Introduction

Sudan is considered to be one of the rishiest African and Arab countries with regard to cattle population estimated as 103,278,000 which included 28,618,000 cattle 39,296,000 sheep, 30,649,000 goats and 4.715,000 camels. (MAFR 2011).

Agriculture is the major source of income in Sudan. There are different agro-climate zones, soil types and available water resources.

About 86% of the feeds for animals in Sudan are derived from rangelands–crop residues and agricultural by-products contribute 10% whereas 4% of the feed is from the irrigated forage and concentrates. (AOAD 1994).

Sudan produces all the raw material necessary for feeding cattle and small ruminants on feedlots and dairy farming systems.

The agro-industrial by-products of the country include molasses cottonseed cakes, groundnut cakes, sesame cakes, sun flower cakes and wheat bran.

In Sudan agro-industrial by-products are commonly used as roughages source for ruminants especially at periods of green forage shortage. The seasonal change and availability of roughages affects their prices especially in the dry season period. During this period there is also plenty of supply of cattle for fatting. This supply increases the demand for roughages and consequently the roughage prices increase which jeopardize the fattening operations (Elkhidir, 2004). In a study conducted by Arab Organization for Agricultural Development (AOAD), Abu Suwar and Drag (2002) estimated that natural ranges contributed about 77.6 million tons of dry matter, crop residues and by-products 22 million tons, irrigated forages 4 million tons and concentrates by 1-2 million tons to the annual feed available for livestock in Sudan.

Beef cattle have been the main concern of the country due to their contribution to the national economy. Sudan Baggara cattle are numerically the most important beef cattle in Sudan, raised by nomads in the Baggara belt that comprise Southern Darfur, Southern Kordofan, Sinnar and White Nile State (Elkhalifa*et al*., 1985) its homeland is the savannah belt of Central Sudan Lying about latitudes 10-16N, Western Baggara cattle are the major beef cattle in Sudan they are provide the bulk of meat considerably to the export of beef cattle (El-tahir, 2007).

General Objectives:

The main objectives of the study are:-

- To study the effect of Roughage (Sorghum straw, Groundnut hay and Baggasse) on feedlot performance and carcass characteristics of Sudan Baggarabulls.
- Encourage the use for the agricultural by-products and turn them to useful nutritious profitable commodity through the fattening of cattle.

CHAPTER ONE

Literature Review

1.1. Cattle types in the Sudan:

Bennett *etal.*,(1954) classified cattle of the Sudan into three main types, Northern or Arab, Southern or Nilotic and Nuba Mountains cattle

1.1.1. Northern or Arab type:

The cattle of Northern Sudan were divided by Payne (1970) into Baggara, Kenana, Butana, and White Nile.

Baggaratype: found in the Savannah regions between White Nile and Western frontier of the Sudan (Khalil, 1961). Their northern limit is about 12 ½°N and their southern limit is about 10°N. The most usual cattle coat colour is white or red; however, cattle of many different colours are seen. They possess a small hump and the dewlap is large and prominent [Wilson and Clarke, 1975]. In Darfour, BeniHelba and Falata tribes show preference for white colour (Nyalwai type). While in Kordofan dark and red are preferred by Messiriya and Hawazma tribes. The dark red and black coloured cattle of Messiriya and Hawazma tribes are smaller in size than the whitish Nyalawai type (Elkhalifa*et al.*, 1985).

Baggara cattle are named according to the tribal ownership into:

1.1.2. Nyalawi: Found in Darfur region .The most usual colour is white colour covering the whole body. Black and mixed coat colours are also present. Sometimes white coat colour with black spots colour is seen.

1.1.3. Mesairi: Found in Kordofan region. The coat colour is dark red with a bright red strip on the back and at the top of the head. Other variable red colours are found.

1.1.4. Rizaigi: Found in Darfur with deep dark red coat colour and black colour along the neck, the lateral side of the head, the hind quarters and shoulder sides.

Kenana type: found east of the Blue Nile in an acacia scrub having 336-457mm rainfall. This area lies between 10° to 14° latitude north. The coat colour is whitish grey. The horns seldom exceed 31-35 cm. The hump is cervicothoracic in position and slopes from front to rear.

Butana: found in a semi-arid area incompassed by the River Nile, Blue Nile and Atbara River. In The north, the Atbara River is making its northern border while the Blue Nile making its southern boundary and the River Nile is making the western boundary. The coat colour of Butana cattle is usually red although mixed coloured animals are found.

White Nile: found in an acacia scrub area, in the White Nile Valley in Kosti District, where the Kenana are influenced by the Baggara and termed "White Nile"(Mason and Maule, 1960). In this type there are many coat colours, red, fawn, white, black and admixture of these colours.

1.1.5. Nuba Mountain type:

Mason and Maule (1960) classified this breed as Zebu. Mills (1953) stated that cattle of this breed possess a hump and a well developed dewlap, the head shape is typical of Bosbrachyceros cattle. These cattle are found in Southern Kordofan. Different coat colours are found. They have a short broad head and their horns are short but very variable in form, lateral, straight or lyre-shaped. The hump is also very variable in size and they possess a very well developed dewlap (Mason and Maule, 1960).

1.2. Crop residues:

Crop residues are materials, which are generated after crop has been harvested (Dixon and Egan, 1987). The nature of crop residues produced depends on the amount and types of crops grown in specific area. The main basal feeds for ruminants in warm climatic developing countries are essentially crop residues and poor quality grasses from rangeland either grazed or, manually collected at very advanced stage of maturity during the dry seasons. Many by-products have a substantial potential value as animal feedstuffs. Ruminants, especially, have the unique capacity to utilize fibre, because of their rumen microbes. This means that cereals can be largely replaced by these by-products. Consequently the competition between human and animal nutrition can be decreased. The utilization of agro-industrial by-products may be economically worthwhile, since conventional feedstuffs are often expensive (Mirzaei-Aghsaghali and Maheri-Sis 2008). However, their inherent low concentration of fermentable nitrogen (N) and carbohydrates limits their feeding value (Sarwar and Nisa 1999).

1.3. Agro-industrial by-products:

Agro-industrial by-products are derived from processing of particular crop or animal product usually by an agricultural firm. Included in this category are material like molasses, baggasse, oil seed cakes, cereal straws and hulls.

By-products are ideal for forage-based diets because they are typically low in starch, moderate in protein and most importantly of low cost (Poore*et al.*, 2002). Supplements are usually necessary to meet the energy and protein requirements of the animal; however, as the fiber increases in the forage and starch increases in the supplement, forage intake as well as digestibility decreases. By-products are typically low in starch but still adequate in energy because of the highly digestible fiber fraction of the feedstuff. This allows for proper intake and utilization of the forage as well as meeting the animal's requirements for energy (Lusby, 2006). The shortage and high costs of conventional raw materials necessitates the use of these agricultural residues in animal feeds. However, the high lignin content, the low level of soluble carbohydrate and the relative absence of both fermentable nitrogen and bypass protein are responsible for the low nutritional value of untreated residues (Hamad and El-Saied 1982; Preston and Leng 1984; Sundstol 1988).

Agro-industrial by-products in Sudan consist of cereal straws, sugar-cane by-products, oil seed cakes and groundnut by products. It's difficult to estimate annual production of these by-products as cropping area varies annually (Abu Suwar*et al*., 2008).

1.4. Digestibility of Agricultural by-products:

A major constraint to livestock production in tropical areas is the scarcity and fluctuating quantity and quality year-round feed supply. During dry seasons, the natural pasture drops in quantity and quality, especially in energy and nitrogen content. As a consequence, feed intake declines and animal productivity is curtailed. Moreover, tropical crops have a large proportion of lignified cell walls with low fermentation rates, leading to low digestibility and limited intake (Ibrahim *etal*., 1995).

Nutritive value of feeds is determined by number of factors, including composition, odor, texture and taste (Schneider and Flat, 1975). These factors are generally measurable in the case of the animal as digestibility and intake. Digestibility is simply a measure of the availability of nutrients. When digestibility is combined with intake data, one can make an accurate prediction of overall nutritive value. Of the two factors, intake is relatively more important than digestibility in determining overall nutritive value because highly digestible feeds are of little value unless consumed by the animal in question.

However, digestibility usually provides a fairly reliable index of nutritive value because more digestible feeds are normally consumed to a greater extent than less digestible feeds. Only that portion which is soluble or is rendered soluble by hydrolysis or some other chemical or physical changes can be taken up into the circulation and assists in supplying the animal body with material for building and repair of tissue or supply the energy necessary for body functions. In addition, measures of digestibility are somewhat easier to obtain than measures of intake and thus, considerable effort has been made by animal nutritionists to develop effective means of determining digestibility (Khan *et al*., 2003).

1.5. Feed classification:

Livestock feed provide the basic nutrients required for animal production, including energy, proteins and amino acids (macro-nutrient and minerals vitamins and other micro-nutrients). Feed may be broadly classified as concentrates and roughages, depending on their protein and energy composition (John and Hall 2009).

1.5.1. Concentrates:

Concentrates are feeds that contain a high density of nutrient usually low in crude fiber content less than 18% of dry matter (DM) and high in total digestible nutrients (FAO 1983).

1.5.2. Roughages:

Roughages are feeds with a low density of nutrients with a crude fiber content over 18% of DM including most fresh and dried forages and fodder (FAO 1983). Roughages as described by (Abu-Swar 2005[a]).

Plant is a material available to be consumed by an animal from forage plants grasses and or agricultural by-products. (Cheeke, 2005) described

roughages as bulky feeds, high in fiber and low in energy. The National Research Council (NRC 1996) classified feedstuffs as roughages
When they contain greater than 18% crude fiber and less than 70% total digestible nutrient (TDN).

Roughages can also be grouped on their nutritive value into maintenance productive and sub maintenance type of roughages which has about 3-5% digestible crude protein (DCP) e.g. cereal fodder grasses and hay productive types of roughages have more than 5% (DCP) e.g. legume fodder and their hay sub-maintenance type of roughages have below 3% (DCP) e.g. Straw, Stover and Sugarcane Tops (NRC 1996).

1.5.3. Animal feedstuffs:

A feedstuffs can be defined as any component of diet {ration} that serves some useful function in the animal body most feedstuffs provide a source of one or more nutrients such as energy, protein minerals or vitamins (John and Hall 2009).

1.5.4. Essential nutrients:

Essential nutrients are nutrient that are needed by all living things. These nutrients must either be fed or made by the animals from building blocks obtained through eating drinking or breathing(John and Hall 2009).

1.5.5. Water:

Water is the most essential nutrient for life. Cattle can live for many days or a few weeks without food but will die within a few days without water. Water needs to be fresh, clean, and plentiful to ensure maximum intake the temperature of the water does not seem to affect cattle very mush. Research indicates that cattle readily drink water that is 40-90F water intake will vary with environmental temperature and dryness of the feed (John and Hall 2009).

1.5.6.Role of water in animal body:

1.5.6.1. Water functions:

Water in the body performs many functions – water helps to:-

1. Eliminate waste products of digestion and metabolism.
2. Regulate blood osmotic pressure.
3. Produce milk and saliva.
4. Transport nutrients, hormone and other chemical messages within the body and aid in temperature regulation affected by evaporation of water from the skin and respiratory tract (Bartlet, 1996).

1.5.6.2. Energy:

Energy is the fuel for all bodily processes breathing walking eating, growth, lactation and reproduction – starches, sugars and fats are all sources of energy. Maintenance energy is the fuel used to keep the animal alive without losing or gaining weight or giving milk-cold weather mud, increased walking, and larger body size increase energy needed for maintenance. Energy above that used for maintenance is available for reproduction, lactation and growth. Energy requirements for cattle and energy content of feeds are expressed in several different ways-total digestible nutrient (TDN)metabolizable energy (ME), and net energy (NE) for beef cattle, (TDN) is the most commonly used system (John and Hall 2009).

1.5.6.3. Protein:

Protein is the basic structure used to make all tissue-muscle, bone, skin, hair, organs and milk. It is important not only for growth and milk production, but protein is needed daily as the body is constantly repairing itself and replacing lost cells and tissue.

Protein is made up of amino acids. Animals use the amino acids from digested protein to build and replace tissue. Because of the rumen microbes, cattle can make all the amino acids they need as long as there is enough protein in the diet.

Plant protein is the primary source of protein in cattle diets. Mature cattle and heavy stockers can use non protein nitrogen (NPN) such as urea as a source for part of their protein. Cattle can then use the amino acids made by the microbes.

Protein requirement of cattle and feed content of protein is usually expressed as crude protein (CP). Crude protein=nitrogen x 6.25 to estimate the protein value of the feed. Some of CP is not available to the cow, and CP from different feeds may not be used at the same efficiency so nutritionists often use metabolizable protein (MP) instead-most protein is digested by rumen microbes and is known as degraded intake protein (DIP). Protein not degraded in the rumen passes to the small intestine and is known as undegraded intake protein (UIP).

UIP is often referred to as by pass protein. Most protein entering the small intestine will be digested and absorbed for various body functions (John and Hall 2009).

1.6. Minerals:

Minerals are important for a variety of function. Minerals along with proteins form structures like bone and teeth.

Minerals can be divided into two types' macro and micro.

Macro minerals are needed in ounces or grams per day. Micro minerals on other hand are needed in milligrams or part per million (PPM).

Micro minerals are often called trace minerals.

Vitamin (C) and (B) complex vitamins are water soluble and are needed daily.

The rumen microbes produce all or nearly all of the (B) vitamins needed by cattle grazing cattle usually get enough vitamin (A) and (E) from lush green forage, and they produce vitamin (D) response to sunlight vitamin (C) and (K) requirements are low and provided by the diet, so deficiencies are not a problem in cattle (John and Hall 2009).

1.7. Urea:

Urea is the most common of non-protein nitrogen (NPN) fed NPN must be fed with an energy source that is readily available to the rumen (John and Hall 2009). It should not make up more than 1% of the total diet or 3% of the concentrate mix-urea is often used in lick tanks liquid protein supplements to increase the CP value of the product.

1.7.1.Agro-industrial by-products:

Agro-industrial by-products are derived from processing of particular crop or animal product usually by an agricultural firm-included in this category are material like molasses, baggasse oil cakes, cereal straws and hulls.

By-products are ideal for forage-based diets because they are typically low in starch, moderate in protein and most importantly of low cost (Poore*et al.*, 2002). Supplements are usually necessary to meet the energy and protein requirements of the animal; however, as the fiber increases in the forage and starch increases in the supplement, forage intake as well as digestibility decreases. By-products are typically low in starch but still adequate in energy because of the highly digestible fiber faction of the feedstuff.

This allows for proper intake and utilization of forage as well as meeting the animal’s requirements for energy (Lusby 2006).

Agro-industrial by-products in Sudan consist of cereal straws, sugarcane by-products, oil cakes and groundnut by-products.

It’sdifficult to estimate annual production of these by-products as cropping area varies annually (Abu Swar*et al.*, 2008).

1.8. Molasses:

Molasses is one of the important by products from sugar-refinishing industry by extracting boiling and reboiling the juice of sugarcane or sugar beets. Several grandees of molasses can be created-these may be used as energy source in ruminant feeding practice also in the production of ethanol and the bakery yeast. Molasses may also be used in the fermentation of rum and beer (Tag eldin, 2009) molasses analysis on (DM) base contains 73.5% DM, 11.62 MJ/kg ME, CP 4.75 g/kg (Sulieman and Mubrouk 1999).

Molasses functions primarily as an energy source and can be fed at levels up to 30% of diet (Elkhidir and Ibrahim 1999), stated that molasses could be used above 50% of the total diet with the same production as that obtained when using conventional Dura based diets they also stated that molasses prevent the dusty characteristics of wheat bran and hence reduced its wastage during feeding moreover the good taste and flavor which flavor more intake by ruminants of low quality feed when mixed with molasses (Pollot and Ahmed 1979) used molasses as source of energy for feeding watish sheep. They used iso-nitrogenous diets mixed at the rate of 15, 30, 45 and 60% molasses. They found that the diet containing 30% molasses (8.49 MJ/kg DM) gave the good live weight gain.

1.9. Oil cakes:

Oil cakes are by-products of the vegetable oil extraction industry. Although many varieties of seeds and fruits are cultivated primarily for their oil content, the protein rich residues left after oil extraction represent an immense resource upon which the world production of animal protein for human consumption largely depends.

In the tropics and sub-tropics soya bean, groundnut and sesame are the principal oilseeds yielding protein-rich oilcake after oil removal.

1.10. Groundnut cake:

Oil cakes are by-product of vegetable edible oil production mechanically extracted groundnut cakes contain 43% crude protein (CP) 12.68% crude fiber (CF) and 11.27 MJ/kg ME (Sulieman and Mubrouk 1999)

1.10.1.By-product:

Croup in Sudan yield about 22 million tons dry matter (Abu Suwar and Drag 2002[a]) the agro-industrial residues are an important source of animal feed in the developing countries and Sudan. In the develop countries they depend on the improved pastures and good quality feeds for feeding their animals.

In Sudan the decrease of productivity of rang land and the limited forage production beside the increase of sorghum straw prices these factor increase the importance of these by-product.

Factors limiting the utilization of agro-industrial by-products in Sudan: as reported by (Abu Suwar and Drag 2002).

1. Most of the roughages are produced in the rain fed area and expand in over wide area where no sources of drinking water are available for the animals in most of the year.
2. These by-products are owned by the farmers who lack the modern technology to treat and utilize these by-products.
3. The high cost of collection and transportation of by-product specially they have low density and low nutritive value.
4. The absence of agricultural grazing co-operation.
5. The production area is very far from the marketing area so the cost of transportation is very high.
6. Unawareness on the environmental benefits by using agro-industrial by-products as animal feeds.

7. The absence of the techniques of binding pressing and treatment of these by-products.

1.10.2.Baggasse:

In Sudan agro-industrial by-products were commonly used as roughage for ruminants especially at periods of green forage shortage due to seasonality. The scarcity and resultant high price of cereal grains have revived interest in finishing beef cattle on sugarcane baggasse (SCB), is one of the available and cheap agro-industrial by-product in the Sudan. Finishing Sudan Baggara bulls on sugarcane baggasse reduces the competition between man and animals for cereal grains (Elkhalifa 1985).

Livestock fattening in Sudan is based on sorghum grains and oilseed cakes at ratio of 50% each (Eltayeb*et al*., 1990; Mustafa *et al*., 1990). Other researchers (Elhag and George, 1981, Elkhidir, 1984, 1995, Tibin and Ahmed 1997[ab]) sighted the use of agricultural and agro-industrial by-products in livestock fattening in Sudan.

Traditionally cattle destined for slaughter are directed drawn from pasture, subjected to shorter feeding period to reach the market weight and improve meat quality. The nutritive value of sugarcane baggasse: is very poor due to its high fiber content, low digestibility of DM (only 25%) and extremely low (TDN) ranging from 20-35% as reported by (Ensminger*et al*., 1990). Abu Suwar and Drag (2002) reported 47.9% (CF) and 1.72 MJ/kg DM metabolizable energy (ME) value for (SCB) in Sudan to improve the nutritive value of SCB, pelleting was used for one of the diets based on SCB as complete diet (Ensminger*et al*., 1990 and Reddy 2004) reported that pelleting poor quality roughage will markedly increase the consumption of roughage, but in palletizing complete feeds incorporation of concentrate mixture at 30% level appear to be the upper limited for optimizing the feed intake, otherwise feed intake is decreased.

1.10.3.Sorghum straw:

Sorghum straw is an agricultural by-product remaining after harvesting the cereal crop. It is an aerial part of sorghum plant that either left in the field to be ploughed later in the soil or being grazed by animals. In Sudan sorghum straw were harvested two weeks after grain harvest and may be subjected to further processing like shopping or pelleting to be fed to animals (Abdelrahman 1981) reported that Sudan produces about 64% of all the amount of sorghum straw in the Arab World, but its use as an animal feed is abundant in spite of the high transportation costs. Chemically sorghum straw is primarily composed of cellulose, hemicelluloses and lignin in addition to protein, sugar and ash (Elkhidir*et al*., 1984).

1.10.4.Groundnut by-product:

Groundnut is annual legumes produced mainly in tropical and semi-tropical environment. The main producer is India China Nigeria the United State and Brazil (Cheeke 2005).

Sudan produces 1.1 million of the groundnut annually (Abu Suwar and Drag 2002[a]).

1.11.Groundnut hay:

Almost one million hectares of groundnuts are grown annually (Anon 1977) and groundnut hay is a plentiful by-product from this sector of Sudanese agriculture. Groundnut hay contains 9% crude protein and 61.7 total digestible nutrients (TDN) (Abu Suwar and Drag 2002).

Ahmed *et al*., (1977) reported that the growth response to dietary protein by Sudanese zebu calves (Kenana) of about 75kg initial live weight and 8 months of age was measured in growth trials of 112 day; forty five animals were allocated to one of the three groups given groundnut hay *ad libitum* plus a sorghum based concentrate (containing 117, 155 or 201g CP/kg DM offered at 3kg/animal/day).

The average growth was 0.55, 0.75 and 0.85kg/day with intake of 2.0, 2.5 and 2.7kg hay DM/day; 2.3, 2.5 and 2.7kg hay DM/day; 2.3, 2.5 and 2.3kg concentrate DM/day; feed conversion of 7.8, 6.5 and 5.8 for increasing protein level respectively.

Initial live weight as shown to have positive relationship with rate of live weight gain at the two lower protein levels, but not at the highest protein level.

1.11.1.Feed intake:

Feeding is a complex activity which includes such action as search for food, recognition of food and movement towards it, sensory appraisal of food, the initiation of eating and ingestion. Feed intake is an important determinate of growth. The natural drive to eat is determined by complex interactions between biological mechanisms of appetite control and responses to challenges from the physical environment (Matteri, 2001). Feed intake increases as digestible energy increases and stops when energy requirements are fulfilled. It has been recognized that in ruminants there is appositive relationship between the digestibility of foods and their intake. In other words food that is digested rapidly and of high digestibility, promote high intake (McDonald, *et al*., 2011).

Generally animals which eat more will produce more, be meat or milk (Preston 1968).

1.11.2. Live weight gain:

The growth rate is affected by many factors mainly initial live weight, dry matter intake plane of nutrition, breed, sex, growth promoters and environmental factors.

Elhag and George (1981) reported daily weight gains ranging from 1.0 to 1.2kg for Western Baggara bulls fed ration containing high levels of poor quality agro-industrial by-products, while Gumaa(1996) reported 1.03kg per head per day for the same breed fed diet with energy 11.35 MJ/kg.

Salim (2009) used four types of roughages in fattening Baggara bulls. The first group was fed sorghum straw, the second group was fed groundnut hay, the third group was fed groundnut hulls and forth group was fed baggasse. He reported the daily live weight gain was significantly different between the four groups ($P<0.01$); it was 1.24, 0.86, 0.57 and 0.44kg/day for groundnut hay, sorghum straw, baggasse and groundnut hulls group respectively.

1.11.3. Feed conversion ratio:

Feed conversion ratio is defined as feed consumed per unit of weight gain and it is negatively related to the live weight gain. Feed conversion ratio (FCR) is a measure of the amount of feed eaten per unit of body weight gain or carcass weight gain. Factors affecting FCR include sex breed and plane of nutrition.

Mustafa *et al*., (1990) used mature Baggara bulls of feedlot of different levels of concentrates with different proportion of milled Stover. They obtained feed conversion values that ranged from 7.4 to 8.5kg DM/kg live weight. Salim (2009) used four types of roughages in feeding Baggara bulls and reported that feed conversion ratio (kg. DM/kg gain) was significantly different between the four groups ($P<0.01$) it was 7.33, 9.23, 10.83 and 14.66 for groundnut hay, sorghum straw, baggasse and groundnut hulls groups respectively.

1.11.4. Live animal measurements:

Measurements taken on live animal have been used extensively for a variety of reasons in both experimental work and in practice. Some are linear and are taken either with various types of measuring rods or sticks or with calipers (Lawrence and Fowler 1997).

Determination of live weight is necessary to calculate feed requirements, animal growth, marketing weight and estimation of animal's cash value as well as conducting breeding studies, field experiments and estimation of dressed carcass weight (Payne 1990). Alsiddig(2007) stated that all of studied ages were significantly heavier than those of Messarri cattle subtype. Heart girth around the hump had the closest relationship with live weight, particularly for medium and heavy weight bull groups. The best correlation coefficient was found in the heavy group, which indicated that a high accuracy existed in the use of live weight of heavy humped cattle (Abdelhadi and Babiker 2009).

1.12. Body components:

Brody (1945) reported that as animals grow they do not simply increase in weight and size but they show what is termed development, which mean the various parts of the body grow at different rates, so that its proportion changes as animal matures.

Body composition is dynamic and changes continuously in response to environmental factors. Knowledge of source of variation of body composition can help in developing strategies to alleviate undesirable effects of poor nutrition and to optimize the use of feedstuffs by animal (Kabbali*et al.*, 1992). The four major elements deterring the quality of beef animal are size or weight, body composition, attractiveness and eat ability (Preston and Willis 1974).

1.13. Non carcass components:

Non carcass components include offal's such as heart, lungs and trachea, head, liver as well as alimentary tract and hide.

Eltahir(1994) reported that the proportion of head, hide, heart, lungs and trachea, alimentary tract, liver, spleen, omental fat, four feet and tail of Baggara bulls kept on molasses diet were 5.56, 8.98, 0.41, 1.4, 6.29, 1.53, 0.35, 0.9, 2.44 and 0.33 respectively.

Mohammed (1999) reported and average weight of non carcass components as head, four feet, liver, heart, lungs, mesenteric fat and omental fat as 6.51, 2.47, 1.35, 0.35, 1.64, 0.47 and 0.56kg respectively.

Fadol(2005) studied the effect of feedlot regimen in Baggara bulls and she found that non carcass components showed no significant difference between the two groups except the weight of head which was significantly ($P<0.05$) heavier in restricted bulls than in *ad libitum* fed bulls.

1.14. Dressing percentage:

The weight of the carcass in relation to the weight of the live animal is an important measurement of meat yield. It is normally expressed as killing-out percentage (Warriss, 2000). The significant of dressing percentage for both the consumer and the producer is that it defines the saleable part of the animal. The dressing percentage is represented by the proportion of the dressed carcass divided by slaughter weight and multiplied by hundred. It may be calculated on full or empty body weight basis. As an animal grows dressing percentage increase steadily due to the higher rate of muscle and fat growth in the carcass than growth of component in the body cavity.

The most important biological factors that affect dressing percentage include weight of animal at slaughter, nutrition, breed and sex. Nutrition is one of the most important factors that affect dressing percentage.

Animals on higher levels of feeding tend to kill out better and *ad libitum* fed animals also kill out better than animals fed the same diet to a restricted scale (Kempster*et al*., 1982).

1.15. Carcass composition:

There are many parts of a living animal that we do not want to eat. Examples are the hide of fleece and the contents of the gastrointestinal tract of the weight of the live animal therefore, only a proportion is useful as saleable meat.

However in general terms the carcass consists of all those parts of the animal that will eventually be sold as joints or steaks of meat (Warriss 2000). The carcass composition of beef cattle is influenced by differences in plane of nutrition, breed type, sex and slaughter weight as animal grows the increase in weight is accompanied by changes in the relative proportion of carcass tissues (Berg and Butterfield 1976). If these changes were known or could be predicted, then all animals could be slaughtered at the optimum carcass composition (Keane and More O'Ferral 1992). Eltahir(1994) reported that the carcass of Baggara bulls kept on molasses diet contained 64.57 muscles 21.36 bones and 14.06 fats.

Fadol(2005) studied the effect of feedlot regimen on carcass composition of Baggara bulls and reported that there were no significant differences in the percentage of muscle, bone fat and connective tissue trimmings between wholesale cuts except rump. In the rump the fat percentage was significantly greater and the connective tissue trimmings were significantly lower in *adlibitum* fed bulls than restricted bulls.

1.16.Muscle to bone ratio:

Conformation describes the shape of the carcass and is a reflection of the proportion of muscle to bone in it. Carcasses with good conformation have the appearance of thicker, more defined muscle. At the same level of fatness these yield more lean meat, and joints and steaks of better appearance (Warriss 2000).

Among carcasses of similar weights, the percentage of muscle, fat and bone varies considerably depending on breed type and growth rate. The proportion of lean meat in the carcass is of major importance sine it is the prime determinate of yield and commercial value. Leanness is the criterion by which most consumers' judge quality and value for many. Taken as generalized ideal the best carcass should have an optimum level of fatness and minimum bone (Kempester*et al.*, 1982).

Eltahir(1994) found that the muscle: bone ratio, muscle: fat ratio and bone fat ratios of Baggara bulls were 3.0, 4.6 and 1.52 respectively.

1.16.1.Water holding capacity:

A working definition of WHC is the ability of meat to hold its own or added water during the application of any force (Hamm 1986).

Water holding capacity of meat its ability to passively immobilize within it, all or part of its own or added fluid it is important because several qualities attributes of meat (color, texture, firmness juiciness and toughness) are at least in direly affects by its water holding capacity (Monin an Ouali, 1991).

In general, breed, sex, age and plane of nutrition affect water content (Cole and Lwarie, 1974).

1.17. Carcass measurements:

The most commonly techniques used for carcass measurements are:-

Carcass weight, killing out proportion, fat thickness area of *longissimussdorsi* muscle and liner measurements Yeasts(1952) reported that carcass length, depth and width measurement had been advocated as useful predicators of carcass composition. The length seems to have no predictive value while width measurements usually were influenced by fat deposition than muscle (Butterfield, 1965).

1.18. Wholesale cuts yield:

The economics of production of beef from cattle that yield a high percentage of highly acceptable retail cuts with minimum amount of fat is of great importance to beef cattle industry (Prior *et al*., 1977).

Berg and Butterfield (1966) found no differences in the proportion of the muscle in various joints when comparing Hereford, dairy shorthorn and Friesian steers on different planes of nutrition.

Kempester*et al*., (1982) showed that higher priced – joints – accounted for 49% of the total lean weight.Half of this was in three large joints of the hind limb; silverside, topside and thick flank.

Eltahir(1994) found that the overall mean percentage of wholesale cuts of Baggara bulls on carcass weight basis were 2.95, 5.35 5.52, 13.68, 9.53, 4.52, 1.87, 8.64, 5.0, 4.39, 4.47, 9.62, 6.8 and 17.59, for shin, neck, clod, chuck extended roosting rib, thick rib,thin rib, brisket, thin flank, thick flank, leg, sirloin, rump, and top silver side respectively.

CHAPTER TWO

Materials and Methods

2.1. Experimental animals:

This experiment was conducted at the Animal Production Research Center Kuku (APRC) Khartoum North during March – June 2013.

Thirty six entire Sudan Baggara bulls of 1to1.5 year old were used. The bulls were purchased from local market of Omdurman (El-Moelh). They were trekked to the experiment and accommodated into three feeding groups of twelve animals each, further sub-divided into four sub-groups of four animals each in shaded pens (4x3meters).

The pen's side were made of two inches iron pipes, the pens were equipped with feeding trough attach to the outer side of the pens to facilitate easy feeding, water troughs were placed inside the pens under the shade, protected from sun heat and dirt, clean fresh water was available all over the day and night.

The animals were identified by ear tags on arrival they were dosed against internal and external parasites using anathematic (ivermectin).

2.2. Feed and feeding:

The three feeding bull groups were offeredmolasses based diet with different type of roughages,sorghum straw, baggasse, groundnut hay for group A, B, C respectively, fresh water was freely available for animals.

The molasses based diet was composed of 52% molasses, 39% wheat bran, 5% groundnut cakes, 3% urea, and 1% common salt. The chemical composition of feed used was shown in table **(1).**

Table 1. Chemical composition of different ingredient used in diets.

Sample type	D.M%	Ash%	C.P.%	E.E%	C.F%
Groundnut Hay	94.20	8.38	7.14	1.00	43.00
Sorghum Straw	92.20	8.13	10.27	1.20	39.00
Baggasse	97.10	9.16	4.28	0.80	58.00
Molasses Concentrate ration	96.60	9.10	20.98	1.40	7.20

DM = Dry matter
C.P. = Crude protein
E.E. = Ether extract
C.F. = Crude fiber.

Sorghum straw (Control) for group (A)groundnut hay for group (B) and baggasse for group (C) offered separately as a roughage and molasses based first at 8:00 am daily, the molasses and urea were incorporated as major source of energy and nitrogen respectively. Daily feed intake was calculated as the difference between offered and the refusal.

2.3. Live animal measurements:

Body linear measurement were taken at the start and at the end of the experiment using a steel tape measure graduated in centimeters. All body measurements were conducted using a measuring tape except for height at withered and height at rump where a cal separated stick was used:

(A) Heart girth: measured around the chest at the forth rib.

(B) Heart girth around hump: measured around the chest and it included the hump.

(C) Body length: measured from the ground level to the highest point of hump.

(D) Height at wither: from the ground to the highest point of the wither.

(E) Height at rump: from the ground level to the highest point of rump.

(F) Abdomen circumference: taken around the abdomen at the last rib.

(G) Chest depth: was taken as the perpendicular distance between the midpoint at the back immediately behind hump and the sternum.

(H) Pelvic width: represented the distanced between the medical surfaces of tubercoxae.

2.4. Feedlot performance:

Bull weighed at weekly intervals and the growth rate was calculated as daily gain at the end of the experiment as total gain over days on feed.

Feed conversion ratio was calculated as the

$$\frac{\text{total feed intake in dry matter (kg)}}{\text{Total / weight gain live weight (kg)}}$$

2.5. Slaughter and carcass characteristics:

Nine animals from each experimental group were slaughtered at finishing live weight of group (A) and group (B)and group (C).

The bulls were weighed before slaughter which is performed according to the Muslim practice by servering the Jugular veins, carotid arteries, trachea and esophagus by a sharp knife without stunning.

Blood was collected immediately at the time of slaughter using a plastic bucket under the neck and weighed.

The hide was weighed after dressing and then evisceration was performed the elementary tract was removed and thenafter cleaning. The contents weighed again to obtain the empty weight by subtracting gut fill weight from slaughter weight.

2.6. Non carcass component:

The internal offal's (heart, liver, spleen lung, trachea, diaphragm, pancreas, genital organs, omental fat and mesenteric fat and the tail was removed at its base and weighed the kidneys and its fat were left intact in carcass).

After complete bleeding and removed of head, the four feet were removed at the proximal cannon bones, the tail was removed at the first intercoccyeal articulation and then hide was removed manually, after dressing and evisceration the internal organs and offal's were removed and weight. The alimentary tract was weighed and then cleaned of its contents {fill} and reweighed. The weight of fill was calculated as difference between the full and empty weight of the alimentary tract.

The weight of fill was subtracted from the slaughter weight to determine the empty body weight.

2.7. Carcass component:

The carcass was weighed hot and split along the vertebral Colum into the left and right sides and chilled for 24 hrs at 4ºC.

The left side was prepared for dissection first the pelvic fat, the kidney and kidney fat were removed and weighed separately cold carcass wt. was weighed to obtain chilled carcass weight.

2.8. Linear carcass measurements:

The carcass was hanged by hind limbs with aid of gahnlorel and the following measurements were made using measuring tape graduated in centimeters.

- Leg length: measured from the distal end of the tarsal bone along the inside of the leg to the surface of meat above the sgmysis of pelvic.

- Leg circumference: measured from a point in front of tail, head, passed along the rump and turned upward to the starting point encircling rump.
- Abdominal circumference: measured by encircling the abdominal cavity from the spinal of 4th lumber vertebra to the adage of flank.
- Shin length: measured using a measuring tape from elbow joint to the metarsal bone.
- Carcass length: measured from the anterior edge of the first ribs to the acetabulum branch of the pubis on the ischium.

2.9. Wholesale cuts: the left side of each carcass was jointed into 14 standardized wholesale cuts according to M.L.C. (1974).

The cuts were: shin, clod, neck, brisket, thick ribs, thin ribs, extending roasting ribs, chuck and blade, thick flank, rump, sirloin, topside and silverside and leg. Each wholesale cut was weighed and expressed as percentage of carcass side weight.

2.10. Sirloin dissection:

Each sirloin cut was separated into muscle, bone, fat and connective tissue, each component was weighed using (OHAUS) balance of 20kg maximum capacity load to the nearest (gm) and expressed as percentage of joint.

2.11. Meat chemical composition:

Twelve samples for analysis were taken from the muscle *longissmusdorsi* of left carcass for meat chemical composition; samples were immediately minced and stored at 10ºC waiting analysis. Chemical composition of meat included determination of ash, CP, ether extract, EE, DM according to AOAC (2000).

Method samples intended for colour measurement were allowed to bloom for 30 minutes at 4ºC m\hunter colour components L^*(lightness, a^* redness and b^* yellowness) were determined using hunter lab tristmuluscolourimeter mode D25 14-2.

2.12. Meat quality attributes:

2.12.1. Water holding capacity:

The measured areas were used to determine water holding capacity of meat as:-

Water holding capacity =

$$\frac{\text{Diffused water area – meat film area}}{\text{Meat film area}}$$

About 3gm of minced sample was placed on humidified filter paper (what man No. 1) kept on saturated kcl solution and pressed between two Plexiglas plat for 3 minutes at 25kg load. The meat film area and diffused water area were traced with a ball pen and the filter paper was allowed to dry, the areas traced were measured with a compensating Plano-meter.

2.12.2. Fat thickness:

Was measured perpendicular to the external fat surface and constituted. The average measurement of the fat thickness at point {¼, ½ and ¾} of the lateral length of *longissmussdorsi* muscle and recorded to the nearest mm.

CHAPTER THREE

Results

3.1. Live animal measurements:

Linear body measurements of the three groups of Baggara bulls fed difference type of source roughage (groundnut hay, sorghum straw, sugarcane baggasse), are shown in table **(2).**

Final measurements of fattened animals in table **(2)** revealed no significant differences among all groups in side length, face length, chest depth, pelvic width, height at hump abdomens circumference, body length, heart girth around at hump, heart girth, height at wither. All final linear measurements increased over initial measurements.

3.2. Feedlot performance:

Feedlot performance of Baggara bulls in this study is presented in table **(3)**, the experimental roughages indicated no difference in daily gain, total live weight gain, final weight, and initial live weight and feed conversion ratio except feed intake found significant ($P<0.01$) group B (sorghum straw) showed the highest feed intake followed group A fed (groundnut hay) and C (baggasse). Final body weight of the experimental bulls groups was not significantly different. Final live weight was higher in the group B fed sorghum straw followed by croup A (groundnut hay) and the least final body weight were in group C (sugarcane baggasse).

Table 2. Effect of feeding different Roughages source (groundnut hay, sorghum straw, baggasse) on linear body measurement in (cm) of Sudan Baggara bulls

Parameter	Group A Groundnut Hay	Group B Sorghum Straw	Group C Baggasse	Overall Mean ± SD	Level of significance
No. of animal	9	9	9	27	-
Initial live wt. (kg)	192.92±8.90	195.42±8.38	193.75±79	194.03±8.84	NS
Height at wither	116.94±3.31	118.83±5.30	116.00±2.93	117.26±4.01	NS
Heart girth	147.67±4.44	150.11±3.31	150.44±6.80	149.41±5.01	NS
Heart girth around at hump	171.67±5.31	169.67±3.24	168.11±6.11	169.81±5.06	NS
Body length	136.22±10.18	128.00±5.78	129.22±5.01	131.15±7.97	NS
Abdomen circumference	168.67±5.65	164.56±5.24	170.89±5.20	168.04±5.81	NS
Height at hump	124.03±3.27	122.61±3.52	123.50±3.22	123.38±3.23	NS
Pelvic width	28.22±2.33	28.89±2.97	28.00±2.17	28.37±2.45	NS
Chest depth	58.13±5.60	56.58±1.83	55.51±1.36	56.74±3.53	NS
Face length	46.56±2.40	47.89±2.52	48.11±2.20	47.52±2.40	NS
Side length	110.22±9.84	105.22±5.97	106.67±5.74	106.37±7.74	NS

In this and subsequent tables the following appreviation stand for different superscripts stand for significance

SD= Standard deviation.

NS= Non significant at P≤0.05.

NS = Not significant (P>0.05).

* = Significant at (P<0.05).

** = Significant at (P<0.01).

*** = Significant at (P<0.001).

Table 3. Feedlot performance of Sudan Baggara bulls fed different source of Roughage (groundnut hay, sorghum straw, baggasse)

Parameters kg	Group A Groundnut Hay	Group B Sorghum Straw	Group C Baggasse	Mean ± SD	Level of significance
No of animals	12	12	12	36	-
Initial live wt. (kg)	192.92±8.90	195.42±8.38	193.75±79	194.03±8.84	NS
Period of day	70	70	70	70	-
Final wt. (kg)	259.58±18.02	270.00±16.09	264.58±23.78	264.72±19.49	NS
Average daily/ gain	0.95±0.21	1.06±0.20	1.11±0.29	1.99±0.42	NS
Daily feed intake as fed (kg / head)	8.81±0.51[b]	9.68±0.78[a]	8.86±0.49[b]	9.12±0.72	**
FCR kg/feed kg gain	9.71±2.36	9.40±1.93	11.10±9.62	10.07±5.70	NS
Total body weight gain	66.67±15.27	74.58±14.68	70.83±20.54	70.69±16.86	NS

In this and subsequent tables. In the same row means not followed by the same letter differ significantly at subsequent level of significance.

Total live weight gain showed no significant differences among treatment groups.

The group B showed the highest total live weight gain followed by group C and A.

Total gain showed no significant different (P>0.05) among all treatments.

Feed conversion ratio was not significantly affected by type of roughages. The best FCR followed by group A and C.

3.3. Carcass measurements:

Carcass measurements form bulls fed different type of roughages are showed in table **(4)**. No significant differences in carcass measurements of all bull groups exceptfor carcass length group A showed the highest carcass length followed by group B and C.

3.4. Non carcass components:

The mean values of non carcass components expressed as percentage of empty body weights of slaughtered bulls fed on diets that contained different source of roughage are given in table **(5)** all parameters showed no significant differences among treatments except gut fill (P<0.01) which heavier in group C baggasse, blood, head, hid, four feet, genitalia, lung and trachea, pancreas, spleen, diaphragm, tail, rum full, rum empty, omasum full, omasum empty, abomasums full, abomasums empty, intestine full, intestine empty and liver, showed no significant differences between groups.

Table 4. Effect of feeding different Roughages source type (groundnut hay, sorghum straw, baggasse) on carcass measurement (cm) of Sudan Baggara bulls

Parameter	Group A Groundnut Hay	Group B Sorghum Straw	Group C Baggasse	Overall Mean ± SD	Level of significance
Neck length	35.66±1.22	41.35±10.10	37.00±1.50	30.00±6.22	NS
Shin length	36.55±1.42	37.05±1.33	36.55±1.23	36.72±1.30	NS
Shoulder length	35.83±1.69	34.88±2.27	33.83±2.09	34.85±2.12	NS
Chest depth	68.44±4.50	57.27±22.43	64.94±4.31	63.55±13.77	NS
Abdominal circumference	78.33±4.84	78.89±4.31	76.11±4.31	77.78±4.49	NS
Pelvic width	33.55±2.44	33.11±3.55	32.94±1.74	33.20±2.59	NS
Carcass length	117.89±2.84[a]	114.67±3.27[b]	114.33±2.60[b]	115.63±3.27	*
Leg circumference	91.67±6.74	90.44±3.08	88.78±2.43	90.30±4.49	NS
Leg length	41.33±1.25	40.44±1.04	41.44±2.20	41.07±1.60	NS

Table 5. Effect of feeding different Roughages source (groundnut hay, sorghum straw, baggasse) on non-carcass component aspercentage of empty body weight of Sudan Baggara bulls

Parameter	Group A Groundnut Hay	Group B Sorghum Straw	Group C Baggasse	Overall Mean ± SD	Level of significance
No. of animal	9	9	9	9	-
Blood	4.35±0.46	4.04±0.36	4.04±0.47	4.15±0.44	NS
Head	6.29±0.27	6.78±1.71	6.55±0.43	6.54±1.01	NS
Hide	9.72±4.32	8.41±0.25	8.35±0.61	8.82±2.54	NS
Four feet	2.36±0.17	2.34±0.14	2.49±0.23	2.40±0.19	NS
Genitalia	1.03±0.17	0.97±0.25	1.17±0.15	1.06±0.26	NS
Lung and trachea	1.21±0.43	1.23±0.14	1.41±0.12	1.28±0.27	NS
Pancreas	0.16±0.04	0.29±0.48	0.24±0.32	0.23±0.33	NS
Spleen	0.37±0.10	0.36±0.06	0.41±0.09	0.38±0.09	NS
Heart	0.37±0.09	0.43±0.06	0.41±0.05	0.41±0.07	NS
Diaphragm	0.62±0.06	0.60±0.06	0.58±0.12	0.60±0.08	NS
Tail	0.47±0.60	0.52±0.12	0.49±0.06	0.49±0.08	NS
Rum full	9.60±2.55	10.10±2.98	11.38±1.40	10.36±2.43	NS
Rum empty	3.27±1.10	3.34±1.59	2.73±0.36	3.11±1.13	NS
Omasum full	1.23±0.18	1.32±0.19	1.84±0.46	1.37±0.33	NS
Omasum empty	0.99±0.76	0.88±0.15	2.73±0.36	3.11±1.13	NS
Abomasums full	0.79±0.17	0.88±0.13	0.83±0.12	0.83±0.14	NS
Abomasums empty	0.54±0.06	0.58±0.11	0.55±0.55	0.55±0.24	NS
Intestine full	4.48±0.46	4.64±0.59	5.13±0.78	4.75±0.16	NS
Intestine empty	2.37±0.62	2.84±0.81	2.77±0.13	2.75±0.50	NS
Liver	1.28±0.27	1.35±0.15	1.47±0.11	1.37±0.20	NS
Cut fill	9.03±4.50[b]	9.33±3.32[b]	12.17±1.49[a]	10.17±3.10	**
EBW	244.57±14.84	248.74±18.27	235.11±9.85	243.03±15.19	NS

3.5. Carcass yield and characteristic:

Table **(6)** gives carcass yield and characteristics of bulls fed diets containing different types of roughages.

Slaughter weight and empty body weight were not significantly different in three groups but were heavier in group B followed by group A and group C.Hot carcass and cold carcass weight showed the same trend as the slaughter weight.

Hot dressing percentage and cold dressing percentage was not significantly affected ($P>0.05$) by roughage type. Croup B showed the highest value followed by group A and group C which was the lowest.Gut fill showed significant difference ($P<0.01$) between the three groups.

3.5.1. Wholesale cuts yield:

Table **(7)** shows the yield of wholesale cuts from carcass of bulls fed different type of roughage. Significant differences were found among wholesale cuts obtained from carcass chilled carcass weight was significantly ($P<0.05$) higher in group B and C than group A.

Significant differences was found among groups in Brisket ($P<0.01$) which was significantly higher in group C followed by group B and group C. Hind quarter flank showed a highly significant ($P<0.01$) in group A, while group B and C showed similar results.

Top side and silver side obtained significant ($P<0.01$) difference it was similar in group B and C while group C was the least.

Kidney fat obtained significantly ($P<0.01$) highest percentage in group C followed by group A and group B.

Pelvic fat was greater in group B than in the other groups with a significant differences ($P<0.001$) between groups.

Table 6. Carcass yield and characteristics of Sudan Baggara bulls fed different roughages source (groundnut hay, sorghum straw, baggasse)

Parameter	**Group A Groundnut Hay**	**Group B Sorghum Straw**	**Group C Baggasse**	**Overall Mean ± SD**	**Level of significance**
No. of animal	9	9	9	27	-
Slaughter wt. (kg)	266.67±15.61	268.33±11.45	264.44±8.81	266.48±11.91	NS
Empty body weight (kg)	244.57±14.84	248.74±18.27	235.77±9.85	243.03±15.19	NS
Hot carcass weight (kg)	144.10±11.94	145.08±9.55	138.26±7.15	142.8±9.85	NS
Cold carcass weight (kg)	140.24±12.28	141.82±9.18	134.91±6.68	138.99±9.75	NS
Hot dressing percentage of (LW)	54.09±1.24	54.06±1.18	52.28±2.38	53.47±1.93	
Cold dressing percentage of (LW)	52.58±0.88	52.85±0.76	51.17±0.17	52.20±0.90	NS
Hot dressing percentage of (EBW)	58.99±0.6	58.44±0.1	56.54±0.7	57.99±0.14	NS
Cold dressing percentage of (EBW)	57.71±0.04	57.18±1.14	58.38±0.63	57.75±0.16	NS

Table 7. Effect of different Roughages source (groundnut hay, sorghum straw, baggasse) on whole sale cut as percentage ofleft carcass weight of Sudan Baggara bulls

Parameter	Group A Groundnut Hay	Group B Sorghum Straw	Group C Baggasse	Overall Mean ± SD	Level of significance
No. of animal	9	9	9	9	-
Left side wt.	70.21±5.81	71.54±5.07	67.78±4.01	69.84±5.07	NS
Clod	5.84±0.74[b]	6.33±0.42[a]	6.21±0.62[a]	6.13±0.62	*
Neck	5.83±0.70	6.84±0.82	6.43±0.80	6.37±0.85	NS
Shin	3.44±0.89	3.23±0.13	3.28±0.15	3.32±0.51	NS
Chuck and blade	11.70±0.94	11.20±0.97	10.79±0.87	11.23±0.97	NS
Thick ribs	5.44±0.85	6.07±0.48	5.85±0.55	5.79±0.68	NS
Thin ribs	3.10±0.30	3.29±0.16	3.32±0.24	3.23±0.25	NS
Extended roosting ribs	7.15±0.87	7.46±0.65	6.86±0.83	7.15±0.80	NS
Brisket	5.78±1.25[b]	6.98±0.48[b]	7.40±0.76[a]	6.72±1.10	**
Leg	5.02±0.55	5.20±0.19	5.30±0.41	5.17±0.41	NS
Thick flank	5.12±0.83	4.66±0.41	4.65±0.46	4.81±0.61	NS
Hind quarter flank	11.51±6.57[a]	6.24±0.59[b]	6.26±0.42[b]	8.09±4.45	**
Top side and silver	11.86±6.44[b]	17.79±0.63[a]	17.76±0.76[a]	15.80±4.59	**
Rump	5.81±0.58	6.20±0.41	6.21±0.39	6.07±0.49	NS
Sirloin	6.34±0.76	6.66±0.40	6.60±0.31	6.53±0.53	NS
Omential fat	1.11±0.32	1.07±0.20	1.14±0.32	1.11±0.28	NS
Mesenteric fat	0.36±0.02	0.32±0.08	0.32±0.09	0.33±0.13	NS
Kidney	0.44±0.06	0.59±0.40	0.49±0.09	0.51±0.24	NS
Kidney fat	1.92±0.53[b]	0.51±0.09[b]	2.05±0.69[a]	1.49±0.86	**
Pelvic fat	0.39±0.10[b]	1.75±0.73[a]	0.53±0.12[b]	0.89±0.75	***

3.5.2.Sirloin composition:

The composition of sirloin cut of bulls fed different sources of roughage content is displayed in table **(8)**.

There were no significant differences in the weights of sirloin cut, percentage muscle, bone fat.

Connective tissue (C.T) weight was significantly ($P<0.05$) heavier in sirloin cut of group B than those from the other groups.

Muscle percentage though not significantly different it was similar in group A and C followed by group B.

Fat percentage in all groups are similar showingnon significant difference ($P>0.05$).

Connective tissue percentage showed significant difference ($P<0.01$) it was higher in group B followed by group C and A.

The bone percentage was the higher in group B, C and A in that order.

The result also revealed that there were no significant difference in muscle: fat ratio and muscle:bone ratio for bulls fed different roughage in their diet.

3.6. Meat chemical composition:

The chemical composition of *longissimusdorsi* muscle obtained from bulls fed on diets containing different source of roughages presented in table **(9)**.

No significant effect on meat chemical composition except in ash which showed significant different ($P<0.01$) which is higher in group C while group B and A were similar either extract was the highest in the group A than other groups C, B.

Table 8. Effect of feeding different Roughages source(groundnut hay, sorghum straw, baggasse) on carcass (component) of Sudan Baggara bullsas percentage of sirloin cuts

Parameter	Group A Groundnut Hay	Group B Sorghum Straw	Group C Baggasse	Overall Mean ± SD	Level of significance
Sirloin (kg)	4.49±0.17	4.77±0.44	4.47±0.26	4.57±0.50	NS
Muscle (kg)	2.62±0.38	2.57±0.31	2.56±0.09	2.58±0.28	NS
Bone (kg)	1.29±0.17	1.41±0.20	1.31±0.15	1.33±0.17	NS
Fat (kg)	0.42±0.16	0.39±0.12	0.39±0.11	0.40±0.13	NS
C.T. (kg)	0.15±0.07[b]	0.23±0.07[a]	0.18±0.02[b]	0.19±0.07	*
Muscle % of carcass wt.	58.97±4.49	54.64±5.73	58.32±3.70	56.98±4.84	NS
Bone % of carcass wt.	28.73±7.31	29.55±2.10	29.30±3.10	29.19±6.06	NS
Fat % of carcass wt.	8.94±2.84	8.10±2.48	8.91±2.36	8.05±2.50	NS
C.T. % of carcass wt.	3.64±0.95[b]	5.76±1.90[a]	4.32±0.55[b]	4.58±1.52	**
Muscle: bone ratio	2.05±0.80	1.84±0.14	1.99±0.18	1.96±0.19	NS
Muscle: fat ratio	6.59±0.72	6.74±0.26	6.54±0.11	6.62±0.19	NS

% Percentage of Sirloin weight.

C.T. = Connective tissue.

Table 9. Effect of feeding different Roughages source (groundnut hay, sorghum straw, baggasse) on meat chemical composition of Sudan Baggara bulls

Parameter %	Group A Groundnut Hay	Group B Sorghum Straw	Group C Baggasse	Overall Mean ± SD	Level of significance
Dry matter	37.85±15.42	37.84±15.50	04.27±11.04	38.65±12.84	NS
Ash	4.33±0.24[b]	4.31±0.34[b]	5.08±0.32[a]	4.57±0.46	**
C.P.	19.20±0.87	21.36±2.14	20.34±2.02	20.30±1.84	NS
Ether Extract	1.95±0.48	1.49±0.42	1.79±0.97	1.74±0.64	NS

3.7. Meat quality attributes:

Meat quality attributes of bulls fed diets containing different sources of roughage are presented in table **(10)**. Water holding capacity was not significantly different (P>0.05) among groups but was highest in group A and C followed by group B.

Color of the meat from bulls fed different type of roughage indicated that there were no significant difference among treatment groups for the degree of lightness (L), redness (a) but yellowness (b) showed significant different between groups (P<0.01) it was similar in group A and Bwhere as group C showed the least group score.

Table 10. Effect of feeding different Roughages source (groundnut hay, sorghum straw, baggasse) on meat qualityattributes of Sudan Baggara bulls

Parameter	Treatments				
	Group A Groundnut Hay	Group B Sorghum Straw	Group C Baggasse	Overall Mean ± SD	Level of significance
Lightness (L)	32.89±1.10	32.61±0.58	32.84±0.93	32.78±0.87	NS
Redness (a)	19.14±1.11	18.60±0.48	18.41±1.03	18.71±0.43	NS
Yellowness (b)	8.33±0.38[a]	8.18±0.30[a]	7.58±0.42	8.03±0.48	**
Water holding capacity	46.54±11.09	45.66±6.29	46.32±5.95	46.17±7.82	NS
Fat thickness	0.26±0.15	0.19±0.07	0.28±0.08	0.24±0.11	NS

CHAPTER FOUR

Discussion

The result under this study indicated that there were no significant differences in initial live weight among groups. Final body weight of the experimental bull groups was not significantly changed.

These results were supported by the findings of Gumaa(1996)who reported higher daily weight gain 1.54 to 0.76kg and 1.10 to 0.75 for Baggara and Kenana bulls respectively.In this study average daily live weight gain were on the line with the finding of Mohammed (1999)Intesar(2002) and Itidal(2004), while Salim (2009) used four types of roughages in Fattening Baggara bulls. (Sorghum straw, Groundnut hay, Groundnut hulls and Baggasse) she reported the daily live weight gain was significantly different between the four groups ($P<0.01$) she reported 1.24, 0.86, 0.57 and 0.44kg/day for groundnut hay, sorghum straw, baggasse and groundnut hulls group respectively.

Feed intake was significantly differences among groups. Feed intake are influence by many factors include age, metabolic demand, thermal environment, photo-period, disease and psychosocial stress as reported by (Matteri 2001). Feed intake increases as digestible energy increases and stops when energy requirement are fulfilled. It has been recognized that in ruminants there is positive relationship between the digestibility of foods and their intake. In other ward’s foods that are digested rapidly, and of high digestibility, promote high intake (McDonald 2011).

Generally animals which eat more will produce more meat or milk (Preston 1968). Observation in group C baggassewith lower energy content and high fiber content need more saliva for chewing and the bulls in first experimental eat the concentrate and prefer it than bagasse (Roughage) more time chewing and secreted more saliva before swallasing the bolus. This observation were reported by many researchers (Sudweek*et al*., 1981); Beauchemin and Buchanan Smith (1996); Loginbuhl*et al*., (2000).

Feed conversion ratio in this study was not significantly different (P>0.05). It rangedfrom 11.10 to 9.40kg DM/feed kg live weight gain. Sugarcane Baggasseimprove feed conversion ratio this finding were within the range (7.29-11.3kg) reported Morre(1991) for Sudan Baggara cattle. Manal (2009) reported higher value of feed conversion ratio (14.66) for Baggara bulls fed treated groundnut hulls.

Carcass measurement showed no significantdifferent between the groups (P>0.05). Result obtained were higher than the finding of Mohammed (2004) fed molasses base diet for bulls slaughtered at 200kg live weight and similar to those slaughtered at 300kg live weight. Leg circumferencewas similar bull slaughtered at 300kg by Eltahir(2007) but higher than those slaughtered at 200kg and lower leg circumferencethan the bulls slaughtered at 400kg live weight for the same author.

Most of the parameters of non-carcass component shown in table **(5)** indicated no significant differences among treatments except gut fill which were higher in group C baggasse followed by B and A. this could be explained by the fact that the non-carcass components are affected mainly by nutrition (Wise, *et al*., 1961).

Elbukhary(2005) reported that animal on high plane of nutrition had heavier visceral organs. The results showed that the blood, four feet, head, spleen and hide were higher in group A fed groundnut hay than the group fed sorghum straw. Ahmed (2010) reported similar result when he used different levels of treated sugarcane baggasse in diets for fattening Baggara bulls. Gaili and Osman (1977) also reported that differences between non carcass components were small and non significant.

The differences between the weights of the non carcass components in this study and the values obtained for the same breed by Eltahir(2004), Gumaa(1996), Mohammed (1999), and Mohammed [2004] might be due to differences in slaughter weight of bulls used. Owen *et al.*, (1982) indicated that the percentage of offals and internal organs were affected by slaughter weight. Similar result reported by Soheir(2014) when she used different sources of ensiled groundnut hulls for fattening Baggara cattle.

Carcass yield and characteristics of bull fed different sources of Roughages indicated that slaughter weight and empty body weight were not significantly different in the three groups but they were slightly heavier in the control group.

Hot carcass weight and cold carcass weight, were not affected by the type of Roughages. Slaughter weight was not affected significantly with the source of Roughage in the diet. The current findings was in with Ahmed (2010) who found that slaughter weight, empty body weight as well as hot and carcass weight were not affected by increasing the sources of treated sugarcane baggasse in the diet.

The current finding indicated that dressing percentage of hot and cold carcasses either on live weight base or on an empty body weight base was not affected by the type of Roughages. Cold dressing percentage decreased slightly with the type of Roughage baggasse and could be due to the increase in gut fill percentage.

The above mentioned results were in line with that reported by Ahmed (2003), Elkhidir(2004), Mohammed (2004), and Ahmed(2010) and were greater than the reported by Salim (2009). The result in this study similar with Soheir(2014) fed groundnut hulls.

Commercial wholesale cuts weights from carcasses of bulls fed different type of Roughages were found significant different ($P<0.05$) in cold it was higher in the group fed sorghum straw followed by group fed baggasse.

Ahmed (2003) and Mohammed (1999) and Soheir(2014) observed similar result and reported there were no significant differences in several wholesale cuts of bulls fed different source of energy protein. Elkhidir(2004) reported the same results and found that all commercial wholesale cuts weight greater in carcass from bulls given 0% baggassesource in their diets and decreased with addition of baggasse diets. Eltahir(1994) reported values of wholesale cuts for Baggara cattle higher than in the present study.This difference might be due to difference in slaughter weight of animals or could be attributed to muscles development and the fat deposit in the wholesale cuts.

The composition of sirloin cut of bulls from the different dietary type of roughage as percentage of the cut weight were not significantly different except connective tissues which was higher in group B followed by C and A. The percentage of bone was highest in bull group B fed sorghum group followed group fed baggasse. Fat percentage was similar in the three groups. But it was higher in group A followed by C and B.

The result also revealed that there were no significant differences in muscle bone ratio. Muscle fat ratio, bulls fed groundnut hay in the diet showed the higher score (2.05) while the group fed sorghum straw showed the lowest score. This could be due to the increase fat decreased muscle proportion.

In this study muscle to bone ratio was similar to that reported by Ahmed (2003) and Mohammed (1999), Elkhidir(2004), Fadol(2005), Salim (2009) and Ahmed (2010) for the same breed.

Meat chemical composition of *longissimusdorsi* muscle revealed that there were no significant differences between dietary treatment except the ash found significant different ($P<0.01$) it was higher in group fed baggasse. Ether extract was the highest in group fed groundnut hay.

In the ash found significant different ($P<0.01$) highest score for group fed baggasse and was higher than that reported by Mohammed (2004), Elkhidir(2004) and Ahmed (2010) for the same breed.

The quality attributes compassion showed no significance different ($P>0.05$) among all groups except in yellowness (b) which revealed significant different ($P<0.01$).

The intensity of meat colourin this study ranged between 32-89 – 32-84 of lightness (L) that was on the line of finding of Mohammed (2004) and Eltahir(2007)who reported the same score of muscle. The studied bulls revealed higher redness intensity that reported by Mohammed (2004) and Eltahir(2007) but similar to that reported by Elbukhary(2005).

Slaughter weight which is linked with age is also imperative in determing meat lightness of cattle finished on different production systems Aberle*et al*., (2001) showed that differences in colour are attributed to species, age, sex, muscle structure and physical activity source.

Conclusion and Recommendations

Groundnut hay, Sorghum straw and Baggasse are produced in large amounts in Sudan but they contained high sources of fibrous materials which reduce its nutritive value and digestibility.

Different physical and chemical treatments can be used to improve digestibility and nutritive value for use it in diets for ruminants.

Groundnut hay was similar to that sorghum straw in meat quality attributes and meat chemical composition and non carcass component and carcass yield and characteristics of Baggara bulls sorghum straw observed good result.

Roughages decrease the cost of feeding and making fattening business more profitable and available in Sudan as cheap agro-industrial by-products available in huge quantities, as replacement for sorghum grain to reduce the cost of finishing beef cattle.

The baggasse could be used satisfactorily in fattening beef cattle in feedlots around towns and big cities in Sudan especially during periods of feed shortage, and could be used efficiently as basal roughage in complete diet for fatting beef cattle to decrease the cost of feeding.

Using groundnut hay in fattening animals of low initial weight would be expected to gain fastest if given a high protein diet; more work is required to investigatethese factors in animals of higher weight and using diets with the different protein sources.

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