements of the ash

Table 2.2: Average Milk Fat (%) of Different Ruminant Animals

Cow	Goat	Sheep	Buffalo	Sources
3.90	4.50	7.20	7.40	Wong *et al*., (1988)
3.34	4.14	7.00	4.38	Alichanidis & Polychroniadou,(1996)
3.90	3.50	6.00	8.00	USDA, (2007)

Table 2.3: **Average Milk Protein (%) of Different Ruminant Animals.**

Cow	**Goat**	**Sheep**	**Buffalo**	**Source**
3.30	3.20	4.60	3.80	Wong *et al*. (1998)
3.29	3.56	5.98	1.03	Alichanidis and Polychroniadou (1996)
3.20	3.10	5.40	4.5	USDA (2007)

fraction demonstrate a wide variation not only in response to the various stages in the lactation cycle, but on a daily basis as well (Neville *et al*., 1995; USDA, 2007).Table 2.4 shows the average per cent milk ash of different ruminant animal species as reported by some authors.

2.9.4 Lactose

Lactose is the major carbohydrate that has been identified in milk (USDA, 2007). It is a disaccharide composed of glucose and galactose which are liberated when lactose is hydrolysed either by lactase or bacteria. The amount of lactose in milk ranges from 3.5 to 5.0% (Anon, 1990). The lactose in concentration of goat and sheep are usually found to be lower than that of cow milk, but the magnitude of the difference is hard to quantify because of variation in methods of analysis employed (Akinsoyinu *et al*.,1977).Table 2.5 shows the average per cent milk lactose of various ruminant animal species as reported by different authors.

2.9.5 Calcium

Calcium is a nutrient that all living organism needs; including humans. It is most aboundant minerals in the body and it is vital for bone health. Human needs calcium to build and maintain strong bone and teeth. It is also necessary for maintaining healthy communication between the brain and other part of the body. It play a role in muscles movement and the cardiovascular function. Calcium occurs naturally, peoples also need vitamin D and this vitamins comes from fish oil, fortified dairy product and exposure to sunlight (Visioli,2014).

2.9.6 Phosphorus

Phosphorus is minerals found in the bones. Along with calcium, phosphorus is needed to build strong healthy bones. As well as keeping other part of the body healthy' milk and milk product are high in calcium and phosphorus. A half cup of milk (4ounce) contain 111-138mg of phosphorus. Some liquid dairy substitute can be used in cooking to replace milk (Jaswinder et al., 2018).

2.9.7 pH

pH level of milk is around 6.5-6.7 and since it falls below the neutral pH of 7.0 we can say that it is slightly acidic. Body works constantly to keep the healthy balance. This includes balancing acidity and alkalinity, also known as pH level. body carefully control the pH level of fluid such as blood and digestive juices. Blood has pH range of 7.35-7.45. (Alistair S.2007).

2.10 Factors that Affect Milk Quality and Quantity

2.10.1 Age

Age is closely related to body weight and parity (lactation number) as it affects milk production (Devendra and Burns, 1982). Both milk fat and protein tend to decline as the animal becomes older (Bailey *et al.*, 2005). Milk fat falls about 0.2% each year from the first to fifth lactation likely as a result of higher production and more udder infection. Protein decrease by 0.02 to 0.05% each lactation as animal grows older in age (Bailey *et al.*, 2005). In West African Dwarf goats, the average fat content increases from 1^{st} to 6^{th} partly from 6.8% to 7.8%, total protein content 5.8% to 6.2% and later on decreases as the animal grows older and the level of production increases. Similarly, milk yield increases with the first six years of age of the animal. After these stages, the milk yield and composition of the animal begins to decrease as it grows older. (Gall, 1981, Midau *et al*., 2010).

Table 2.4: Average Milk Ash (%) of Different Ruminant Animals.

Cow	**Goat**	**Sheep**	**Buffalo**	**Source**
0.70	0.80	0.80	0.80	Mahoney,(1988)
0.72	0.82	0.96	0.20	Alichanidis and Polychroniadou (1996)
0.70	0.86	0.90	0.21	Web and Johson (1965)

Table 2.5: **Average Milk Lactose (%) of Different Ruminant Animals.**

Cow	Goat	Sheep	Buffalo	Source
4.60	4.30	4.80	4.80	Wong *et al*. (1988)
4.66	4.45	5.36	6.89	Alichanidis and Polychroniadou (1996)
4.70	4.10	4.80	6.74	Harlan and Artfied (2008)
4.90	4.27	4.81	6.68	Webb *et al.* (1995)

2.10.2 Length of lactation and dry period

Lactation period is the time from calving until the animal is dried up. This period is usually 300-305 days in cows, 70-90 days in sheep and 100-110 days in goat, with the limit of 265-340 days (38-49 weeks) in cow depending on the open period (the time between calving and conception) (Jamrozik *et al*., 2007). Some goat's milk producers breed high yield goats only every second year to ensure continuity of milk production with a resulting lactation of up to 22 months. However, the more usual practice is to breed them annually resulting in a lactation of ten months and dry period of two months. Non-dairy breeds may not lactate this long, and then the dry period will be longer than two months (Devendra and Burns, 1982). Short dry period reduces subsequent milk yield (Schmidt and Vanvleck, 1974).

2.10.3. Stage of lactation Within species and within breed, stage of lactation, regardless of species or breed has the greatest influence on milk composition as change in milk constituents occur as lactation advances (Devendra and Burns, 1982).It was reported that there was a rise in fat content of milk with the advancing lactation in West African dwarf goats with peak milk yield reached between the 8^{th} and 12^{th} week of lactation (Mba *et al*., 1975). As the yield decreases, there is a resultant decrease in solid non- fat to the end of the lactation (Yetismeyen, 2000). The stage of lactation affect milk protein and fat percentage, the highest percentage of fat and protein in milk is found just after parturition. The levels drop to their lowest point between 25 and 50 days (Bailey *et al*., 2005).

2.10.4. Nutritional effect of milk quality and quantity

Regardless of genetics, the composition of the daily diet and its amount in relation to production requirement can cause significant change in milk composition (Haenlein, 1992). For good quality milk, a complete sensitive feeding system with complete diet of hay, silage and concentrate mixed together (TMR, total mixed ration) is therefore required. Energy shortage in the diet can change the fatty acid composition of milk fat towards more medium-chain fatty acids, with low daily milk yield and high fat content (Morian-Fehr, 1981; Bailey *et al*., 2005).

When grain concentrate supplementation makes up more than 50% of the daily dry matter intake by goat, sheep and cow, there will be decreased chewing, less rumination and shortage of salivation of rumen content which will lead to low milk constituents (Kawas *et al*., 1991). To prevent a decreased rumen pH, the feeding of buffer with sodium bicarbonate and magnesium oxide is beneficial (Hadjipanayiotou, 1988). This has been shown in several studies, where yields were even increased while restoring milk fat content to an optimal level (Bailey *et al*., 2005).

2.10.5. Udder Health

Mastitis conditions affect milk composition in sheep as it does in cow or goat milk, except that somatic cell counts (SCC) in milk is more related to pathogenic condition in sheep (Bufano *et al*., 1996). Milk from mastitis udders exhibits greatly increased proteolysic activity. This proteolysis leads to a decrease in relative proportion of casein protein of animals (Auldist *et al*., 1995). With increase in SCC, it has been reported that milk pH, whey protein, fat content, rennet clotting time and rate of clot firmness decreased (Diaz *et al*., 1996). It has not been determined, however whether the deterioration of rennin characteristics is due primarily to the normal physiological SCC increase at the end of lactation and the concurrent change in milk composition, or to subclinical and clinical mastitis conditions in the udder, which also produces high SCC and changes milk composition (Haenlein *et al*., 2006).

2.10.6. Multiple births

Mammary growth during gestation is said to be affected by the number of kids and have subsequent effect on milk production which is dependent on age, body mass and season (Gall, 1981). Linda *et al. (*2004) found no evidence of effect of litter size on milk yield and composition. However, Browning *et al*. (1995) found that alpine that gave birth to singles had a lower milk production than those with twins and triplet despite removal of kids at birth.

2.11 Effect of season on milk composition

There are clear seasonal variaton differences in milk composition of the major and minor components (Renner, 1982) but they are confounded with climate changes which have influence on the milk composition. Negative correlation had been observed between high environmental temperature and the amount of fat and protein (Ozrenk and Selcuk, 2008)

2.11.1. Effect of season on milk protein

Silvia *et al*. (2011) reported that there was a significant change in the protein content as a result of seasonal factors. In an experiment to evaluate the effect of season on milk composition, Chilard *et al*. (2001) worked on Turkana sheep fed on fresh forages both in summer and early autumn (April to September) and found that milk protein was affected by season. The highest content was in August and September with the value of 7.08% and lowest 3.39%, respectively. This is because forages have high nutrient value during the raining season (August to September) than in the dry seasons. A high-light to dark ratio leads to a consequence of greater secretion whose concentration in plasma is higher in the raining than in the dry season (Tucker, 1989). Some studies showed that the amount of short chain fatty acids in the milk varies significantly with season.

It has been found that fat content reaches its highest value in the summer and lowest value in the winter (Silvia *et al*., 2011). Investigations show that the amount of tocopherol is elevated during winter months and summer months (Lindmark-Mansson and Akesson, 2000; Lock and Gansworthy, 2003). Muhuyi *et al*. (2000) reported that fat content of in cow milk is about 0.72% higher in dry season in Sahiwaland Friesian-sahiwal cows. Sharma *et al.* (2002) on the contrary stated that fat per cent of milk is not influenced by season of the year.in addition Sevi *et al*. (2004) reported that protein composition of cow milk is affected by season of the year with the highest percentage in the winter (Silvia *et al.*, 2011).

This may be ascribed to a high-light- to dark ratio leading to reduction in fat and protein contents of milk, probably as a consequence of greater secretion of prolactin whose concentration in plasma is higher in the summer than the winter. On the contrary, Yeikyo *et al*. (1963), Sharma *et al.* (2002) and Ozrenk and Selculk (2008) reported that the influence of season on the protein content is not remarkable as compared with other constituents of milk. Table 2.6 shows the per cent milk protein at different season.

2.11.2. Effect of season on milk fat

Hot season depress as fat content of milk with gradual increase during the colder period (cold). Sharma *et al.* (2002) reported that there is about 0.74% increase in fat content in cold dry months than in wet season. Midau *et al*. (2010) found milk fat to be statistically similar in Sokoto Red goats in different seasons of the year. However, there was about 0.27% increase in fat of cows calving in January (winter) than the cows that calve in July (summer) in the 270 days of lactation (Ozrenk and Selculk, 2008 ;). Table 2.7 shows the per cent milk fat of milk of different species of ruminant animals as affected by season.

Table 2.6: **Per cent (%) Milk Protein at Different Seasons**

Specie	Dry	Rainy	Sources
Goat	4.46	4.31	Banda *et al*., (1987)
Sheep	4.58	4.84	Banda *et al*., (1987)
Goat	3.52	3.53	Zahraddeen , (2007)
Cow	3.40	3.30	Silvia *et al*., (2011)
Cow	2.86	2.79	Ozrenk (2008)
Cow	3.75	3.50	Bansal *et al*., (2009)

2.11.3. Effect of season on total solids

Seasonal variations characterized in the concentrations of several constituents of goat's milk in a manner that is analogous to that observed in dairy cattle. Such variations include fluctuations in the amounts of fat, solid non- fat and total solids. These concentrations are found to increase in winter months and early spring than in summer months (Bruhn and Frank, 1997). Muhuyi *et al.* (2000) worked on effect of season on Sahiwal and Friesian cross bred cows reported that total solids content was about 1.34% higher in dry season.

2.11.4. Effect of season on lactose

Like other components of milk, lactose is also affected by season. Silvia *et al*. (2011) working on effect of season on cow milk composition reported high lactose content in winter season than during spring and summer seasons and during autumn season than spring season.

Low value during the dry season may be linked to poor nutrition during this season (Zahraddeen *et al*., 2007).

2.12 Nutritional Value of Goat Milk

Although the production volume of goat milk is relatively small in total world milk supply, nutritious that it can actually serve as a substitute for a meal. It is also preferred due to its low fat content and its capability to neutralize the acids and toxins present in the body. Cow milk is mucus forming for many people; however, goat milk is not only non-mucus forming, but actually helps to neutralize mucus. It is known for its superior in calcium content, in comparison with other animals' milk and the healing enzymes present in it).

Table 2.7: Per cent (%) Milk Fat at Different Seasons

Specie`	Dry	Wet	Sources
Cow	4.76	4.02	Muhuyi *et al*., (2000)
Cow	4.64	4.44	Sharma *et al*.,(1998)
Goat	4.84	5.01	Midau *et al*., (2010)
Cow	3.70	3.40	USDA, (2007)
Goat	6.71	6.80	Banda *et al*., (1987)
Sheep	6.14	5.90	Banda *et al*., 1987
Goat	4.49	5.04	USDA, 2007

Children with problems digesting cow's milk may have a viable alternative in raw goat's milk which is the second best food option, first being mother's milk, that can consume comfortably, even if they are sensitive to cow or other animals milk.

In fact, goat's milk is very similar to human milk, children who drink goat's milk tend to remain more satisfied between meals and sleep through the night (Park, 2006).goat keeping has a significant economic importance in countries where climatic conditions are not favourable for cattle raising (Park, 2006). Goat's milk is the most complete food known which is highly compatible and nourishing natural food(Biswas, 2006). It is so highly

The vitamin and mineral content of goat's milk and cow's milk are fairly similar, though goat's milk contains a bit more calcium, vitamin B6, vitamin A, potassium, niacin, copper and the antioxidant selenium. On the other hand, cow's milk contains more vitamin B12 and much more folic acid. Since goat's milk contains less than ten percent of the amount of folic acid contained in cow's milk, it must be supplemented with folic acid (Tracey, 2001). For this reason, be sure you get a goat's milk that is supplemented with folic acid, which the best brands usually are. Generally, the American Academy of Pediatrics does not recommend the use of goat's milk products in infants under one year because they can cause intestinal irritation and anaemia. Infants under one year of age who are allergic to cow's milk-based formulas, soy formulas or hypoallergenic formulas are sometimes put on goat's milk formula, but only with consultation from baby's doctor or a paediatric nutritionist (Tracey, 2001). Glycerol ethers are much higher in goat than in cow milk which appears to be important for the nutrition of the nursing new born. Goat milk also has lower contents of erotic acid which can be significant in the prevention of fatty liver syndrome. However, the membranes around fat globules in goat milk are more fragile which may be related to their greater susceptibility to develop off flavours than cow milk (Haenlein, 1992)

2.13 Nutritional Value of Sheep Milk

The nutritional value of sheep milk is higher than that of goat and cow milks, with higher levels of proteins, lipids, minerals, and vitamins essential to human health and a caloric value corresponding to 5932 kJ/kg (Haelein, 2001; Kaminarides *et al*., 2007; Park *et al*., 2007; Barłowska *et al*., 2011). Sheep milk contains almost twice as much protein as goat and cow milks. These proteins molecular forms and amino acid sequences have nutritional quality, as well as positive impact on digestibility, and thermo stability (Claeys *et al*., 2014). Sheep milk has higher serine, alanine, histidine, valine, and lysine contents, whereas the cystine and glycine contents are lower. The high nutritional value of sheep milk is also related to the proline content, which affects the production of haemoglobin (Molik *et al* 2012). Triacylglycerols (TAGs) constitute the largest group of lipids (nearly 98%), and they include a large number of esterified fatty acids. The TAG profile of sheep milk shows similarities to that reported for cow milk. However, sheep milk has a higher percentage of medium-chain TAGs (C26–C36) than cow milk and a lower proportion of long-chain TAGs (C46–C54) medium chain TAGs have lower melting points and smaller molecular sizes. They are liquid at room temperature and less energy dense (Recio *et al*., 2009). Sheep milk fat is highly saturated (65 to 75 g/100 g of total fatty acids) with 11% short- and medium-chain fatty acids (Revilla *et al*., 2017); the fatty acid content of sheep milk does not substantially differ from cow milk in butyric acid (C4:0) content, but it contains more saturated fatty acids, such as caproic (C6:0), caprylic (C8:0), and capric (C10:0) acids. Low concentrations of butyric acid contribute to the inhibition *in vitro* of the human cancer cell lines, although caproic, caprylic, and capric acids could reduce body weight and body fat (Rasmussen *et al*., 2010; Foglietta *et al*., 1998).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

The study was conducted in four ecological zones of Nigeria; one location was randomly selected in each of the zone. The locations included Jalingo Taraba state in Northern Guinea Savannah, Mubi of Adamawa State in Southern Guinea Savannah, Gwale of Kano state in Sudan Savannah and Maiduguri of Borno State in Semi-Arid/Arid Zone.

3.2. Description of Location

3.2.1 Southern Guinea Savannah

Southern Guinea Savannah lies on latitude 8^{O} 30^{I} North and longitude $4^{0}33^{1}$ East. It has a total annual rainfall of 1327 mm for 2005 and 1209 mm for 2006 and is characterised by a mean rainfall above 500 mm; the mean temperature is 33.3^{0}C.The dry season is shorter and last for four to five month. It has wood land vegetation with tall grasses up to 3 m high the trees are short with large and broad leaves. The states that fall in this zone include Taraba, Kogi, Nasarawa, FCT, Kwara and Niger (Areola *et al.,* 1982: Sawunmi and Akintola 2010).).

3.2.2 Northern Guinea Savannah

NGS zone lies on latitude $11^{0}11^{1}$ North, longitude 7^{0} 38^{I} East and at an altitude of 686m above sea level. The climate is relatively dry, with an annual rainfall ranging from 700 to 1400 mm occurring between the months of April and early October. The dry season begins around the middle of October with dry cold weather (harmattan) that ends in February. This is followed by relatively hot-dry weather from March to April when rain begins. The minimum and maximum temperatures range from 19 and 39^0C, and the relative humidity varies between 35% in dry season to 80% in wet season. The states that fall in this zone include Southern Bauchi, Adamawa, Kaduna and Southern Katsina (IAR, 2013: Sawunmi and Akintola 2010).

3.2.3 Sudan Savannah

Sudan Savannah zone is situated between latitude 9^o30^1 and 12^o31^1 North and longitude 4^0 and 14^1 East which covers about 22.8million hectare representing about one quarter of Nigeria's geographical area. The average precipitation per year here is between 500-1000 mm. The region is characterised by high annual average temperature (28 to 32^oC), short wet season and long dry season (7-9 months), abundant short grasses (<2m) and few scattered trees. The states that fall in this zone include Sokoto, Kebbi, Zamfara, Katsina, Kano and Yobe. (Sawunmi and Akintola 2010).

3.2.4 Semi-Arid/Arid zone

Semi-Arid/Arid zone is situated on latitude 11^0 51^1 North, longitude 30^0 05^1East and at Altitude 354 m above sea level. It falls within the sahellian region (semi-arid zone) of Africa, which is characterised by short duration (3-4 months) of rainfall. Rainfall varies from 300 to 500 mm, ambient temperature are highest by April and May and is in the range of 30 to 35^0C while relative humidity ranges from 45 to 50%. The states that fall within this zone include Northern Borno, Yobe, Sokoto and Northern Jigawa (Kelou, 2005).

3.3 Experimental Animals and Management

The animals used in this study were eighty four (84) comprising of forty eight sheep and thirty six goats reared by small-holder farmers. The breeds of sheep include Balami, Uda, West African Dwarf and Yankasa, while the breeds of goat are Sokoto Red, West

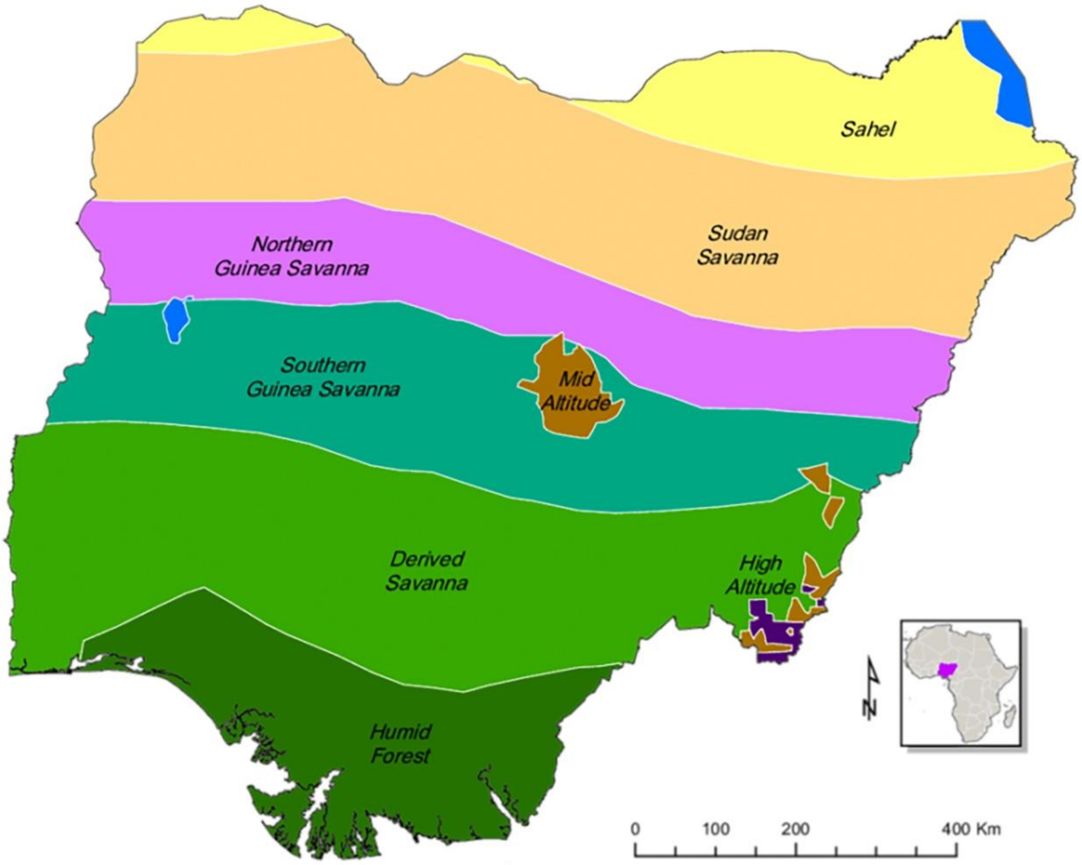

Fig. 3.1: Map of the Study Area

Source: Jeffrey (2013)

African Dwarf and Sahel goats that are kept and managed under the small-holders' husbandry system in Nigeria. These breeds have been previously described by Fasae et al. (2015).

The small-holder husbandry system has been described by Butswat and Bello (2002). The management system is mostly traditional and this ranges from free-range grazing and browsing with little or no supplementary feeding during the non-cropping period to tethering with zero grazing during the cropping season (Butswat and Bello, 2002).

The animals moved about freely and were fed forages which were abundantly available during raining season beside the road side and other feed sources such as house vegetable refuse dump. They fed on leaves and crop residues during dry season. During the raining season, forage was available (giant star grasses) and centro (centrosemo pubescens).

The farmers within the study locations gave supplement in form of kitchen wastes as peels (yam and potatoes) in Jalingo, brewer dried grain, industrial by-product of processed food in Kano and Potash (Kanwu) stover from millet and maize mostly in Mubi .and Maiduguri. Groundnut haulms, kitchen waste, cowpea husk, stalk, grain chaff and salt lick were also supplement in all location. Animal in which the backbone cannot even be felt with firm pressure, the lumber processes, cannot be felt because of the fat covered and full eye muscle has very thick fat covered which may be flabby, and the age of the animal selected is about 20-22 month. Milk sample had collected early in the morning younger ones are introduce to stimulate the milk let down.

3.4 Data Collection

The data for the study were collected over a period of six months covering both the dry and wet seasons. The dry season between October and December while the wet season between August and early October.

3.5 Milk Sample Collection

Five millimetres (5mm) of milk was collected from eighty-four animals in the two seasons into a clean and dry 10 ml empty sample bottle using hand milking then quickly transported to the laboratory for analyses. The milk from animals are collected early in the morning, and animal were stimulated using their offspring or younger ones. The udder of animals would be clean before the milk collection. The samples were quickly transported inside the ice spark to the laboratory for analysis. The milk samples were stored in deep-freezer cabinet at about -5^{0}C until required for analysis. Before analysis each sample was thawed at 40^{0}C to melt the fat and then cooled to 20^{o}C.

3.6 Milk Sample Analyses

The milk samples were analyzed at the Laboratory of Department of Animal Science, Faculty of Agricultural Science, Adamawa State University, Mubi. The parameters that were determined are lactose, total solid, solid non-fat, protein, fat, ash, calcium and phosphorus.

Proximate analysis total solids (TS) and ash contents (AC) were determined by using the method reported by Association of Analytical Chemists AOAC, (2000). Lactose content (LC) were determined by difference % Lactose =% total solids - (% fat+ % protein+ % total ash) (Mahoney, 1988). Protein content (PC) was determined by Kjeldahl method (Barłowska *et al.*, 2011). Fat content, Gerber method (Mahoney, 1988) were used to determine the milk fat content. Solids non-fat (SNF %) was determined by difference. These were done by subtracting the per cent fat from per cent total solids. %SNF = %TS – %fat (Mahoney, 1988). Calcium can be determine by the use of atomic absorption spectroscopy and phosphorus by colorimetry with measurement of phosphomolybdenum blue complex at 880nm for maximum sensitivity. pH is determine by calculating using the expression pH=log($H30^+$). (Buck et al 2002).

3.7 Determination of Age

The age of the animals was determined by dentition method as reported by Butswat (1994) in table 3.1.

3.8 Determination of Body Condition

Body condition score was determined as per the procedure laid down by Jefferies (1961) and Butswat (1994). In table 3.2

3.9 Data Analysis

Data generated were subjected to the analyses of variance (ANOVA) SAS (2002) method using Completely Randomized Design (CRD) and significant means were subsequently separated using Duncan's Multiple Range Test (DMRT) method described by Humburg (1977).

3.10 Experimental Model

$X_{ij} = \mu + T_i + eij$

Table 3.1: Determination of age in sheep and goats

Age (months)	Dentition
12	All temporary teeth present
24	2nd central permanent incisors
48	2nd pair permanent incisors
60	3rd pair premolars
72	4th corner molars

Source: Butswat (1994)

Table 9: Determination of Body Condition

Score	Animal body condition
0	Animals emaciated and at the point of death
1	Animals have prominent backbone with virtually no fresh around the bones; sharp lumbar processes and thin eye muscle
2	Animal have prominent but smooth backbone and rounded lumbar processes and eye muscles with moderate depth and little fat.
3	Animal have smooth and rounded backbone with good fat coverage
4	Animal have barely detectable backbone, lumber processes thickly covered by muscles and full eye muscle with thick fat coverage
5	Animal in which the backbone cannot even be felt with firm pressure, the lumber processes, cannot be felt because of the fat covered and full eye muscle has very thick fat covered which may be flabby

Source:(Butswat 1994; Jefferies 1961)

Where;

X_{ij} = individual observation on jth sheep or goats in the ith factor (breeds,species, season and location)

μ = population mean

Ti = effect ith factor on milk composition

eij = random error associated with xij.

CHAPTER FOUR

4.0 RESULTS

4.1 Effects of Locations on Milk Composition in Sheep

Table 4.1 shows the Influence of locations on milk composition of Sheep. All the parameters was significantly different (P<0.01) across the four locations. Crude protein was higher (P<0.01) with the values of 5.57, in Jalingo of Southern Guinea Savannah. fat was significantly hgher (P<0.01) in Jalingo, Gwale and Maiduguri with the value of (5.99, 5.82 and 5.68%) while lower in Mubi with the value of (3.18%), pH was significantly higher (P<0.01) with the value of (6.69, 6.61) in Jalingo and mubi while lower in Gwale and Maiduguri with the value of (6.42, 6.41), Ash was significantly higher (P<0.01) in Gwale and Maiduguri with the value of (0.87,0.84%). Lactose was significantly higher (P<0.01) in Mubi, Gwale and Maiduguri with the value of (4.75, 4.91, 4.91%). Phosphorus and calcium was significantly higher (P<0.01) in Gwale and Maiduguri with the value of (145.20, 145.22; 196.58, 196.88mg/ml). Solid non-fat and total solid was significantly higher (P<0.01) in Jalingo with the value of 8.40 and 14.39%.

4.2 Effects of locations on Milk Composition in Goats

The Influence of locations on milk composition of Indigenous goats is shown in Table 4.2 Crude protein was significantly higher (P<0.01) in Jalingo Mubi and Gwale. with the value of (4.12, 3.84, 4.24%). Fat was significantly higher (P<0.01) with the values of (4.64, 4.95%) in Jalingo and Gwale while lower in Mubi and Maiduguri with value of (3.14, 3.73%), pH was significantly different (P<0.01) higher in Jalingo and Mubi with the value of (6.58, 6.57) while lower in maiduguri with the (6.20), Ash was significantly higher (P<0.01) in Gwale and Maiduguri with the value of (0.79, 0.70%

Table 4.1: Influence of Location on Milk composition of Sheep

Parameters (%)	Location				SEM	LOS
	Jalingo	**Mubi**	**Gwale**	**Maiduguri**		
N	12	12	12	12		
Crude protein (%)	5.57^{a}	4.45^{c}	5.19^{b}	5.12^{b}	0.31	**
Fat (%)	5.99^{a}	3.18^{b}	5.82^{a}	5.68^{a}	0.42	**
pH	6.69^{a}	6.61^{a}	6.42^{b}	$6.41^{\mathbf{b}}$	0.68	**
Ash (%)	0.75^{b}	0.61^{c}	0.87^{a}	0.84^{a}	0.04	**
Lactose (%)	3.89^{b}	4.75^{a}	4.91^{a}	4.91^{a}	1.15	**
Phosphorus (mg/100ml)	75.83^{c}	111.19^{b}	145.20^{a}	145.22^{a}	9.96	**
Calcium (mg/100ml)	124.82^{c}	156.45^{b}	196.58^{a}	196.88^{a}	7.36	**
Solid Non Fat (%)	8.40^{a}	4.79^{b}	4.80^{b}	4.95^{b}	0.67	**
Total Solid (%)	14.39^{a}	8.57^{c}	12.00^{b}	12.33^{b}	0.69	**

^{a,b,c} means with different superscripts along the same row show significantly different at P<0.01, N= Numbers of animals, SEM= Standard Error of Mean, LOS= Level of Significance, **= Highly Significant at (P<0.01)

Table 4.2: Influence of Location on Milk Composition of Indigenous Goats

Parameters (%)	Location				SEM	LOS
	Jalingo	Mubi	Gwale	Maiduguri		
N	9	9	9	9		
Crude protein (%)	4.12[a]	3.84[a]	4.24[a]	3.24[b]	0.39	**
Fat (%)	4.64[a]	3.14[b]	4.95[a]	3.73[b]	0.55	**
pH	6.58[a]	6.57[a]	6.32[b]	6.20[c]	0.08	**
Ash (%)	0.56[b]	0.27[c]	0.79[a]	0.71[a]	0.07	**
Lactose (%)	4.28[b]	4.54[a]	4.66[a]	4.28[b]	0.17	**
Phosphorus (mg/100ml)	71,42[d]	91.60[c]	132.53[a]	113.42[b]	7.25	**
Calcium (mg/100ml)	107.43[c]	164.43[a]	172.18[a]	133.00[b]	10.91	**
Solid Non Fat (%)	7.80[a]	4.80[b]	4.64[b]	4.40[b]	0.64	**
Total Solid (%)	12.75[a]	9.12[b]	11.9[a]	11.77[a]	0.81	**

[a,b,c] means with different superscripts along the same row show significantly different at P<0.01, N= Numbers of animals SEM= Standard Error of Mean, LOS= Level of Significance, **= Highly Significant at P<0.01

while lower in Mubi with the value of (0.27%), lactose was significantly higher (P<0.01) in Mubi and Gwale with the value of (4.54, 4.66%) while lower in Jalingo and Maiduguri with the value of (4.28, 4.66%). Calcium was significantly higher (P<0.01) in Mubi and Gwale with the value of (164.43, 172.18mg/ml) while lower in Jalingo with the value of (107.43mg/ml). Phosphorus was significantly higher (P<0.01) in Gwale with the value of (132.53mg/ml) while lower in Mubi with the value of (91.60mg/ml) Solid non-fat was significantly higher (P<0.01) in Jalingo with the value of (7.80%) while lower in Mubi, Gwale and Maiduguri with the value of (4.60, 4.64 and 4.40%). Total solids was significantly higher (P<0.01) in Jalingo, Gwale and Maiduguri with the value of (12.75, 11.9 and 11.77%) while lower in Mubi with the value of (9.12%) from goats respectively.

4.3: Milk Composition of Indigenous Sheep and Goats in Jalingo

Table 4.3: shows the milk composition of indigenous sheep and goats in Jalingo of southern guinea savannah zone. Fat, pH, ash, lactose and calcium were significantly higher (P<0.01) with the values of (5.99, 6.69, 0.75 and 4.99%) in sheep while lower with the value of (4.64, 6.58, 4.28 and 107.42%) in goats. There was none significance difference (P>0.05) in crude protein, phosphorus, solids non-fat and total solid respectively.

4.4: Milk Composition of Indigenous Sheep and Goats in Mubi

Table 4.4: shows the milk composition of Indigenous sheep and goats in Mubi of Northern Guinea Savannah zone. Sheep significantly higher (P<0.01) in crude protein, phosphorus and total solids with the value of (5.15, 111.12mg/ml and 12.08%).

4.5: Milk Composition of Indigenous Sheep and Goats in Gwale

Table 4.5: presents the milk composition of Indigenous Sheep and goats in Gwale of Sudan Savannah zone of Nigeria. Sheep milk was significantly higher (P<0.01) in crude protein, fat, pH, ash, lactose, phosphorus and calcium with the value of (4.89%, 5.82%, 6.42%, 0.87%, 4.91%, 145.20mg/ml and 1996.58mg/ml). Solid non-fat was significantly higher (P<0.05) in sheep. There was non-significant difference in total solid.

4.6. Milk composition of Indigenous Sheep and Goats in Maiduguri

Table 4.6: shows the milk composition of indigenous sheep and goats in Maiduguri of Semi-Arid/Arid zone of Nigeria. Sheep milk was significantly higher (P<0.01) in Crude protein (4.12%) fat (5.69%), ash (0.84%) pH (6.42), lactose (4.91%), phosphorus (145.22 mg/100ml), calcium (196.88 mg/100ml), solid non-fat (9.95%) and total solid (12.33%) were higher (P<0.01) in sheep.

4.7 Influence of Specie on Milk Composition of Sheep and Goats

The Influence of specie on milk composition of sheep and goats is shown in Table 4.7. Sheep had higher (P<0.01) values of crude protein (5.23%), fat (6.10%), ash (0.89%), lactose (4.70%), phosphorus (132.22mg/ml) and calcium (172.67ptmg/ml). Solid non-fat and total solids were not significantly different (P>0.05).

4.8 Effect of Breed on Milk Composition in Sheep

Table 4.8 shows the effect of breed on milk composition of Indigenous Sheep. Breed significantly (P<0.01) affected all the parameters except fat and ash content which had no significant differences in the four breed of sheep. Crude protein, and pH, were significantly higher (P<0.01) higher in West African dwarf with the value of (6.04, 6.81%). Lactose and total solid were significantly higher (P<0.01) in Yankasa. Solid

Table 4.3: Milk Composition of Indigenous Sheep and Goats in Jalingo

	Species			
Parameters (%)	Sheep	Goats	SEM	LOS
N	12	9		
Crude protein (%)	4.57	4.12	0.61	NS
Fat (%)	5.99^{a}	4.64^{b}	0.09	**
pH	6.69^{a}	6.58^{b}	0.06	**
Ash (%)	0.75^{a}	0.53^{b}	0.13	**
Lactose (%)	4.99^{a}	4.28^{b}	0.11	**
Phosphorus (mg/100ml)	75.82	71.42	9.81	NS
Calcium (mg/100ml)	124.81^{a}	107.42^{b}	1.97	**
Solid Non Fat (%)	8.40	7.80	2.02	NS
Total Solid (%)	14.40	12.71	2.23	NS

^{a,b,c} means with different superscripts along the same row show significantly different at P<0.01, 05 N= Numbers of animals SEM= Standard Error of Mean, LOS= Level of Significance, NS= not significant, **= Highly Significant at P<0.01

Table 4.4: Milk Composition of Indigenous Sheep and Goats in Mubi

Parameters (%)	Species		SEM	LOS
	Sheep	Goats		
N	12	9		
Crude protein (%)	5.15[a]	3.83[b]	0.39	**
Fat (%)	4.18	4.33	0.2	NS
pH	6.61	6.68	0.12	NS
Ash (%)	0.89	0.87	0.03	NS
Lactose (%)	4.76	4.94	0.29	NS
Phosphorus (mg/100ml)	111.12[a]	91.60[b]	21.53	*
Calcium (mg/100ml)	156.45	164.44	16.80	NS
Solid Non Fat (%)	9.79	9.81	0.35	NS
Total Solids (%)	12.08[a]	11.22[b]	0.35	**

[a,b,c] means with different superscripts along the same row show significantly different at P<0.01, N= Numbers of animals SEM= Standard Error of Mean, LOS= Level of Significance, NS= not significant, *= Significant at P<0.05 **= Highly Significant at P<0.01

Table 4.5: Milk Composition of Indigenous Sheep and Goats in Gwale

	Species			
Parameters (%)	Sheep	Goats	SEM	LOS
N	12	9		
Crude protein (%)	4.89[a]	3.26[b]	0.33	**
Fat (%)	5.82[a]	3.64[b]	0.60	**
pH	6.42[a]	6.18[b]	0.12	**
Ash (%)	0.87[a]	0.69[b]	0.05	**
Lactose (%)	4.91[a]	4.30[b]	1.18	**
Phosphorus (mg/100ml)	145.20[a]	113.52[b]	2.04	**
Calcium (mg/100ml)	196.58[a]	135.60[b]	2.37	**
Solid Non Fat (%)	8.81[a]	7.39[b]	0.42	*
Total Solid (%)	12.01	11.76	0.63	NS

[a,b,c] means with different superscripts along the same row show significantly different at P<0.01, N= Numbers of animals SEM= Standard Error of Mean, LOS= Level of Significance, NS= not significant, *= Significant at P<0.05 **= Highly Significant at P<0.01

Table 4.6: Milk Composition of Indigenous Sheep and Goats in Maiduguri

Parameters	Species		SEM	LOS
	Sheep	Goats		
N	12	9		
Crude protein (%)	4.12[a]	3.24[b]	0.35	**
Fat (%)	5.69[a]	3.73[b]	0.62	**
pH	6.42[a]	6.20[b]	0.12	**
Ash (%)	0.84[a]	0.71[b]	0.08	**
Lactose (%)	4.91[a]	4.28[b]	0.18	**
Phosphorus (mg/100ml)	145.22[a]	113.54[b]	2.04	**
Calcium (mg/100ml)	196.88[a]	133.00[b]	2.16	**
Solid Non Fat (%)	9.95[a]	8.40[b]	0.36	**
Total Solid (%)	12.33[a]	11.78[b]	0.55	**

[a,b,c] means with different superscripts along the same row show significantly different at P<0.01, N= Numbers of animals SEM= Standard Error of Mean, LOS= Level of Significance, **= Highly Significant at P<0.01

Table 4.7: Influence of Specie on Milk Composition of Sheep and Goats

	Specie			
Parameters (%)	**Sheep**	**Goats**	**SEM**	**LOS**
N	48	36		
Crude protein (%)	5.23^{a}	3.62^{b}	0.55	**
Fat (%)	6.10^{a}	4.79^{b}	0.90	**
pH	6.52^{a}	6.38^{b}	0.16	**
Ash (%)	0.89^{a}	0.75^{b}	0.17	**
Lactose (%)	4.70^{a}	4.34^{b}	0.28	**
Phosphorus (mg/100ml)	132.30^{a}	97.52^{b}	20.34	**
Calcium (mg/100ml)	172.67^{a}	135.11^{b}	19.99	**
Solid Non Fat (%)	9.50	9.35	1.38	NS
Total Solid (%)	13.60	13.35	1.67	NS

^{a,b,c} means with different superscripts along the same row show significantly different at P<0.01, 05 N= Numbers of animals SEM= Standard Error of Mean, LOS= Level of Significance, NS= not significant, **= Highly Significant at P<0.01

Table 4.8: Effects of Breed on Milk Composition of Indigenous Sheep

	Breed					
Parameters (%)	**Yankasa**	**Balami**	**Uda**	**WAD**	**SEM**	**LOS**
N	12	12	12	12		
Crude protein (%)	4.40^{c}	5.30^{b}	5.08^{b}	6.04^{a}	0.38	**
Fat (%)	5.06	4.98	4.86	6.30	0.71	NS
pH	6.48^{b}	6.48^{b}	6.52^{b}	6.81^{a}	0.05	**
Ash (%)	0.95	0.90	0.98	0.98	1.26	NS
Lactose (%)	5.68^{a}	4.53^{b}	4.49^{b}	4.07^{b}	0.21	**
Phosphorus (mg/100ml)	112.05^{b}	143.07^{a}	136.80^{a}	106.40^{c}	12.69	**
Calcium (mg/100ml)	164.02^{b}	184.75^{a}	186.56^{a}	128.50^{c}	13.65	**
Solid Non Fat (%)	7.46^{b}	7.83^{b}	8.21^{a}	8.45^{a}	0.84	**
Total Solid (%)	16.66^{a}	15.25^{b}	14.85^{c}	14.60^{b}	1.13	**

^{a,b,c} means with different superscripts along the same row show significantly different at P<0.01, N= Numbers of animals WAD=West African Dwarf SEM= Standard Error of Mean, LOS= Level of Significance, NS= Not significant, **= Highly Significant at P<0.01

non-fat were significantly higher (P<0.01) in Uda and WAD with the values of (8.21 and 8.45%). Lactose and was significantly higher (P<0.01) in Yankasa sheep with the value of (5.68). Phosphorus and calcium were significantly higher (P<0.01) in Balami and Uda with the values of (143.07, 136.80, 184.75, 186.56mg/ml).

4.9 Effect of Breed on Milk Composition in Goats

The Effect of breed on milk composition of Indigenous Goats is presented in Table 4.9 . Crude protein and fat was significantly different (P<0.01) higher in WAD with value of (5.02 and 4.00%) while lower in Sokoto Red and Sahel goats with the value of (3.32, 3.54: 3.45 and 3.57%), pH was significantly higher (P<0.01) in Sokoto Red and WAD with the value of (6.41 and 6.55%). Lactose was significantly higher (P<0.01) in Sokoto Red and Sahel with the value of (4.38 and 4.39%) while lower in WAD with the value of (4.07%). Phosphorus was significantly higher (P<0.01) in Sahel with the value of (110.17mg/ml) while lower in WAD with the value of (90.02mg/ml). Calcium was significantly higher (P<0.01) in Red Sokoto and Sahel with the value of (135.93 and 143.57mg/ml) while lower in WAD with the value of (105.46mg/ml). Solids non-fat and total solid was significantly higher (P<0.01) in WAD with the value of (7.78 and 13.20%) while lower in Red Sokoto and Sahel with the value of (5.31, 11.00, 4.55, 11.20%) respectively.

4.10 Effect of Season on Milk Compositional in Sheep

Table 4.10 shows the influence of season on milk composition of Indigenous sheep. The parameters were not significantly different (P>0.05) across the two seasons except for solids non-fat which was significantly higher (P<0.05) in dry season with a value of (11.96%) while lower with the value (11.23%) in wet season in sheep respectively.

Table 4.9: Effect of Breed on Milk Composition of Indigenous Goats

	Breed				
Parameters (%)	Red Sokoto	WAD	Sahel	SEM	LOS
N	12	12	12		
Crude protein (%)	3.32^{b}	5.02^{a}	3.54^{b}	0.23	**
Fat (%)	3.45^{b}	4.00^{a}	3.57^{b}	0.27	**
pH	6.41^{ab}	6.55^{a}	6.30^{b}	0.12	**
Ash (%)	0.48^{b}	0.77^{a}	0.56^{b}	0.12	**
Lactose (%)	4.38^{a}	4.07^{b}	4.39^{a}	0.14	**
Phosphorus (mg/100ml)	98.91^{b}	90.02^{c}	110.17^{a}	6.88	**
Calcium (mg/100ml)	135.93^{a}	106.46^{b}	143.57^{a}	10.96	**
Solid Non Fat (%)	5.31^{b}	7.89^{a}	4.55^{b}	1.01	**
Total Solid (%)	11.00^{b}	13.20^{a}	11.20^{b}	1.25	**

^{a,b,c} means with different superscripts along the same row show significantly different at P<0.01, WAD= West African Dwarf, N= Numbers of animals SEM= Standard error of Mean, LOS= Level of Significance, **= Highly Significant at P<0.01

Table 4.10: Influence of Season on Milk composition of Indigenous Sheep

	Season			
Parameters (%)	Dry	Wet	SEM	LOS
N	42	42		
Crude protein (%)	4.90	5.01	0.58	NS
Fat (%)	5.88	5.91	1.04	NS
pH	6.54	6.53	1.16	NS
Ash (%)	0.72	0.66	0.18	NS
Lactose (%)	4.94	5.06	0.33	NS
Phosphorus (mg/100ml)	128.40	118.19	23.41	NS
Calcium (mg/100ml)	177.36	167.99	22.56	NS
Solid Non Fat (%)	11.96^{a}	11.23^{b}	1.35	*
Total Solid (%)	15.96	15.05	1.72	NS

^{a,b,c} means with different superscripts along the same row show significantly different at P<0.01, N= Numbers of animals SEM= Standard Error of Mean, LOS= Level of Significance, NS= Not significant, *= Significant at P<0.05

4.11 Effect of Season on Milk Composition in Goats

Table 4.11 shows the influence of season on milk composition of Indigenous goats. The crude protein, pH, ash, lactose, phosphorus and calcium were not significantly different (P>0.01). Fats, solids non-fat and total solids was significantly higher (P<0.01) in wet season with the values of (4.74, 13.61 and 17.87%) while lower in dry season with the value of (3.38, 11.78 and 16.58%) in dry season respectively.

4.12: Correlation Matrix of Sheep Milk Composition

Table 4.12 show the overall correlation matrix of sheep milk components. There were significant positive and negative differences (P<0.05) correlation between most of the milk component parameters. The positive correlation between crude protein and fat was (0.64), crude protein and pH was (0.38), crude protein and solid non-fat (0.25), fat and ash (0.53), pH and ash (0.63), pH and lactose (0.36), pH and solid non-fat (0.40), ash and total solid (0.41), lactose and phosphorus (0.31), lactose and calcium (0.36), phosphorus and calcium (0.29), solid non-fat and total solid (0.73).

The negative correlation between crude protein and lactose was (-0.29), crude protein and phosphorus was (-0.77), fat and lactose (-0.40), fat and phosphorus (-0.56), fat and calcium (-0.61), pH and phosphorus (-0.67), ash and lactose (-0.48), ash and calcium (-0.44), lactose and total solid (-0.31), phosphorus and solid non-fat (-0.57), calcium and solid non-fat (-0.47), calcium and total solid (-0.57) and solid non-fat and total solid (-0.56).

4.13 Correlation Matrix of Goat’s Milk Composition

Table 4.13 shows the overall correlation matrix of goat milk components. There were significant positive and negative differences (P<0.05) correlation between most of the milk component parameters. The positive correlation between crude protein and

Table 4.11: Influence of Season on Milk Composition of Indigenous Goats

	Season			
Parameters	Dry	Wet	SEM	LOS
N	36	36		
Crude protein (%)	3.81	3.82	0.60	NS
Fat (%)	3.38^{b}	4.74^{a}	0.87	**
pH	6.36	6.43	0.15	NS
Ash (%)	0.60	0.67	0.17	NS
Lactose (%)	4.51	4.47	0.27	NS
Phosphorus (mg/100ml)	110.86	110.17	19.86	NS
Calcium (mg/100ml)	156.66	150.09	23.70	NS
Solid Non Fat (%)	11.78^{b}	13.61^{a}	1.18	**
Total Solid (%)	16.58^{b}	17.87^{a}	1.37	**

^{a,b,c} means with different superscripts along the same row show significantly different at P<0.01, N= Numbers of animals SEM= Standard Error of Mean, LOS= Level of Significance, NS= Not significant, **=Highly Significant at P<0.0

Table 4.12: Correlation Matrix of Milk Composition in Indigenous Sheep

Parameters	1.Crude protein	2.Fats	3.pH	4.Ash	5.Lactose	6.Phosphorus	7.Cal
1							
2	0.38*						
3	-0.003	0.08					
4	0.58**	0.72**	-0.26*				
5	-0.13ns	-0.12ns	-0.41*	0.005ns			
6	0.17ns	0.11ns	-0.47*	0.32*	0.61**		
7	0.26*	0.19ns	0.43*	0.42*	0.64**	0.88***	
8	0.07ns	0.07ns	0.20ns	0.16ns	0.49*	0.49*	-0.50*
9	0.28*	0.64**	0.03ns	0.69**	-0.25*	-0.13ns	-0.06n

NS= Not significant, *= Significant at P<0.05 **= Highly Significant at P<0.01 *** Extremely Significant; 1 = Crude protein (%), 2 = Fat (%), 3 = pH, 4= Ash (%), 5= Lactose (%), 6= Phosphorus(mg/100ml), 7= Calcium(mg/100ml), 8= Solid Non Fat (%), 9= Total Solid (%).

Table 4.13: Correlation Matrix for Some Goats' Milk Composition

Parameters	1.Crude protein	2.Fats	3.pH	4.Ash	5.Lactose	6.Phosphorus	7.Calcium
1							
2	0.64**						
3	0.35*	0.13ns					
4	0.03ns	0.53*	0.63**				
5	-0.29*	-0.40*	0.36*	-0.48*			
6	-0.77**	-0.56**	-	0.18ns	0.31*		

			0.67**				
7	-0.08ns	-0.61**	0.03ns	-0.44**	0.36*	0.29*	
8	0.25*	0.21ns	0.40*	-0.09ns	-0.12ns	-0.57**	-0.47*
9	-0.06ns	0.22ns	0.11ns	0.41*	-0.31*	-0.11ns	-0.56**

NS= Not significant, *= Significant at P<0.05 **= Highly Significant at P<0.01, NS= Not significant, 1 = Crude protein (%), 2 = Fat (%), 3 = pH, 4= Ash (%), 5= Lactose (%), 6= Phosphorus(mg/100ml), 7= Calcium(mg/100ml), 8= Solid Non Fat (%), 9= Total Solid (%)

fat was (0.64), crude protein and ash (0.13), crude protein and pH (0.35), crude protein and total solids (0.25), pH and ash (0.63), pH and lactose (0.36), pH and solid non-fat (0.40) pH and calcium (0.03), ash and total solid (0.41), ash and fat (0.53), phosphorus and calcium (0.29), solids non-fat and total solid (0.73).

The negative correlation between crude protein and lactose was s(-0.29), crude protein and phosphorus (-0.77), fat and lactose (-0.40), fat and phosphorus (-0.56), fat and calcium (-0.61), ash and lactose (-0.48), ash and calcium (-0.44), lactose and total solid (-0.31), phosphorus and solid non-fat (-.57), calcium and solid non-fat (-0.47), solid non-fat and total solid (-0.56).

CHAPTER FIVE

5.0 DISCUSSION

5.1 Effect of locations on Milk Composition in Sheep and Goats

The significant crude protein and fat values reported in this study were lower than the mean values reported by Adewumin and Olosimon (2009), in the rain forest region of Nigeria. The disparity may be attributed to ecological zone and plane of nutrition in the area. The significant values of crude protein, fat, pH, ash and lactose reported in Jalingo of Southern Guinea Savannah in this study were higher than the values reported by Ochepo *et al.*, (2015) in the rain forest region of Nigeria.

Phosphorus and calcium were higher in Gwale of Sudan Savannah. The higher values of phosphorus and calcium reported in Gwale of Sudan Savannah and Maiduguri of Semi-Arid and Arid for phosphorus was higher than the value (141mg/100ml) reported by Balthazar *et al.*, (2017) in maiduguri of sahel zone with the value of (161.02mg/ml), (199.98mg/ml) while the value of calcium were similar. The variation in chemical composition of fresh sheep milk as reported by Tamime *et al.* (2011) over time and among animals depends on several factors, such as the stage of lactation, parity, season, environmental temperature, lactation efficiency, animal age and nutrition, genetic factors (species and breed), and diseases of the udder (Tamime *et al.*, 2011).

The result of protein and fats in this study were in consonant with the report of Danladi, in kano with the value (5.12, 5.68), Pape-Zambito *et al.*, (2007) in fain forest with the value of (5.19, 5.65). Ahamefule *et al.* (2011) reported that there were significant differences in milk composition which include crude protein, calcium, phosphorus, lactose, solid non-fat, total solid, and ash. The significant differences may be attributed to the effect of ecological zone and plane of nutrition and environmental factors.

5.1.1 Milk Composition of Indigenous Sheep and Goats in Jalingo

This result shows that the value of fat, pH, ash, lactose and calcium were higher in sheep than in goats. The value recorded in this study were lower than the values recorded by Adewumi and Olorunnisomo (2009) who recorded that milk crude protein, fat, ash, lactose, solid non-fat and total solid were 5.52, 6.77, 0.84, 5.58, 11.8 and 17.2 in West African dwarf sheep and 5.33, 6.77, 0.84, 5.58, 11.8 and 19.2 in Yankasa sheep. The milk composition of goats observed in this study were lower than these reported by Aduli *et al.* (2001) who reported crude protein, fats, solids non-fat, total solids and ash with the values of 5.49, 5.80, 9.57, 15.37 and 0.77 where significantly deferent. This differences may be due to location, environment and plane of nutrition.

5.1.2: Milk Composition of Indigenous Sheep and Goats in Mubi

Sheep had higher crude protein, ash and phosphorus obtained is lower than what was reported by Balthazal, (2017) who reported the parameters fat, ash, lactose, calcium and phosphorus with the value of 5.9, 0.9, 4.8, 197.5, and 141.0 respectively. These differences may be due to plane of nutrition of the area.

The result of goats milk composition parameters obtained in this study agreed with the result of Zahraddeen, *et al* (2007) who reported values of 3.84, 4.38, 11.30, 0.84, 6.32 and 4.90in crude protein, fats, total solid, ash, pH and lactose The result obtained from this study falls within the values reported by Talukder, (2013).

5.1.3: Milk Composition of Indigenous Sheep and Goats in Gwale

Sheep had higher values for all parameters. The result obtain in this study disagree with the result of Yusha'u *et al.* (2018) who reported non-significant effect of specie on total solid, crude, ash, lactose, fat, protein fat and solid non-fat (15.43, 0.81, 4.45, 5.32, 5.86

and 9.56) in Gwale of Sudan Savannah zone of Nigeria. These differences may be due to the time in which this research was conducted and environment of the area.

The milk composition of goats recorded in this study were similar with the result of Agnihotri and Rajkumar (2007) whose recorded the value of 11.60, 3.61, 7.60 and 6.15 total solid, fat, solid non-fat, ash and pH. The result also recorded by Young, (2016) for fat, crude protein, lactose, ash, ash, total solid and calcium with the value of 3.8, 3.5, 4.1, 0.8, 12.2, 13.4 respectively were similar with the result recorded in this study. Caprine milk, on the average, contains 12.2% total solids, consisting of 3.8% fat, 3.5% protein, 4.1% lactose, and 0.8% ash Young and Park (2016).. High variability in goat milk composition between different seasons and genotypes has also been noted. The casein composition of goat milk is influenced by genetic polymorphism on the casein loci. (USDA 2007).

5.1.4 Milk composition of Indigenous Sheep and Goats in Maiduguri

The milk composition values recorded shows that sheep milk had higher values for all parameters measured. This result agreed with the result recorded by Ferro (2017) with the values of 3.33, 3.10, 4.55 and 11.70 for crude protein, lactose, fat and solid non-fat for goats in Brazil. The values of 3.20 (Wong *et al*., 1988), 3.3 (Park, 2006), 3.10, (USDA 2007) was also reported for crude protein in goat. The percentage of crude protein, lactose, pH and total solids (4.60, 4.81, 0.84 and 13-15respectively) recorded in sheep by Yushau (2018) were similar with the result recorded in sheep, but disagreed with the results of Adewumi and Olorunnisomo (2009) who reported value of 5.33, 7.45, 0.84, 5.58, 11.8 and 19.20 in crude protein, solids non fats, ash, lactose and calcium which is higher than the result obtained in this study. These differences may be due to environment and plane of nutrition

5.2 Influence of Specie on Milk Composition of Sheep and Goats

The result for this studies recorded agreed with the result of Adewuni and Olorunnisomo (2009) who's stated 5.33, 6.77, 0.84, and 4.75 in crude protein, fat, ash and lactose in sheep. The study also agrees with the report of Balthazal *et al.*, (2017) who reported the values of (5.9, 0.9, 4.8, and 5.5) for fat, ash, lactose and crude protein in sheep.

In goats, the result were similar with the result of Addass *et al* (2010) who reported 3.84, 4.38, 11.30, 0.84, 6.32 and 4.90 in crude protein, fat, total solid, ash, pH, and lactose respectively. Zahraddeen (2007) also recorded the value of 3.52, 4.77, 11.67, 0.87, 6.32 and 4.29 for crude protein, fat, total solid, ash, pH and lactose respectively. The result obtained in this study however disagreed with the result of Syarifah, (2018) who recorded the values of 10.95, 2.49 and 3.58 total solids, lactose and crude protein. These differences may be due to feed and environment factors of the area.

5.3 Effects of Breeds on Milk Composition in Sheep and Goats

The crude protein values recoded are similar with the report of USDA, (2007) (5.40); Alchanidu and Polychroniadou (1996), (5.98%) and Wong *et al*. (1988) (4.60%), Even though milk composition may vary due to a number of non-nutritional factors such as milking technique, unequal interval between milking and diseases, particularly mastitis (McDonald *et al*.2011). This study shows that Yankasa contains the highest lactose with the value of 5.68 and lower in West African dwarf 4.07. This result obtained disagrees with the result of Echepo *et al.*, (2015) who's stated that there were no significant differences between Yankasa and West African dwarf sheep in lactose, pH, ash and solid non fats respectively. The result recorded were similar with the result of Adewumi and Olorunnsomo (2009), who indicated that there are significant differences in

Yankasa, West African dwarf and Crossbred sheep in south west of Nigeria in all the parameters except ash and pH.

In this study, protein and calcium content were high in Red Sokoto and low in west African dwarf while west African dwarf was highest in fat, solid non-fat and total solid and then Sahel was highest in ash, lactose and phosphorus. This agreed with the result of Addass, *et al (*2010) who reported significant differences in breed of goat. The milk fat obtained in this study was 4.35, 4.70 and 5.17% for Red Sokoto, West African Dwarf and Sahel respectively. Sahel goats had the highest fat content of 5.17 and Red Sokoto was lowest in fat content. These value obtained were similar with the value of 5.04% and 4.94% for fats and lactose reported by Zahraddeen, *et al*, (2007); 5.7 reported by Alawa and Oji, (2008); 5.32% Mba *et al*, (1975); 4.30% Sonkey (1991); 4.60% Akinsoyinu, *et al*, (1981) and 4.75% reported by Ehoche and Bavanendram, (1983). They all reported that the similarities may be due to similarity in breed. Crude protein content was highest in Red Sokoto (3.82%) and lowest in WAD (3.25%). highest (5.17%) in Sahel Goat and lowest (4.35%) in Red Sokoto. Crude protein and fat content decreases as lactation progresses. This result is consonant with the result reported by Agbede, *et al* (1997). However, variations in milk constituents, even with animals within same location, would tend to highlight the high genetic variations within the species; these differences tend to occur because the West African dwarf goat has not been improved for yield and constituents of milk (Adewumi and Olarinisomo, 2009).

5.4 Effect of Season on Milk Composition in Sheep and Goats

The influence of season on milk composition of sheep in this study showed no significant differences in all the parameters except total solid. This study is in contrast with the study of Leila Nateghi, (2015) who reported seasonal differences in all the parameters in sheep. This may be due to the period in which this study was conducted (Early August-October for wet season and late October-December for dry season); but the study agreed with the result of Zahraddeen (2016) who reported seasonal differences in total solid and fat content. These differences may be due to plane of nutrition in the wet season.

The similar crude protein, pH, ash, phosphorus and calcium obtained disagrees with the result of Adass, (2010) who reported that there were significant differences in fat, crude protein, ash and pH. The higher fat observed in wet season disagrees with the result of Admasu (2019) who reported the amount of fat in winter and summer milk to be 4.05% and 3.81% respectively and statistically showed a significant difference at ($P<0.05$). Zahraddeen, (2007) reported that there were no significant differences in protein, solid non-fat and ash. Lactose content was also found to be non-significant. Generally, some milk constituents were reported to be lower in the dry season than wet season which might be due to poor nutrition during the dry season. This result agrees with the report of (Egbowon 2004) who highlighted that under feeding reduces total milk production and milk components generally. Protein, Solids non-fat and total solids were high in wet season than the dry season (Laila *et al.,* 2014). Summer milk was significantly higher (13.31%) in total solid content than dry season milk 12.02% (Laila *et al.,* 2014). It was observed that the milk composition is higher in the wet season. This may be due to availability of forage in wet season than dry season. The significant effect of season in this study was similar to the values obtained (11.4% and 17.1%) in dry and wet season by Alawa and Oji (2008).

5.5: Correlation Coefficient of Milk Composition in Sheep and Goats

The Correlation matrix of milk composition parameters in Indigenous sheep showed the negative and positive relationship in measured parameters within breeds. Ante Raka (2019) reported that there were positive relationship in milk composition on calcium and protein fat and ash, total solids and crude protein and crude protein and calcium. While the negative relationship were pH and ash, pH and lactose and pH and phosphorus.

This may be due to Factors ranging from nutrition, season and environment of study could be implicated for the variations in milk composition; however, variations in milk composition, even with animals within same location, would tend to highlight the high genetic variations within the breed.

Correlation matrix for some goats' milk composition as showed there were positive and negative relationships in breed among measured parameter. These agrees with the result of Zahraddeen, *et al* (2007) who reported that there were positive relationship in fats and ash, fats and lactose, total solids and fats, crude protein and fats was, crude protein and lactose, lactose and fats was, total solids and fats and total solids and lactose . While the negative were calcium and fat and calcium was, calcium and solid non-fat, lactose and total solid, ash and calcium, fats and phosphorus and lactose and total solid in Sokoto Red goats. The positive and negative correlation may be due to genetic differences within breed, environmental conditions, feeding, management conditions, season, locality, and stage of lactation.

CHAPTER SIX

6.0: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1: Summary

This study was conducted in two seasons; wet (August- early October) and dry (late October – December) of 2019 in order to determine the influence of location on milk composition on sheep and goats managed by small holder husbandry system in one location each of (Southern Guinea Savannah, Northern Guinea Savannah, Sudan Savannah and Semi-Arid and Arid) of Nigeria.

Crude protein was higher ($P<0.01$) with the values of 5.57, in Jalingo of Southern Guinea Savannah. Mubi of Northern Guinea Savannah recorded lower in crude protein (4.45%), fat was significantly different ($P<0.01$) higher in Jalingo, Gwale and Maiduguri with the value of (5.99, 5.82 and 5.68%) while lowest in Mubi with the value of (3.18%), pH was significantly different ($P<0.01$) higher with the value of (6.69,6.61) in Jalingo and mubi while lower in Gwale and Maiduguri with the value of (6.42,6.41), Ash was significantly different ($P<0.01$) higher in Gwale and Maiduguri with the value of (0.87,0.84%) while lower in Jalingo and Mubi with the value of (0.75,0.61%), lactose was significantly different ($P<0.01$) higher in Mubi, Gwale and Maiduguri with the value of (4.75, 4.91, 4.91%) while lower in Jalingo with the value of (3.89%),

The influence of Jalingo in southern guinea savannah zones on milk composition of sheep and goats shows that there were non-significant differences in crude protein, phosphorus, solids non-fat and total solids.The values of fats, pH, lactose, ash, and calcium 5.99, 6.69, 4.99, 0.75 and 124.81 were higher in sheep than in goats which is 4.64, 6.58, 4.28, 0.53, and 107.42 respectively.

The influence of Mubi of northern guinea savannah zone on milk composition of sheep and goats shows that there were significant differences at (P<0.01) in crude protein, phosphorus and total solids. Sheep had the higher values of 5.15, 111.12 and 12.08 than goats 3.83, 91.60 and 11.22. While fat, pH, ash, lactose, calcium and solids non-fat were not significantly different.

The influence of Gwale sudan savannah zones on milk composition of sheep and goats shows that there were significant differences in all parameters except total solid. Sheep had the highest values in all the parameters than goats.

The influence of Maiduguri of semi-arid and arid zone on milk composition of sheep and goats shows that there were significant difference at (P<0.01) in all the parameters. Sheep recorded the higher value than goat.

The influence of species on milk composition of sheep and goats shows that there were significant differences (P<0.01) in all the parameters except solid non-fat and total solid. The result shows that sheep had a higher value in all the parameters than goats.

The influence of breeds of sheep on milk composition parameters shows that there were significant differences at (P<0.01) in all the parameters except fats and ash. West African dwarf has a higher crude protein, pH, and solid non-fat with the values of 6.04, 6.81 and 8.45 while lower in Yankasa with the value of 4.40, 6.48 and 7.46. Uda and Balami had the higher value of phosphorus and calcium, t with the values of 136.80, 186.56, lowest in West African Dwarf with 106.40, 128.50 and 8.45. yankasa had the higher lactose and total solids with the values of 5.68 and 16.66.

The influence of breed of goats on milk composition shows that there were significantly difference at (P<0.01) in all the parameters. Crude protein, was higher in West African Dwarf and lowest Sokoto Red fats was higher in West African dwarf pH was higher in

West African Dwarf ash is higher in west African dwarf than red sokoto, lactose was higher in Sahel than west African dwarf, phosphorus is high in sahel than west African dwarf, calcium is high in Sahel than West African Dwarf, solids non-fat and total solid were higher in West African Dwarf.

The influence of season on sheep milk composition shows that there were non-significant differences (P>0.05) in all the parameters except solids non-fat. Dry season had the higher solids non-fat with the value of 11.96 than wet season which is 11.23.

The influence of season on goat milk composition shows that there were significant differences at (P<0.01) in fat, solid non-fat and total solids. Wet season had a higher fat, solid non-fat and total solid with the value of 4.74, 13.61 and 17.87 .

6.2 CONCLUSION

The following conclusions were made from the findings of this study:

(a) SGS zone (Jalingo) had better milk composition in terms of CP% (5.57), SNF (8.40) and TS (14.3g) for sheep and SNF (7.80) for goats.

(b) Sheep milk was better than goats in terms of CP% (5.25) Fats% (0.8g) Phosphorus and calcium content of 132.30 and 172.67mg/ml respectively.

(c) WAD sheep had better milk with CP% (6.04) while Yankasa had better lactose and total solids percentage of 5.68 and 16.66 respectively.

(d) WAD had better CP and TS percentage of 5.02 and 13.20 respectively.

(e) Uda and West Africa Dwarf had higher solid non-fat.

(f) Dry season gave better SNF% (11.96) for sheep milk while wet season gave better Fats, SNF and total TS percentages of 4.74, 13.61 and 17.86 respectively for goats milk.

6.3: Recommendation

The following recommendations were made from the study:

1. Crude protein and solid non-fat of sheep milk in Jalingo was better 7% and by 41% respectively.
2. Crude protein, fat, ash and calcium of sheep milk was 31%, 22%,11% and 22% respectively better than goats milk.
3. Solid non-fat in dry season was 6% better in sheep milk.
4. Sheep milk solid non-fat was 6% better in dry season.
5. Further study should be carried out on the influence of parity and litter size on the composition of milk from sheep and goats.

REFERENCES

Addass, P.A., Midau A. and Babale D.M.(2010). Haematic-biochemical finding of indigenous goats in mubi, Adamawa State, Nigeria. Journal of Agriculture and Social Science 6(1):14-16

Adebarimo, W. (1990). Soya beans making waves in Nigeria. *Authority Agriculture News* 3:42 45.

Adewumi O. O. (2005). Sheep milk: The most important but neglected source of protein. Proceedings of the 10th Annual Conference of Animal Science Association of Nigeria, University of Ado-Ekiti, Nigeria September 12-15, 2005, pp237-239.

Adewumi O.O. and O. A. Olorunnisimu(2009). Milk yield and milk composition for West African dwarf Yankasa and Cross breeding sheep in south west of Nigeria. *Livestock hResearch for Rural Development* 21(3)pp65-72

Adewumi, O. O., Ologun, A. G. and Alokan, J. A. (2001). Sensory evaluation and marketability of sheep milk in Nigeria. *Journal of Agriculture, Forestry and Fisheries,* 2: 5-7

Adu, I. F. and Ngere L. O. (1979).The indigenous sheep of Nigeria. *World Review of Animal Production* 15(3):51-60

Aduli, B. S., Eduvie, I. O., Lakpini, C. A. M. and Malau-Aduli, A. E. O. (2001). Effects of supplementation on the milk yield of Red Sokoto does. Proceedings of the 26th Annual Conference of Nigerian Society for Animal Production. March, 21-25 2001, Ahmadu Bello University, Zaria, Nigeria .Pp 353-355.

Aduli, E., Othniel, M. and Yakubu R. A. (2008) Comparative study of milk compositions of cattle, sheep and goats in Nigeria. *National Animal Production Research Institute and Department of Animal Science, Ahmadu Bello University ,Zaria, Nigeria* 73(6):541-544

Agbede J.O., O.G. Ologun and J. A. Alakan (1997).Milk composition of west African goats in southern region *Nigerian Journal of Animal Production*. 24()175-179.

Agnihotri and V. Ragkumar (2007).Effect of breeds, parity and stage of lactation on milk composition of western region goats india. *International Journals of Dairy sciences*. 2(2)172-177.

Ahamefule, F.O.; Ibeawuchi, J.A. (2005).Milk yield and composition of West African Dwarf does fed Pigeon Pea-Cassava peel based diets. Journal of Animal Veterinary Advance, 4, 991–999.

Akinsoyinu A. O., Mba, A. U. and Olubayo, F.O. (1977).Studies on milk yield and composition of the West African Dwarf Goats in Nigeria. *Journal of Dairy Resource,* 57-82.

Akinsoyinu A. O., Mba, A. U. and Olubayo, F.O. (1981).Studies on milk yield and composition of the West African Dwarf Goats in Nigeria. *Journal of Dairy Resource,* 57-82.

Alawa, J. P. and Oji, U. I. (2008). Effect of pendulous udder enlargement on yield and proximate composition of milk from Red Sokoto Goats. *Journals of Animal Veterinary Advance* 7: 870

Albenzio M., Anna N.P. and Antoneila S (2016).The role of milk nutritionin childhood epilepsy *International Journal of Food and Nutritional Science* 5(4) 141-150.

Alichanidis, E., Polychroniadou, A. (1996). Special feature of dairy products from ewe and goat milk from physiochemical and organoleptic point of view. In: Proceedings, Production and Utilization of ewe and goat milk, Crete, Greece. *International Dairy Federation Publication.* Brussels, Belgium.Pp.21-43

Alistair S.(2007). Study on milk parameters. International Journal of Dairy Technology 60(2):96-105.

Al-Wabel, N. A., Swai, E.S and Adekeye, J.O. (2008). Bacterial flora associated with mastitis in sheep and Goat in Zaria (Nigeria) area. *Livestock Research for Rural Development,* 20(21); 167-170.

Anifantakis, E.M. (1986). Comparison of the physico-chemical properties of ewe's and cow's milk. In: International Dairy Federation (Ed.), Proceedings of the IDF Seminar Production and Utilization of Ewe's and Goat's Milk, Bulletin No. 202. Athens, Greece, pp. 42–53.

Anon, G. (1990). *The History of Dairy Development in Nigeria*. National Seminar on Dairy Production.9-19th August. Hill Station, Jos. Pp: 1-11

Ante-Raka, A. (2019). Handling, processing and marketing of milk in and around Debre berhan milk areas central highland of Ethiopia. *African Journal of Agricultural Research,*7 (8): 87-90

AOAC, (2000). Official Methods of Analysis (17th Ed.). *Association of Official Analytical Chemists*, Inc., Arlington, Virginia, USA. Methods 10, 16, 17.

Auldist, M. J., Walsh, B. J. and Thomson, N. A. (1995). Seasonal and lactation influences on bovine milk composition in New Zealand. *Journal of Dairy Science, 65 (3):401.*

Awotwi, E . K . and Fynn, K. E. (1992). Effects of parity, days in milk, milk production and milk compositions. *African Livestock Research* (Ethiopia).Vol.1. Pp46-69.

Babayan, V. K. (I98I). Medium chain length fatty acid esters and their medical and nutritional application. *Journal American Oil Chemists Society,* 58(1): 49A-5 IA.

Bailey, K. E., Jones, C. M., and Heinrichs, A. J. (2005). Economic returns to Holstein and Jersey herd under multiple components pricing. *Journal of Dairy Science,* 2269-2280.

Balthazara, C.F., Silva, H.L.A, Vieira A.H, Neto R.P.C, Cappato L.P, Coimbra P.T, Moraes J, Andrade M.M, Calado V.M.A., Granato D., Freitas M.Q, Tavares M.I.B, Raices R.S.L, Silva M.C, Cruz A.G. (2017). Assessing the effects of different prebiotic dietary oligosaccharides in sheep milk ice cream. *Food Resource International,* 91:38–46.

Banda J. W., Steinbach, J. and Zerfas, H. P. (1987). Composition and yield of milk from non-dairy goats and sheep in Malawi. University of Malawi Bunda College of Agriculture, Division of Animal Production.*www.agtr.ilri.cgiar.org/.../x5520bib.htm.*

Bansal, B. B., Habib, R. H. and Chen, X. D. (2009). Effect of seasonal variation in milk composition of diary fouling. Proceedings of International Conference on Heat Exchange, fouling and Cleaning VIII-2009 (Peer-reviewed) June 14-19, 2009. Austria.

Barłowska, J., Szwajkowska, M., Litwinczuk, Z. and Kr´ol, J. (2011). Nutritional value and technological suitability of milk from various animal species used for dairy production. *Comprehensive Reviews Food Science Food Safety,* 10: 291–302

Barnet, H. Jr. and Federick, S. (2000). Dairy goat production guide. www.judging-connection.com/pdfs/D. *Small Ruminant Institute Food and Agricultural Science*,102-121.

Biswas, S. (2006). Milk and milk products technology.1st Edition, Jaypee Brothers Medical Publisher Ltd.

Borys, B. and Pisculewski, P. M. (2001). Jakose Oraz Mozliwosci Ksztoltowania portdr owotnychwhasciwoscispozymezchproducktowozarskich. In Polish, summary in English *Roczniki Naukowe Zootechniki*, Supplement 11: 67-86.

Browning, R., Leite-Brewing, M. L. and Sahlu, T. (1995). Factors affecting standardize milk and fat yield in Alpine goats. *Small Ruminant Resource*, 18:173-128.

Bruhn, J .C. and Franke, A.A. (1997). Monthly variations in gross composition of California Herd Milks. *Journal of Dairy Science. 60: 696-700.*

Buck, R.P., S. Rondenini and A. K. Covington (2002). Measurement of milk parameters. *Pure and Applied Chemistry,* 74(11); 2169-2200

Buffano, G., Dario, C. and Laudadio, V. (1996) International Symposium on somatic cell milk of small ruminants. R Rubino (Editor), Bella, Italy September 25-27, Wageningen Pers, EAAP, Publication Number 77: 301-304.

Butswat, I.S R. (1994). Study on seasonal variation in the productive status in sheep and goat in bauchi, Nigeria. Ph.D. thesis Abubakar Tafawa Balewa University, Bauchi Nigeria. pp34-54.

Butswat I. S. R., Zahraddeen, D., Mancha, Y. P. and Dachollom,C.C. (2002). Effects of breeds and parity on milk yield of Red Sokoto and Sahel Goats. *Proceeding of the 7th Annual Conference of Animal Science Association of Nigeria.* Abeokuta, Nigeria.Pp12-21.

Butswat, I. S. R., Zahraddeen, D., Mancha, Y. P. and Dachollom, C.C. (2002). Effects of breeds and parity on milk yield of Red Sokoto and Sahel Goats. *Proceeding of the 7th Annual Conference of Animal Science Association of Nigeria.* Abeokuta, Nigeria.Pp12-21..

Caballero, R., Riseth, J. A., Laban, N., Tyran, E., Musial, W., Molik, E., Boltshauser, A., Moreira, B. M., Coelho, I. S., Brito, O. and Gil, A. (2007). Comparative typology in six European low intensity system of grassland management. *Advances in Agronomy*, 96, 351-420.

Chamberlain, A. (1989). Milk Production in the Tropics. Intermediate. *Tropical Agriculture Series* (W J A Payne, Editor). Longman Group UK Limited, pp 210-219

Charray, J., Humbert, J. N. and Levif, J. (1991). *Manual of sheep production in the humid tropics of Africa C.A.B International* Netherlands. Pp iv-187

Chilard, Y., Ferlay, A. and Doreau, M. (2001). Effect of different types of forages, animal fat or marine oils in cow's diet on milk fat secretion and composition, especially conjugated linoleum acid and polyunsaturated fatty acids. *Livestock Production Science*, 70:31-48.

Claeys, W.L., Verraes C., Cardoen S., De Block J., Huyghebaert A., Raes K., Dewettinck K. and Herman L. (2014). Consumption of raw or heated milk from different species: an evaluation of the nutritional and potential health benefits. *Food Resources*,;42:188–201.

Clare, D. A. and Swaisgood, H. E. (2000). Bioactive Milk peptides: A prospectus. *Journal of Dairy Science*, 83:1187-1195.

Devendra, C. (1988). Sheep and goat production in the tropics. *Journal of Dairy Science*, 63: 1755-1767.

Devendra and Meleroy (1992). Phenotypic characterization and strategies for genetic improvement of West African goats under backyard systems *Journal of Animal Sciences*, 4(5);218-219.

Devendra, C. and Burhm D (1983). Mixed farming and intensification of animal production system in Asia. *Outlook on Agriculture*, 26(4): 255-265.

Diaz, J. R., Muelas, R., Segura, C., Peris, C. and Molina, P. (1996). Effect of mastitis on milk composition of Manchega ewes: preliminary results. In: Proceedings, International Symposium, Somatic Cells and Milk of Small Ruminants. R. Rubino, ed., Bella, Italy, Wageningen Pers, EAAP Publication. No.77.Pp. 305-309.

Economist Intelligence Unit, (2005). November. *Country Report* (Nigeria).Effect of free fatty acids and lysolipids on cellular uptake of doxorubicin in human breast cancer cell lines. *Anticancer Drugs*, 21:674–7.

Egbowon, B. F. (2004). Comparative evaluation of milk secretion rate and milk composition in West African Dwarf and red sokoto goat. M.Sc thesis, Department of animal breeding and genetics. University of Abeokuta, Nigeria. Pp35-47

Ehoche, O.W. and Buvanendran. V. (1983). The yield and composition of milk pre-weaning growth rate of red sokoto goat in Nigeria. *World Review of Animal Production*,19 (2): 19-24

F.A.O. (2015). FAOSTAT: Statistics division. Food and agriculture organization of the United Nations Available from*: http://faostat.fao.org/.*

FAO *Production Yearbook*; FAO, United Nations 1988; 42: 241.

Fasae, O. A., Sowande, O.S. and Adewumi, O. O. (2015). Ruminant animal production and husbandry, lecture Note APH 301 University of Agriculture, Abeokuta, Nigeria. PP: 5-20.

Federick, M and H. J Barnet, H. J.(2003). Dairy goat production guide.judging connection.com/pdfs/D. *Small Ruminant Institute Food and Agricultural Science*,102-121.

Ferro M. M., L. O. Tedeschi and A. S. Atzori (2017).The comprision of the lactation and milk yield and composition of selected breeds of sheep and goats. *American Society of Animal Sciences,* (1) 498-506.

Foglietta, F. Serpe L., Canaparo R., Vivenza N., Riccio G., Imbalzano E., Gasco Fox, P. F. and Sweeney, P. L. H. M. C. (1998). *Dairy Chemistry and Biochemistry.* Blackie Academic and Professional, London, UK. *Food and Nutrition Sciences,* 8 :5

Frelich, J., Slachta, M., Hanus, O., Spicka, J., Samkova, E., Węglarz, A., Zapletal, P. (2012).The effect of different season on the milk quality. *Animal Science Papers and* Editor). Longman Group UK Limited, pp 210-219

Gall .C. (1981*).* Milk Production: Goat production. C., Gall Academic Press, London.Pp.309-344.

Gatenby, R. M. (2002). Sheep. *Macmillan Publishers Limited* Pp 60-63 and 156-158.

Hadjipanayiotou, M. (1988).Effect of Sodium bicarbonate on milk yield and composition and on rumen fermentation of kids, *Small Ruminant Resource,* 1: 37-47

Haelein, G. F. W. (2001). Past, present and future perspective of small ruminant dairy research. *Journal of Dairy Science, 84 (9): 2097-2115.*

Haenlein, G. and Donald, L. (1994). Extension Goat Handbook. Washington, D.C. US Department of Agriculture, Network, Delaware: University of Delaware. *Journals for Wild Life Management,* 52(1): 173-175

Haenlein, G. F. (1992). Status and prospects of the dairy goat industry in the United States. *Journal of Animal Sciences,* 74: 1173-81.

Haenlein, G.F, Park, Y.W., Raynal-Ljutovac, K. and Pirisi, A. (2006).Goat and Sheep milk. *Small Ruminant International Journal, 68:1-2.*

Harlan and Artfield,(2008). A comparative milk composition of cow, sheep and goats in Maiduguri of borno state. *Journal of Animal Science*,*3*(4):165-170.

Hellen, V.R. (1994). *The Science of Animal Agriculture.* Delmar Publishers in New york.Pp.61-72

Humburg. M. (1977). Statistical analysis for decision making. *2nd edition Harcourt brace New York* pp 801

I.A.R (2013). Metrological Service Unit, Institute of Agricultural Research (IAR) Ahmadu Belllo University, Zaria.

Ibeawuchi, J. A. And Dalyop, D. M. (1995). The history of dairy development in Nigeria. National seminar on Dairy production, Hill station, Jos 9-19th (1995). Composition and quality of fresh cow milk offered for sale in part of Plateau State of Nigeria. *Nigerian Journal of Animal Production,* 22*(1):*81-84

Insel, P. Turner, R.E, Ross, D. (2004*).* Nutrition Second edition. American dietetic association. *Journal of Dairy Science*, 91:784–793.

Jahnke, H. E. (1982). Livestock production system and livestock management in tropical Africa. *Journals of Animal and Veterinary Advances,* 6(6): 802-606.

Jamrozik, J., Fatehi, J. and Sehaeffer, C. R. (2007). Application of robust procedure for estimation of breeding values in multiple-trait random regression test- day Model. *Journal of Animal Breeding and Genetics,* 124:3-11

Jaswinder S., Jaspal S. H. and Udey S. C. (2018). Phosphorus nutrition in dairy animals. *International Journal of Current Microbiology and Applied Science* 7(4):3518-3530.

Jefferies, B. C. (1961). Body condition scoring and its use in management. *Tasmanian Journal of Agriculture.*32: 19-21

Jeffrey Alahira (2013). Introducing Agriculture in Nigeria. *www.agriculturenigeria.com.*

Jeffrey, L. And Stevenson A. (2001). Management of dairy cows to minimize reproductive problems after Parturition Department of Animal Science. Kansas State University Manhattan, KS, 66506-0201. USA. 9(12) pp 56-61.

Jenness, R. (1980) Composition and characteristics of goat milk: Review 1968-1979. *Journal Dairy Science, 63*:1605.

Ju`arez, M., Ramos, M., (1986). Physico-chemical characteristics of goat milk as distinct from those of cow milk. In: International Dairy Federation (Ed.), Proceedings of the IDF Seminar Production and Utilization of Ewe’s and Goat’s Milk, Bulletin No. 202. Athens,

Kaminarides, S., Stamou P. and Massouras T. (2007). Comparison of the characteristics of set-type yoghurt made from ovine milk of different fat contents. *International Journal of Food and Science Technology,* 42:1019–28.

Kawas, J. R., Hopes, J., Danelou, D. L. and Lu, C.D. (1991). Influence of forage to the rations on intake, digestibility, and chewing and milk production of dairy goats. *Small Ruminant Resources,* 4:11-18.

Keenan, T.W. and Patton, S. (1995): The structure of Milk. *Hand book of milk composition.* Edited by Jensen RG. Academic Press, USA; Pp5-50.

Kelou, K. M. (2005). *Development of multi-nutrient block for dry season supplementation feeding in sheep in a semi-arid environment*. M.Sc. Thesis, University of Maiduguri, PP: 23-38.

Khalid, U., Nosheen, S., Hussain, S., Taran, M. A., Adiq, S. and Ahmad, M. (2013). Assessment of protein energy malnutrition among children in urban community of Faisalabad Pakistan. *Pakistan Journal of Nutrition,* 12(14):334-339

King, J. O. L. (1978*).* An Introduction to Animal Husbandry, Blackwell Scientific pub.Britain. *Dairy Federation,* Brussels, pp. 21–43

Kisza, J., Stanewski, B., Juskie, M. (1994). Examination of cholesterol in milk fat by gas chromatography (GC). *Edited and published by the Institute of Dairy Technology,* Olsztyn University of Agriculture and Technology, Olsztyn, pp. 75:470-475.

Larson, B.L., Smith, V.R. (Eds.), (1974). Composition of Swedish diary milk. *International Journal of Dairy Science, 13:409-425.*

Leila, N. (2014). Evaluation and compares of the physiochemical properties of different commercial milk product. *European journals of experimental biology*, 3(5):102-105.

Leila, N. M., Yousefi, N., Elham Z., Mohammad G. and Mehran M. (2015).The effect of different seasons on the milk quality. *Journal of Experimental Biology*, 4(1):550-552

Linda, C., Margo, H. and Paul, W. (2004). Dairy goats: Sustainable production. National Sustainable Agriculture Information Service Operated by the National Centre for Appropriate Technology, ATTRA publications. Pp. 32-146.

Lindmark-Mansson, H. and Akesson, B. (2000). Anti-oxidative factors in milk B. *Journal of Nutrition, 84: 5103-5110.*

Mahoney, F. (1988). Rural Dairy Technology Experiences in Ethiopia. ILCA manual No 4. Dairy Technology Unit. ILCA, Addis Ababa, Ethiopia. 64pp.

Manyong, V. M. Smith, S. S. Weber, S. S. Jagtab, G. K. and Otewole, B. (1995). Macro Characterization of Agricultural System in West Africa. An overview resources and crop management research monograph No.21, International Institute of Tropical Agriculture (IITA), Ibadan, pp: 66.

Mathewman, R. (1995). Dairying, Macmillian Education Ltd.pp.1-2.

Mba, A. U., Bayo, S. B. and Oyenuga, V. A. (1975). Studies on milk composition of West African Dwarf goat, Red Sokotoand Saanen goats at different stages of lactation.2. Total solids, butterfat, Solids not fat, Protein, lactose and energy contents of milk. *Journal of Dairy Science Resources, 42:217-226.*

Mcdonald, P., Edwards, R. A., Greenhalgh, J. F. D. and Morgan, C. A. (2011). *Animal Nutrition.* 5th Edition. pp/ 32

Midau, A., Kibon, A., Moruppa, S. M., and Augustine, C. (2010). Influence of season on milk yield and milk composition of Red Sokoto Goats in Mubi Area of Adamawa State. *Journal of Diary Science, 5 (3): 135-141.*

Milani FX, Wendorff WL. 2011. Goat and sheep production in the United States (USA). *Small Ruminant Resources* 101:134–9.

Miller R. H., H. D. Norman, G. R. Wiggans and J. R. Wright (1995). Lactation relationship test-day somatic cells core with test-day and milk yield. *Journal of Dairy sciences*.87:2299-2306.

Moatsou G, Samolada M, Katsabeki A, and Anifantakis E. (2004). Casein fraction of ovine milk from indigenous Greek breeds. Lait 84:285–96.

Molik E, Bonczar G, Misztal T, Zebrowska A, Zieba D. (2012). The effect of the photoperiod and exogenous melatonin on the protein content in sheep milk. In: Hurley WL, editor. Milk protein. 1st ed. Rijeka: *Inter technology Open Editon*.4 (8): pp54

Molik, E. Tyran, E., Musial, W. and Wierzchos, E. (2004). The nature of significance of commercial and cultural Grazing in the polish tara. Proceedings of the conference. “Posture and animal” Brno,September 2-3,pp,92-94.

Morgan, D., Gunneberg, C., Gunnell, D., Healing, T. D., Lamerton S. (2012). Medicinal properties of goat milk. *Journal of Dairy Goat*, 90: 1.

Morian- Fehr, P. (1981). Nutrition and feeding goats; Application to temperate conditions. In goat production. C. Gall. Edition. Academic press London, 193-230.

Muhuyi, W. B., Lukibisi, F. B., Sitenei, K. K. and Ole Sinkeet S. N. (1997). A comparison of Milk yield and composition of Sahiwal and Friesian – Sahiwal cross-breeds in Semiarid Naivasha. Kenya.www.kari.org/…/9th-KE2007400356.pdf

Neville, M. C., Zhang, P. and Allen, J. C. (1995). Minerals, ions and trace elements in milk. *Handbook of milk composition.* Edited by Jensen RG. Academic press USA; 1995: 54375.

Ngele, M. B. (1997). *Studies of pendulous udder development in Nigerian breeds of goats.* M.Sc. Thesis, Department of Animal Science, Ahmadu Bello University, Zaria. Pp6.

Ngere, L.O., Adu, I.F. & Okubanjo, I.O. (2001). The indigenous goats of Nigeria. *Animal Genetic Resources Information* 3: 1– 9.

Nicolos, R. J., Woolfrey, B., Wilson, T.A., Scollin P. (2004). Decreased aortic early atherosclerosis and associated risk factors in hypercholesterolemia hamsters fed a high- or mid oleic acid oil compared to a high linoleics acid oil. *Journal of Nutrition and Biochemistry. 15:540-47.*

Non-Bovine Mammals. Y.W. Park and G.F.W. Haenlein, eds. Blackwell Publishers. Ames, Iowa and Oxford, England. Pp. 34-58.

Nuru, S. (1985). Trends in small ruminant’s production in Nigeria. In: Proceedings of National Conference on small ruminants production, NAPRI, Shika, Nigeria, 6-10 March, pp 36-48

Ochepo1, G.O, Ayoade, J.A.1, Attah, S.1 and Adenkola, A. Y. (2015). Effect of Breed and Method of Milking on Yield and Composition of Sheep Milk, *Journal of Agricultural* Science Vol. 5(7), pp. 232-235

Ontsouka, C. E., Bruckmanier, R. M., Blum, J. W. (2003): Fractionized milk composition during removal of Colostrum and mature milk. *Journal of Daily Science,* 86: 2005-2011.

Otaru, S. M (2002).Goat Milk Production and Processing. *National Animal Production Research Institute, Ahmadu Bello University, Shikka, Zaria, Nigeria.pp.1*-2

Otaru, S.M. and Iyiola-Tunji, A.O. (2015). Small ruminant production and management techniques Paper presented at National Workshop on “Strategies for improving livestock and fisheries extension service delivery for sustainable productivity'' which was held at National Agricultural Extension and Research Liaison Services, Ahmadu Bello University, Zaria from 26th – 28th August, 2014*https://www.researchgate.net/publication/*283513451

Ozrenk, E. and Selculk, I. S. (2008). Effect of seasonal variation on the composition of cow milk in Van Province. *Pakistan. Journal of Nutrition. 7: 161-164.*

Paape, M. and Wiggans G. (2007). Monitoring goat and sheep milk somatic cell counts. *Small Ruminant Resourses* 68:114–25.

Park, Y. W. (1994). Hypo-allergenic and therapeutic significance of goat milk. *Small Ruminant Research*, 14: 151-159.

Park, Y. W. (2006a). Goat milk—chemistry and nutrition. In: Park YW, Haenlein GFW (Eds), Handbook of Milk of Non-bovine Mammals. Blackwell Publishing Professional, Oxford, UK/Ames, Iowa, 34-58.

Park, Y. W. (1991) Nutrient profiles of commercial goat milk cheeses manufactured in the United States. Journal of Dairy Science. *73*, p. 3059.

Park, Y. W., Juarez, M., Ramos, M. and Haenlein, G. F. W. (2006). Physico-chemical characteristics of goat and sheep milk. Journal Small Ruminant. Resources. 68:88–113.

Park, Y.W, Pariza M.W. (2007). Mechanisms of body fat modulation by conjugated linoleic acid (CLA). *Food Resources International,* 40:311–23.

Park, Y.W. (2006b). Goat Milk- Chemistry and Nutrition. In: Handbook of Milk of
Parkash, S. and Jenness, R., 1968. The composition and characteristics of goat milk: Review. *Dairy Animal Science,* 30: 67-72.

Payne, W. J.A. (1990). Introduction to Animal Husbandry in the tropics. (4^{th} efdition.)Longman, London.Pennsylvania State University. (2009).Systematic Breeding Program for dairy cows. Retrieved 2009-05-09.

Rasmussen, J. T, Berglund L., Pallesen, L.T. and Petersen TE (2010) Proteins from the milk fat globule membrane. Poster at the 26th IDF *World Dairy Congress*, September 24–27, Paris, France

Recio, I., de la Fuente, A., Ju´arez, M. and Ramos M. (2009). Bioactive compounds in sheep milk. In: Park YW, editor. Bioactive compounds in milk and dairy products. Iowa: Wiley-Blackwell, p 83–104, Chapter 4.

Rege, J. E. O., Khahi, A., Okomo-Adhiambo, K. M., Mwacharo, J. and Hannote, O. (2001). Zebu cattle of Kenya; uses, performance, farmer preferences, measures of Genetic Diversity and options for improved use, *(Animal Genetic Resources Research vol. 17,Art. N17 Retrieved June 30, 2010 from http: //www.Iord. Org/Lord17/2/swait 7017 htm.).*

Renner, E. (1982). Milk and Milk products in Human Nutrition. VolkswirtschaftlicherVerlag. GmbH Germany, Pp.467.

Revilla I., Escuredo . O., Gonzalez-martin., M. I. Palacios (2017).Fatty acid and fat soluble vitamins I ewes milk predicted by near infrared reflectance spectroscopy. *Determination of Seasonality Food for Chemistry*, 214:468-477.

Rim. W. (1992). Resource inventory and Management Studies Report. Federal Department of Livestock and Pest Control Service. Federal Ministry of Agriculture and Natural Resources, Garki, Abuja, Nigeria. Pp440.

Saini, A. L. and Gill, R. S. (1991). Goat milk: An attractive alternate. Indian Dairy man, *Journal of food and Nutritional Research*, 1(4), 68-81.

SAS (2002). Statistical Analysis System User’s Guide. SAS /STAT Version 9.0 for windows. SAS Institute Inc.North Carolina,USA.

Sawunmi, F. A. and Akintola, J. O. (2010). Effect of climate Variability on Maize Production in Nigeria. *Research Journal of Environmental and Earth Science,* 2(1); 19-30

Schmidt, G. H. and Van- Vleck. C. O. (1974). *Principles of dairy science*. W.H., Freeman and company, San-Francisco. www.ansi.ifas.ufl.edu.. Dairy goat production guide. Pp 234-240

Schmidt, G. H., and Van- Vleck. C. O. (1991). *Principles of dairy science*. W.H., Freeman and company, San-Francisco. *www.ansi.ifas.ufl.edu.DS134*. Dairy goat production guide .Pp 234-240

Selvaggi M, Laudadio V, Dario C, Tufarelli V. 2014a. Investigating the genetic polymorphism of sheep milk proteins: a useful tool for dairy production. *Journal Science Food Agricultural* 94:3090–9.

Sevi, A., Albenzio, M., Marino, R., Santillo, A. and Muscio, A. (2004). Effects of lambing season and stage of lactation on ewe milk quality. *Small Ruminant Resources,* 51: 251-259.

Sharma, R. B., Gupta, M. P. and Ogra, J. L. (1998). Factors affecting yield and chemical quality of goat milk chhana. *Small Ruminant Resources*, 27:257-262.

Shearer, J. K., Bachman, K. C. and Boosinger, J. (1999). The production of quality milk. Institute of food and Agricultural Science. University of Florida. Original Publication date Sept., 1992.Reviewed June 2003.http://ed. Ifas.Ufl.Edu *Reports*., 2012, 30(3), 219-229.

Silvia, M., Georgiana, G. C. and Costel, M. (2011). Variation analysis of cow milk composition quality depending on year, season and lactation in Romania. *Bulletin UASUM Animal Science and Biotechnologies*, 68:1-2

Sonkey M. (1991). Overview of Korean environmental low. *International Journal of Dairy science*.7(5 }23-26

Syarifa S., D. Keumalasari and D. Daulay(2018). Factors affecting yield and chemical quality of goat milk chhana. *Small Ruminant Resources*, 27:257-262.

Talukder M., Quazi A. and Djatikussomo D. (2013). Impact of social individual influence adaptation of social network in small ruminant animals. *Journal of Computer Science*,9(12):1686-1694.

Tamime, A. Y., Wszolek, M., Bozˇanic, R, O. Zer, B. (2011). Popular ovine and caprine fermented milks. *Small Ruminant Resources*, 101:2–16.

Tracey, J. B. (2001). Goat's milk for Infants. Health Options, Megazine. Synthesis. Federal Department of Livestock and Pest Control Services, Abuja, Nigeria. pp289

Tucker, H. A. (1989*)*. Photoperiod affects intake, growth and milk production of cattle. *Feedstuffs*, 61:15-16.

Underwood, E.J., (1977). Trace Elements in Human and Animal Nutrition, 4th ed. Academic Press, New York, p. 173 84–91.

USDA (National Nutrient Database for standard Reference). (2007). [http://www.nal.usda.gov/fine/food comp/Data/] website. (Accessed September 3, 2007). *Journal of Dairy Science. 66:1155.*

Van Neuwenhove, P.C., Oliszewki, R., Gonzalez, N.S. (2007). Fatty acid composition and conjugated linoleic acid content of cow and goat cheeses from northwest Argentina. *Journal of Food Quality* 32:303-314.

Visioli, F., Strata, (2014)A. milk , dairy products, and their functional effect in humans: A narrative review of recent evidence. *Advance Nutrition*, 5: 131-143.

Webb, C.D, Barite H., Silanikove N. and Weller J. I.(1965). Effects of season of birth on the fat and protein production of Israeli Holsteins. *Journal of Dairy Science*, 79**,** 1016–1020.

Wendorff, W.L. 2001. Freezing qualities of raw ovine milk for further processing. *Journal of Dairy Science* 84(E): 74–78.

Wilson W.R, E.R Giuliani and C. P. Tallieercio (1991). Managemennt system in small ruminant. *Dairy Animal Science,* 30: 67-72

Wong, Y., Noble, P., Robert, J., Mark, K., Elmer, H. and Marth, E. D. (1988). Fundamentals of Dairy Chemistry. New York. Van Nostrand Renshold, 1988

Yeikyo, K., Arima, S. and Hashimoto, Y. (1963). Studies on the variance of the composition of milk. *Journal of the faculty of Agriculture Hkkaido University*, 53(2); 228-247.

Yetismeyen, A. (2000*)*. Milk Technology. Ankara University Agriculture Faculty, Ankara Press 4th ed. Academic Press, New York, p. 173 84–91.

Young, W. and Park (2016). Nutritional properties of small ruminant food products and their roleon human health. *Small Ruminant Research*, 135:3–12.

Yusha'u, A. Z., Gimba, C. E., Ekumemgbo, P. A. and Omoniyi, K. I. (2018). Variation in Mineral Composition of Raw Milk of Cow and Sheep Breeds from Kano and Jigawa States, Nigeria, with Season *Chemistry Search Journal 9(1): 58 – 64,* Zahraddeen D., A. A. mohammed and U. Mohammed (2016).Milk Composition of Yankasa Sheep Raised under Small Holder Husbandry system in Zaria Nigeria. *Nigerian Journal of Animal Science,* 18(1): 60-64

Zahraddeen, D., Butswat, I. S. R. And Mbap, S. T. (2007). Evaluation of some factors affecting Milk Composition of indigenous goats in Nigeria. *Livestock Research for Rural Development,* 19(11): 103-110.