CHAPTER ONE

Introduction:

In the developing countries concentrated feed stuff are competed for by human and livestock so most of the developing countries have been fighting against this problem to satisfy the needs of their livestock for both production and reproduction. So the scarcity of feed sources often imposes a major challenge in livestock production in these countries (Aregheore, 2000). Nutritionist partly solved the problem by using unconventional feed stuff that is agro-industrial byproducts like oil seed cakes, molasses and bagass.

Sudan has a large livestock population and it produces large amounts of oil seeds and a large amount of oil seed cakes after extraction of the oil. They are fed to livestock as a source of protein.

The protein can be divided in two parts, for the ruminant animals. The major part that is 'Rumen Degradable Protein' (RDP) and a small but variable amount of dietary protein escape rumen degradation'Un-degradable Dietary Protein (UDP)'. UDP which enters the lower tract is absorbed mostly as amino acids .The RDP fraction after microbial digestion is mainly utilized as the nitrogen source for rumen microbes, for protein synthesis, while the rest is absorbed as ammonia (Mc Donald *et .al*, 2010).

Microbial protein does not satisfy the needs of high growing and high productive animals, so this study was undertaken to determine the ruminal degradability of the dry matter and crude protein of sesame seed cake, ground nut cake and soya bean meal.

CHAPTER TWO

Literature Review

2.1 Animal Feed:

Feeds are divided into two categories roughages and concentrates. The basics for assignment to the groups are rather arbitrary. Feed in the roughage category are bulky, fibrous and relatively low in energy. Whereas, concentrates are so named because they are a more concentrated source of energy or protein and contains less fiber. Therefore, the two main categories are subdivided further upon physical form or nutrient content of various feeds. The roughage categories include: succulent feeds and dry feeds (Bath, *et al*.1985).

Animal nutrition is important for the health and productivity of agricultural animals. Providing proper nutrition is much more than purchasing a bag of feed or putting animals on pasture. The producer should be knowledgeable about the basics of animal physiology. Just as the human body is made up of systems, animals have systems as well. Each of these systems plays a vital role in animal health, Nutrients is important to animals so all systems function properly. In addition, an excess of nutrients, such as minerals, can also cause health problems. Feed additives are used to improve performance in an area and are generally not considered a nutrient source. The major types of feed additives are growth regulators and antibiotics. Producers must provide animals with balanced rations (Bath *et al*.1985).

2.2 Protein Source for ruminants:

Protein source for ruminants are either plant-protein concentrates, non-protein nitrogenous compounds (NPN) or other limited source. Bath *et al*. (1985) demonstrated the requirement of protein for maintenance, growth, reproduction and lactation for dairy cows. Also protein is needed by the body for growth and repair of tissue as part of normal metabolic function. Plant-protein concentrates are mainly composed of oil seed cakes and meals that remained after removal of the oil from oil seeds. Some seeds have a thick coat rich in fiber and of low digestibility, which decrease the nutritive value of the material. Dietary proteins that reach the small intestine of ruminants consist of two protein fractions: microbial and protein undegradable at the rumen level. Microbial protein is produced by the action of the rumen flora, which breaks down the dietary protein to peptides, amino acids and ammonia, after which these materials are used for the synthesis of own proteins (Ružić-Muslić, 2006). In the course of the decomposition and synthesis some losses occur (typically about 20%, but sometimes higher). Thus, reduced amount of amino acids reaches the location where digestion and adoption of proteins occur, which means that the needs of high yielding meat breeds cannot be satisfied by the microbial protein synthesis from the usual sources of protein and energy (Ružić-Muslić et al., 2007d, 2011b). Therefore, in order to ensure optimal pool of amino acids for a particular production, it is necessary to provide protein fraction which avoids degradation of the protein in the rumen (undegradable protein) (Ružić-Muslić et al., 2007, 2011a)

2.2.1 Oil Seed:

Oil seeds, such as soybean, cottonseeds, sunflower seed, sesame seeds and groundnut are annual plants (O'Brien *et al*, 2000). They are the largest source of vegetables oils even though most oil-bearing tree fruits provide the highest oil yields like olive, coconut and palm trees (Gunstone 2002).Oil seeds are also used in animal nutrition because of their high protein content. Their seeds contain energy for the sprouting embryo mainly as oil, compared with cereals, which contains the energy inform of starch (Lueas, 2000). Most oil seeds trees are of tropical origin, There include groundnut, cotton seed, sesame and sunflower seed, some seeds like castor are not suitable for animal nutrition, because they contain toxic substances. Whole oil seeds are sources of fiber, phosphorus, magnesium, vitamin E, niacin and foliate, they also contain phytoestrogens (Goldberg, 2003).

2.2.1.1. Cotton Seed Cake:

The cotton seed consists of two parts, the hull, from which the staple lit and linters arties, and the kernel, from which the oil and meal are obtained. The nutritive value of cotton seed products depends on proportions of husks and lint. Cotton seed cake has good quality but with low content of cystine, methionine and lysine, while it is a good source of threonine (Mc Donald *et al*., 1988).This meal is considered as a poor source of carotene. The seed embryo of cotton contains innumerable gland filled with a poly phenolic aldehyde pigment that is yellow in color known as gossypol. Malik *et al.*,(1996). Antioxidant and symptoms of gossypol toxicity are constipation depressed appetite and loss of weight; death usually results from circulatory failure. Although acute toxicity is low, ingestion of small amounts over a prolonged

period can be lethal. Mature ruminant animals do not show ill-effects even when they consume large quantities of cotton seed meal but young cattle are much more susceptible to its toxic effects (AFRIS, 2004). However, its use in the ration is not recommended for more than 15% due to presence of aflatoxin and pesticide (Pasha, 2006).

2.2.1.2. Sunflower Cake:

Freely in balanced diets for poultry and pigs owing to the absence of toxic compounds. It is a rich source of vegetable protein and other nutrients with crude protein 30.51%, ether extract 0.41%. Crude fiber 18.51% and 10.20% ash (Jabbar, 1998). Sunflower seed cake has probably been fed to monogastric animals rather than to ruminants. Sunflower meal with hulls contain 26% crude protein on a dry-matter basis and dehulled contain 50% crude protein, hulls in sunflower meal with about 50% Sunflower cake is also a source of high quality protein and can be used cellulose and 25% lignin, anti nutritional value of sunflower protein is drastically reduced in animal nutrition (Delic, 1992). Protein quality of sunflower meal is comparable to soy bean meal sunflower is deficient in lysine and is relatively high in fiber (Pasha, 2006). (Pasha, 2006) mentioned that sunflower meal contains phenolic compounds that have an advers effect on palatability and may reduce protein digestibility. Moreover, it has high levels of mycotoxin, which limit its higher level use in livestock feed. Its protein content varies from 28 to 34 percent depending upon the presence of seed hulls. It is also very susceptible to oxidation to prevent from rancidity. (Samaranda *et al*., 2000) mentioned that the current Romanian feeding tables generally use a single value for ruminal degradability of various types of protein meal. Thus, the degradability of sunflower meal is considered 83%. In the case of the mechanically extracted sunflower meal, a correction was

already made, leading to an average degradability of 88%. (Villamide *et al*, 1989) mentioned sunflower contains a high level of crude protein (15 – 45%) and ether extracts (3.5 – 38%). Sunflower meal was equal to cotton seed meal in protein quality and fiber content and it is an effective source of fiber when used at a level of 25% of the ration (Harris and Staples, 2003).

2.2.1.3. Sesame Seed Cake:

Sesame (*Sesamum indiucum*.) also it is known as benni seed, is one of the most ancient oil seeds crop known to mankind, most of the sesame seed are used for oil extraction and the rest are used for edible purposes (Al Kheir *et al*., 2008). The sesame seed contains about 50% oil and 20 – 25% protein (Obeidat et al 2009). The sesame cake has higher crude protein content ranged from 24.1 – 42.6% (Jacob *et al*. 1996), Yousif, R.S and Afaf; A.M (1999) obtained 41.57%. The major world producer as India, Sudan, China and Burma, contribute about 60% of the total world production. Cake oil is highly unsaturated and may result in soft body fat the oil rapidly becomes rancid and un palatable and always associated with vitamin E deficiency. The phytic acid content of the meal leads to un-availability of its phosphorus. Sesame hulls also contain oxalates and may cause toxicity if not decorticated. The meal has a laxative effect. It has high methionine and low lysine content (Bouque and Fiems, 1988).

2.2.1.4. Groundnut cake:

Groundnut is increasingly becoming important as food and feed sources, especially in developing countries where protein from animal sources are not within the reach of the majority of the population (Asibuo *e al*., 2008). This

protein source has sub-optimal amounts of cystine and methionine. It is also deficient in vitamins and calcium. Groundnut cake was found to contain 95.4% dry matter (DM). 7.96% oil, 34.58% crude protein (CP), 9.72% crude fiber (CF), 9.25% Ash and 24.80% NFE (APRC, 1999). It produces soft body fat it is introduced in large quantities – in addition to the laxative effect, anti trypsin factor has been reported in the meal, anti plasmin activity, and thus shortens bleeding time. Ground nut meal may be contaminated with a toxic substance named aflatoxin. (Batal *et al*., 2005).

2.2.1.5. Soybean:

Soybean meal it is a major source of protein used in Animal feed. The first domestication of soybean has been traced to the eastern half of China. According to early authors, soybean production was localized in China until after the Chinese-Japans war of 1894-1895. The production of soybean seeds about 260 million ton in season 2009/2010 in the world (Rynek rzepaku, 2010). In Sudan recently Kenana Sugar Company cultivated soybean seeds, the production of soybean seeds about 500 kg/feddan in season 2011 *(*Zain Elabdin,2006). Soybean meal contains 40-49% crude protein. With regard to high protein content, the soybean meal is mainly used at poultry and pigs nutrition. In mixture for poultry content of soybean meal can approximate to 40% .Generally soybean seeds content 5.6-11.5% of water, ranges for crude protein is from 4.5% to 6.4%, for fat from 15.5% to 24.7% for crude ash from 4.5% to 6.4% for neutral detergent fiber (NDF) from 10% to 14.9%, acid detergent fiber (ADF) from 9 to 11.1%, carbohydrates content from 31.7% to 31.85% on dry matter basis with considerable quantity of lysine *6.2g/16gN) and limited methionine and cystine content (2.9g/16gN) (Poultry Feeding Standards, 2005). The soybean contain very little of starch (4.66-7.0%) and

quite a lot of hemicelluloses and pectin's. Protein of soybean products characterized much quantity of lysine, tryptophan, isoleucine, valine and threonine however sulphuric amino acids are less than in protein of rape products (Ensminger *et al*. 1990; NRC, 1998; Poultry feeding Standers, 2005). Nutritive value of soybean protein is limited by sulphur amino acids and tryptophan. Soybean is characterized by the highest digestibility of protein, lysine and methionine. The amino acids content in soybean protein are a good supplement of grains and covers requirement of animals. According to Banaszkiewiez (2000) the nutritive value of soybean protein obtained by chemical extraction is lower than rape cakes. Lipid fraction of the soybean seeds contains about 99% of triglycerides, in which content of polyunsaturated fatty acids (linoleic and linolenic) and unsaturated oleic acid is high. In the lipid fraction soybean seeds the fatty acids content about 80% and about 50% it is linoleic acid. The concentrations of mineral components in soybean seeds depend on different factors and the most of all is origin, conditions of tillage, variety and technological process. The soybean products contain considerable quantities of phosphorus. In the region of intensive animal production the phosphorus content in the feeds excretion is limiting. There are big differences between soybean full fat and other soybean products. Soybean meal contains anti nutritional compounds, these anti nutritional include trypsin inhibitors, lection flatulence producing compound, and many other allergenic protein (Kim and Baker, 2003: Duns ford *et al* 1989). These anti nutritional compounds can be denatured by fermentation (Feng *et al* 2007) (Ewan, 1975).

2.2.2. Non-protein nitrogen compound (NPN):

Are known as useful sources of nitrogen for ruminant animals, their use depends on the ability of the rumen micro-organisms to use them in the

synthesis of their own cellular tissues and they are thus able to satisfy the microbial protein of the animal's demand for nitrogen. These compounds may include materials such as poultry waste and urea. Ammonia comes as a result of rumen micro-organism action on urea, giving rise to ammonia toxicity. Health hazards are the main constrains of using poultry waste in animal diets. These include pathogens salmonella and the presence of pesticide and drug residues. Urea is the most used source of non-protein nitrogen in ruminant rations. Urea is hydrolyzed by the urease activity of the rumen micro-organisms with the production of ammonia. The speed, with which this reaction takes place when urea enters the rumen, leads to two major problems due to excessive absorption of ammonia toxicity. The later characterized by a muscular twitching, ataxia, excessive salivation, bloat and respiration defects. Ammonia which is the actual toxic agent in urea poisoning is most toxic at high ruminal PH due to the increased permeability of the rumen wall to unionized ammonia compared with the ammonia ion, which pre-dominates at low PH (Mc Donald *et al*., 2010).

2.3. Protein Digestion in Ruminants:

Microbial digestion of proteins is in the rumen is commenced by proteolytic protozoa, proteolytic bacteria and proteolytic fungi. Dietary proteins are fermented to VFA, methane, carbon dioxide and ammonia these are end product. Peptides and amino acids are intermediates which are used by rumen micro organisms to synthesize microbial cell. Ammonia either absorbed dietary across the rumen wall or passes out of the rumen with the fluid phase of digestion or is incorporated into microbial protein. The dietary protein which is not totally degraded passes into the abomasums and duodenum and will be digested by enzymatic hydrolysis (Kempoton *et al.2008*). By-pass protein is

defined as the dietary protein that passes intact from the rumen to duodenum. Digestible by-pass protein is that protein of the by-pass protein which is hydrolyzed in and absorbed from the small intestine. Over protected proteins are neither fermented in the rumen nor digested in the small intestine (Smith *et al*., 1980). Microbial, dietary and endogenous proteins leaving the rumen are subjected to digestion and absorption in the small intestine. Any protein leaving the small intestine may be fermented by microorganisms in the caecum and colon or excreted in the cases, but it is generally believed that the microbial protein produced in these organs is not available as amino acids to the animal. The factors that influence the absorption and supply of amino acids to the tissues of ruminants are therefore complex (MC Donald *et al*., 2010).

2.3.1. Degradation of protein in the rumen:

Intake protein [IP] that passes to the omasum is often called ''by pass'' or undergrounded protein [UIP] to differentiate it from protein synthesis by microbes [BCP] in the rumen and from endogenous secretion.

The IP that passes to the omasum consist of two fractions:

a. Protein that resists microbial attack in the rumen.
b. protein that evades attack in the rumen and passes to the omasum without thoroughly mixing with ruminal content.

The term undegradable protein is most suited to the first fraction, while ''by pass'' would be more suited to the second fraction. The BCP synthesized in the rumen, UIP and endogenous protein together total the amount of protein entering the omasum. Rumen microorganism cause major transformation of dietary nitrogenous compounds most forms of non protein nitrogen are converted almost to ammonia. True protein is degraded to a variable extent to

peptides and amino acids in the rumen which are utilized for synthesis of BCP. Also rumen microbes may supply 60 to 80 percent of the amino acid (protein) absorbed from the intestine (Ensininger *et al*., 1990).

2.3.2. Mechanism of Protein Degradation:

The intake protein (IP) entering the reticulo-rumen may be degraded by both bacteria and protozoa and degradation involves basically two steps:

I. Hydrolysis of peptide bond (proteolysis) to produce peptides and amino acids.
II. Deamination and degradation of amino acid.

Bacteria proteases and proteolytic enzymes activity to on the protein degradation is by microbial exopeptidases and deaminases. Proteolysis, liberated peptides or amino acid may leave the reticulo-rumen, be utilized for microbial growth, or be degraded in the rumen, and therefore only small quantities of free amino acids would be available for absorption or passage from the reticulo-rumen (Kempton *et al*., 1988).

2.3.3. Measuring Protein Degradation:

Measuring protein by rumen microbes is a difficult task. There can be wide variation in protein degradation within and among feed stuff as well as significant difference among animals with regard to the rumen environment and retention time of feed in the reticulo-rumen. There are many sources of analytical error, the most important of which is distinguishing between BCP and UIP. Considerable caution must be exercised in applying the result of a single experiment, and replication of experiment or studies is necessary to help identify contributing variable. No single technique or experimental design is

fully adequate at the present time. Despite the difficulties of making *in vivo* measurement of protein degradation in vivo measurements are essential. Because they serve as the standard against which all chemical or *in vitro* methods for estimating protein degradation should be evaluated. Chemical or *in vitro* methods for estimating protein degradation are important for screening or monitoring purpose, but they must be validated and must not serve as the only estimate of protein degradation (Kempton *et al*., 1988).

2.3.4. Extent of Protein degradation in the rumen:

Both ruminant nutritionists and livestock producers seek more quantitive information on the extent of protein degradation in the rumen. From some studies, most evidence suggests that small grains, such as barley and oats, have protein that is more degradable than the protein in corn. Soybean meal protein is a relatively degradable protein. *In vitro* information on whole cotton seeds and cotton seed meal is very limited, but cotton seed meal prepared by the expeller process may be more resistant than that prepared by the solvent process. Many by-product feeds appear relatively resistant to ruminal degradation. Brewer's grain, corn gluten meal, fish meal, blood meal and meat and bone meal are more resistant than most of feed grains and oil meal. The protein in most forage is quite susceptible to degradation. The *in vitro* estimates of protein degradation in forages are variable (Tsonkov and Bermski, 1985).

2.3.5. Factors influencing rumen protein degradation:

The extent to which protein is degraded in the rumen will depend upon microbial proteolytic activity in the rumen microbial access to the protein, and

rumen turnover. Microbial access to the protein seems to be the most important factor influencing protein degradation in the rumen (Ensminger *et al*., 1990).

2.3.5.1. Tertiary structure of the protein:

Structure of protein is important in determining whether the protein will be degraded or not. Protein treated with formaldehyde has methylene cross-linking and normally degraded to a lesser extent. Protein treated with extensive cross-linking are less accessible to proteolytic enzymes and relatively resistant to degradation (Kempton *et al*., 1988).

2.3.5.2.. Rumen factors:

Retention time of feed protein in the rumen can influence protein degradation. Proteins of a short retention time are degraded to a lesser extent than those with a longer retention time. Increasing the dilution rate of rumen fluid has been demonstrated to increase the flow of protein from the rumen. Environmental temperature can influence the residence time of any feed in the rumen (Leng, 1975).

Rumen pH could affect protein degradation by altering microbial activity and by changing protein solubility. Proteolysis and Deamination are affected by the rumen pH but experimental results are conflicting (Satter and Fsbyter, 1972).

2.4. By-pass Proteins:

These are dietary proteins that pass from rumen unchanged and are available for enzymatic digestion in the abomasums and the small intestine. They are termed ''by-pass protein'' to differentiate them from protein fermented in the rumen, and from total available digestible protein (which is digestible by-pass

protein plus digestible microbial protein) termed ''metabolized protein'' (Burrough *et al*., 1971). The responses of ruminants given low-protein diets to supplementary by-pass protein are in terms of increase feed intake and are relatively easily determined in feed trials. The adequacy of N for the microorganism under practical conditions is not easily determined, but in general this can be relatively inexpensively assured by routine addition of 2 to 4 percent urea to the feed .Other inexpensive forms of NPN that are totally available, like poultry manure, will also suffice for this purpose (Macrac *et al.,*1976*).*

2.4.1. Naturally occurring by-pass proteins:

By-pass protein occurs naturally in feed stuff or can be produced by various chemical or physical manipulations. There is great potential for protecting feed protein from excessive destruction and loss in the rumen.

2.5. Chemical and physical protection of protein from ruminal degradation:

Protein may also be protected chemically and /or physically from rumen fermentation using substances such as tannins, formaldehyde, and glutaraldehyde. Glyoxalin and hexa-methylene-tetramine like formaldehyde treated casein (Hogen *et al*., 1967). Because of the availability of low-cost naturally occurring by-pass protein, chemical treatment of dietary protein is probably uneconomical. Chemical or heat treatment, may find application in some developing countries, where oil seed meals are often prepared without heat, as the protein of these meals are highly soluble (Lord, 2000). Chemical treatment of feed stuffs has been used to provide partial protection against breakdown in the rumen. Presently, formaldehyde treated feeds are used in

Europe. Feeds trials with formaldehyde treated casein appeared to be very promising. Tannins have been used to protect protein from degradation in the rumen by Hossain and Becker, (2001).

CHAPTER THREE

Materials and Methods

This study was carried out in August – 2015 at Kuku Food Research Center to determine the ruminal dry matter (DM) and crude protein (CP) degradability of sesame seed cakes, groundnut cakes and soybean meals.

3.1. The studied cakes:

Ground nut cake (GNC) and sesame seed cake (SSC) were bought from Omdurman market. Soybeans were collected from the Faculty of Agriculture University of Khartoum (Shambat).Soybean meal was prepared after extraction of the oil by hexane at the Food Research Centre (Shambat). All the cakes were milled with a laboratory hammer mill.

3.2. Animals:

One castrated Kenana calf (500 Kg) fitted with a rumen cannula as described by Brown (1968). It was fed twice daily a maintenance ration of concentrates and roughage and clean water was available all the time.

3.3. *In Situ* Study:

It was performed according to the polyester bag technique of Mehrez and Qrskov (1977).The bags were prepared from nylon material of 35-40 µm pore size and weighing 2-3g and the size of each bag was 15.5cm x 8.5cm.The empty bags were individually weighed and their weights were recorded. Five grams from each cake were put in a bag tied with a nylon ribbon, attached to a plastic tube, of 45.5cm length, 0.8cm diameter, and introduced inside the rumen. The bags (three bags/cake/period) containing the samples were incubated for 3, 6,12,24,48 and 72 hours. The bags were immediately removed at the end of each incubation for period. They were thoroughly washed under

running tap water and dried in a forced draught oven at 72˚c overnight, then they were taken out, cooled in desiccators and their weights were recorded.

3.3.1. Calculation of the dry matter degradability:

Dry matter (DM) of residues in the bag was calculated as follows:-

$$\frac{\text{Weight of sample incubated} - \text{Weight of residues after incubation}}{\text{Weight of sample incubated}} \times 100$$

The dry matter disappearance at zero time (Soluble fraction) was estimated as the washing loss by weighing 5gm of each sample into the nylon bags, then rinsed under running tap water and then processed as the residue taken out from the rumen.

3.3.2. Calculation of the crude protein degradability:

Residual samples after drying for every period were separately pooled and made ready for protein determination as described by AOAC (1980). Degraded protein was calculated as follows:-

3.3.3. Calculation of the degradation kinetics of the cakes:

The degradation kinetics of the incubated cakes was described by a curve-linear regression of dry matter and crude protein loss from the bags with time using the equation of Qrskov and McDonald (1979).

$$P = a + b\ (1 - expe^{-ct}) \ldots \text{(i)}$$

Where:

P =Potential degradability.

t =Incubation time.

a =Axis intercept at time zero represents soluble and completely degradable substrate that is rabidly washed out of the bags.

b =the difference between the intercept (a) and the asymptote. Represents soluble but potentially degradable substrate, which is degraded by the microorganisms according to first –order kinetics.

c =Rate constant of (b) function.

Equation (i) provides curve constant which is used in determining the effective degradability (Ed) of DM and CP.

3.4. Statistical Analysis:

The data obtained were subjected to one way analysis of variance. To examine the variation among the three cakes on dry matter and protein loss percentages. Significant differences among the samples means were then determined using Least Significant Difference (LSD) test according to Gomez and Gomez, (1984). The Statistical Package for Social Sciences (SPSS version 10) program was used for the analysis.

CHAPTER FOUR

Results

4.1. Chemical composition of SSC, GNC and SBM:

The chemical composition of the studied oil seeds that is groundnut, sesame and soya bean meal is shown in table (1). GNC registered significantly higher (%) moisture content than SSC and SBM. The dry matter percentage of GNC was lowest. The SSC registered the highest percentage of ash. SBM registered higher C.P (%) than SSC and GNC. E.E (%) was highest in SSC while SSC and SBM were lower in C.F than GNC. The higher N.F.E (%) was registered in SBM.

4.2. Rumen dry matter degradability (%) of SSC, GNC and SBM:

The proportion of the dry matter disappearance from the nylon bags at different incubation periods for groundnut, sesame and soya bean meal is shown in table (2). At zero time SSC registered significantly lower dry matter disappearance (%) than GNC and SBM. In all the cakes rumen degradation percentage increased with the length of the incubation period. Significant differences ($P<0.05$) were found among the three cakes at all the incubation periods except at 24 hours incubation period.SBM registered the highest DM disappearance (%)through all the incubation periods except at 12hrs,while SSC registered the lowest DM disappearance (%) except at 12hours time and GNC was in the middle between SBM and SSC.

4.3. *In situ* dry matter rumen degradation characteristics for SSC, GNC and SBM:

Table (3) shows *in situ* dry matter rumen degradation characteristics from fitted model for the three cakes. Significant differences ($p<0.01$) were found among the three cakes for the washing loss. The lowest value was registered by SSC followed by GNC and the highest value was in SBM.SSC registered significantly higher values for both the water insoluble fraction (b) and the degradation rate (c) of fraction (b) than GNC and SBM. There were no significant differences between SBM and GNC with respect to fraction (b) and its rate of degradation (c). Numerically the highest potential degradability (Pd) was observed in SBM followed by GNC and the least value was observed in SSC. The effective degradability at (0.02) rumen outflow rate did not vary among the three cakes. Significant differences were found among the three cakes in the effective degradability at rumen outflow rate of (0.05)and (0.08) .SBM registered the highest effective degradability values followed by SSC and the lowest was in GNC.

4.4. Rumen crude protein degradability (%) of SSC, GNC and SBM:

The proportion of the crude protein disappearance from the nylon bags at different incubation periods for groundnut, sesame and soya bean meal is shown in table (4). At zero time GNC registered significantly lower crude protein disappearance (%) than SSC and SBM. In all the cakes rumen CP degradation percentage increased with the length of the incubation period. Significant differences ($P<0.01$) were found among the cakes at all the incubation periods except at 72 hours incubation period. Crude Protein degradability values of the cakes ranged from 39.01% for ground nut cake at 3

hrs incubation period to 94.98% for soya bean meal at 72 hrs incubation period. After 48 hours incubation period no significant variation was found among the three cakes. No significant variations were found between GNC and SSC at all the incubation periods except at 12 hours incubation period.SBM registered significantly higher crude protein disappearance (%) through all the incubation periods except at 24hrs.

4.5. Rumen crude protein degradability characteristics of SSC, GNC and SBM:

Table (5) shows *In situ* CP degradation characteristics of the three oil seeds that is washing loss (a) value, potentially degradable fraction(b), potential degradability (pd) and effective degradability (Ed) at three rumen outflow rates. Significant differences ($p<0.01$) were found among the oilseed cakes for all the fitted values .SBM showed significantly higher values for soluble fraction (a),effective degradability, and potential degradability at (0.02 and 0.05) rumen outflow rates than the other two cakes and the lowest fraction (b). No significant variation was seen between GNC and SSC with regard to the potentially degradable fraction (b) and the potential degradability (Pd). The lowest value for the degradation rate (c) of fraction (b) was found in GNC followed by SBM and the highest value was of SSC.

Table 1: Chemical composition (%) of the studied oil seeds cakes

Parameters / Sample	Moisture%	D.M%	C.P%	Ash%	E.E%	C.F%	N.F.E%
Groundnut	8.75	91.25	41.83	8.0	8.1	9.7	23.62
Sesame	2.5	97.5	41.25	13	12.05	8.2	16.55
Soya Bean	1.5	98.5	44.8	6.25	7.1	8.4	32.85

DM: Dry Matter CP: Crude protein

EE: Ether extracts CF: Crude fiber

Ash: Ash content NFE: Nitrogen free extract

Table 2: In situ dry matter degradability (%) of SSC, GNC and SBM

Sample	Sesame	Groundnut	Soya Bean	Significance level
Time hours				
0	14.30 ± 1.86^{b}	24.83 ± 1.66^{a}	26.60 ± 0.00^{a}	**
3	44.33 ± 3.33^{b}	38.33 ± 1.33^{c}	49.33 ± 2.08^{a}	**
6	49.44 ± 0.50^{b}	62.44 ± 0.83^{a}	54.22 ± 1.71^{a}	**
12	77.16 ± 1.16^{a}	62.83 ± 0.50^{b}	71.44 ± 1.07^{a}	**
24	83.55±0.69	86.00±1.76	88.44±7.07	NS
48	86.77 ± 1.38^{b}	90.00 ± 1.45^{b}	94.55 ± 2.22^{a}	**
72	90.22 ± 1.26^{b}	90.77 ± 1.26^{b}	98.00 ± 0.33^{a}	**

**: Significant at ($P<0.01$).

NS: Not significant.

a, b and c: Means within the same row followed by different superscripts are significantly different.

Table (3): *In situ* rumen dry matter degradability characteristics of SSC, GNC and SBM

Sample / Fitted values	Sesame	Groundnut	Soya Bean	Significance level
a(%)	15.40 ± 0.77^{c}	24.47 ± 0.90^{b}	29.03 ± 2.16^{a}	**
b(%)	72.83 ± 1.15^{a}	67.37 ± 0.83^{b}	68.02 ± 2.23^{b}	**
c(%/h)	0.13 ± 0.01^{a}	0.08 ± 0.01^{b}	0.08 ± 0.01^{b}	**
$Ed_{(0.02)}$	78.73 ± 0.66	81.56 ± 5.07	83.10 ± 0.87	NS
$Ed_{(0.05)}$	68.39 ± 0.80^{b}	66.23 ± 0.05^{c}	71.74 ± 0.94^{a}	**
$Ed_{(0.08)}$	60.95 ± 0.82^{b}	58.47 ± 0.05^{c}	63.97 ± 0.79^{a}	**

**: Significance level (P<0.01).

NS: Not significant.

a, b and c : Means within the same row followed by different superscript are significantly (P<0.01) different.

a: Washing Loss.

b: water insoluble nutrient fraction which is potentially degradable by microorganisms.

c: Rate constant of b function.

Ed: Effective degradability at rumen outflow (0.02, 0.05, 0.08).

Table (4) *In situ* Protein degradability (%) of SSC, GNC and SBM

Sample / Incubation period(hour)	Sesame seed cake	Groundnut cake	Soya Bean meal	Significance level
0	20.66±0.00^{b}	18.84±1.81^{b}	27.00±0.00^{a}	**
3	45.45±3.31^{b}	39.01±4.12^{c}	53.00±0.38^{a}	**
6	51.78±0.98^{b}	50.52±1.00^{b}	55.76±0.78^{a}	**
12	83.40±1.70^{a}	64.77±0.44^{c}	74.93±0.87^{b}	**
24	85.40±0.48^{b}	86.08±0.00^{b}	93.98±0.65^{a}	**
48	91.45±0.96^{b}	90.43±0.87^{b}	94.73±0.00^{a}	**
72	91.18±1.26^{b}	92.72±1.03^{a}	94.98±1.73^{a}	NS

- **: Significant at (P<0.01).
- NS: Non Significant at.
- a, b and c: Means within the same raw followed by different superscripts are significantly different.

Table (5): *In situ* crude protein rumen degradability characteristics Of SSC, GNC and SBM

Sample / Fitted values	Sesame seed cake	Groundnut cake	Soya bean meal	Significance level
a (%)	20.28 ± 1.03^{b}	19.95 ± 1.73^{c}	28.92 ± 0.27^{a}	**
b (%)	71.01 ± 1.44^{b}	72.53 ± 1.95^{b}	67.01 ± 0.01^{a}	**
c (%/h)	0.13 ± 0.002^{a}	0.08 ± 0.04^{c}	0.10 ± 0.01^{b}	**
Pd(%)	91.29 ± 0.50^{b}	92.48 ± 0.90^{b}	95.92 ± 0.78^{a}	**
$Ed_{(0.02)}$	81.85 ± 0.43^{b}	79.19 ± 0.35^{c}	85.16 ± 0.17^{a}	**
$Ed_{(0.05)}$	71.27 ± 0.25^{b}	66.44 ± 0.27^{c}	74.20 ± 0.28^{a}	**
$Ed_{(0.08)}$	64.28 ± 0.57	67.21 ± 15.59	66.82 ± 0.42	*

a,b and c: Means within the same row followed by different superscripts are significantly different.

a: Washing Loss.
b: Degradation of water insoluble.
c: Rate constant of b function.
a+b : Potential degradability (Pd).
Ed: Effective degradability at rumen outflow (0.02, 0.05, 0.08).

CHAPTER FIVE
Discussion

Significant differences were obtained among the oilseed cakes for DM and CP degradability in term of both the degradation rate and ruminal degradation characteristics.

In the present study the dry matter of sesame cake degradation was 86.77% and 90.22 % after 48 and 72 hrs incubation periods respectively , and this result is in agreement with result reported by Adnan,.(2010) where dry matter degradability of sesame cake degradation was 86.6% after 48 hrs. In Sudan Aplank,(2007) and Awad,(2012) investigated degradability of some oilseed cakes using nylon bags technique and they reported higher values for the dry matter disappearance percentage of sesame cake than of this study after 48 hours(92.8%and 95.50%) and after72hours (97.4%and 96.63%) incubation periods respectively .

Results obtained by this study revealed that dry matter of groundnut cakes degradability after 48hrs and 72hrs were 90.00% and 90.77% respectively and this result is closer to the result obtained by Abdel Rahman,(2016) for GNC. Higher values than of this work were found by Nidaa *et al.,(*2008) who found DM disappearance percentage of GNC at 48 and 72 incubation periods to be (93.96%) and (94.20%) ; also Turki, (2011) found higher DM disappearance value (94.4 %)at 48hrs.

The degradability of soya bean meal dry matter was higher than that of SSC and GNC.

In the present study the crude protein of sesame seed cake had lower degradability 91.45% and 91.18 % after 48 and 72 hrs respectively and this result is near to the values obtained by Adnan,(2010) who reported that

sesame cakes degradation is (89,63%) at 48hrs. Aplank, (2007) observed lower values, 39.3% and 43.2 % at48 and 72 hrs respectively, than the values of this study.

In this study GNC degradability after 24 , 48 and 72hrs were 86.08 % , 90.43% and 92.72% respectively, and this result is similar to the result obtained by Awad, (2012). And is higher than values of Adel, (2016) 70.74%, 77.39% at48 and 72hrs, incubation time respectively.

Adel Rehman ,(2016) registered lower values 70.74 and 77.39 than of this work for groundnut cake CP degradability at 48hrs period and at 72 hours incubation time respectively.

In the present study, degradation of SBM crude protein crude protein of at 24 hrs and 48 hrs are near to the results obtained by Sadeghi, (2006) that is (93.61%), and (95,5%) at 24 and 48 hrs incubation periods respectively

Many factors may affect the degradability of DM and C.P in the rumen such as variation in the season, samples washing procedures, animal digestive system performance (Nocek and Russell, .1988), variation in the extent of microbial contamination of the incubated sample or inter laboratories differences.

Due to the advances in modern livestock production , it is important for farmers to be able to predict as accurately as possible the amount of feed and true feed required to formulate an optimal diet to sustain a desirable level of production.

CHAPTER SIX

Conclusion and Recommendations

6-1 Conclusion:

- SBM, GNC and SSC are highly degradable sources of protein.
- Although the three cakes were studied under the same environmental conditions they differed in their ruminal degradation rate and characteristics.
- SBM registered the highest degradability rate followed by GNC and the least degradability rate was found in SSC.

6-2 Recommendations:

Research should be conducted to:

Protect these valuable protein sources, using different chemical and physical treatments, from microbial degradation in the rumen.

Evaluate feeding protected protein in increasing the productivity of livestock.

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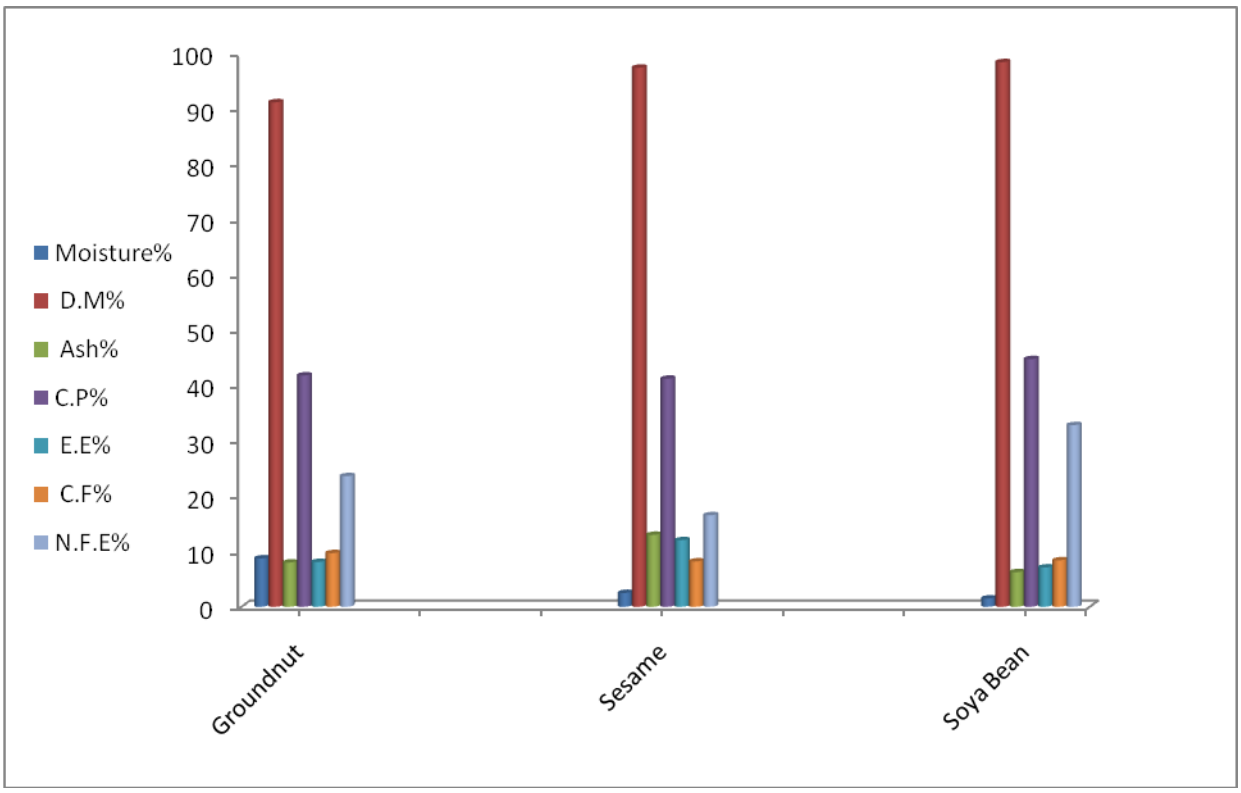

Figure (1): Chemical composition (%) of experimental Oil seeds

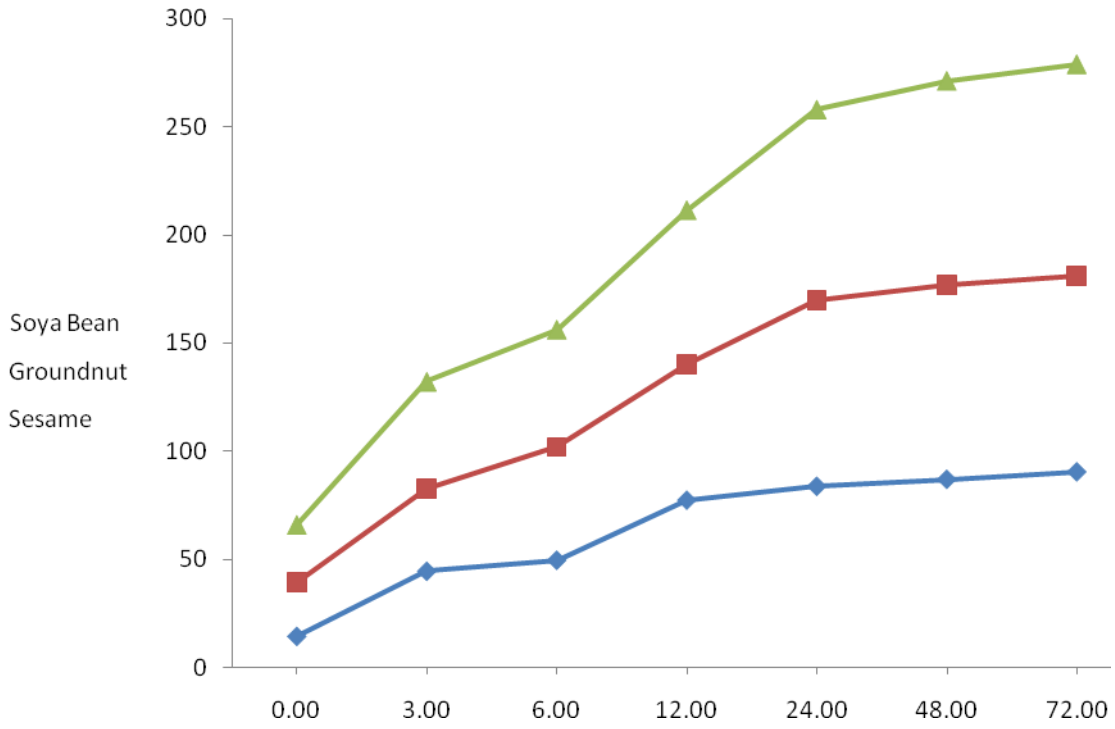

Figure (2):In situ Dry matter degradability(%) disappearance between Different samples (Sesame, GNC and Soya Bean)

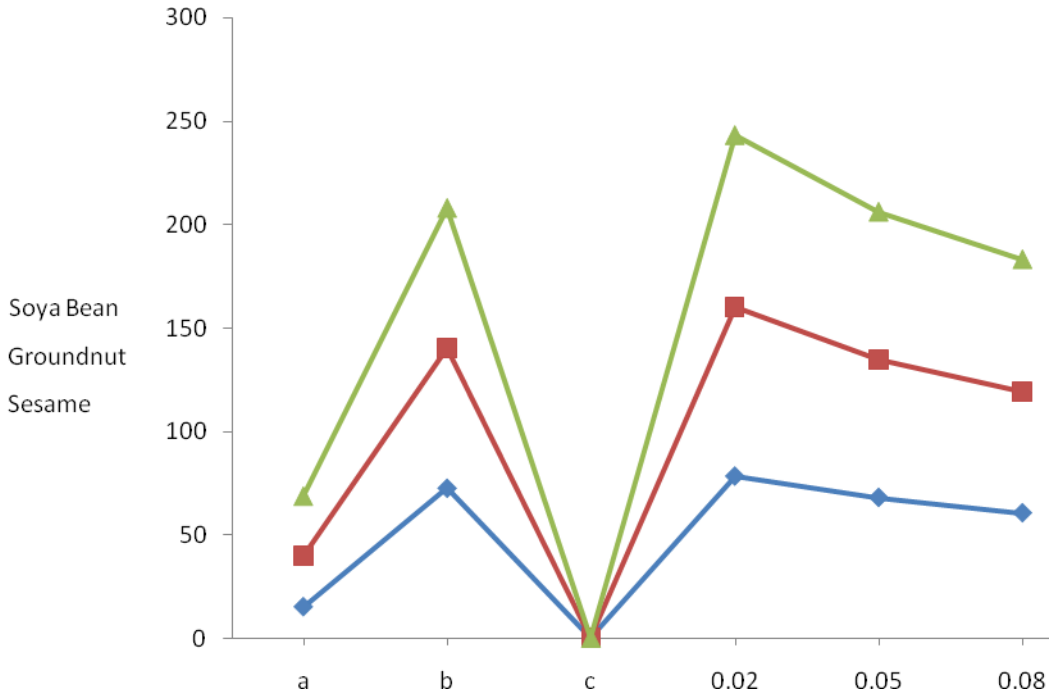

Figure (3): In situ Dry matter degradability characteristics from fitted Between different samples (Sesame, GNC and Soya Bean).

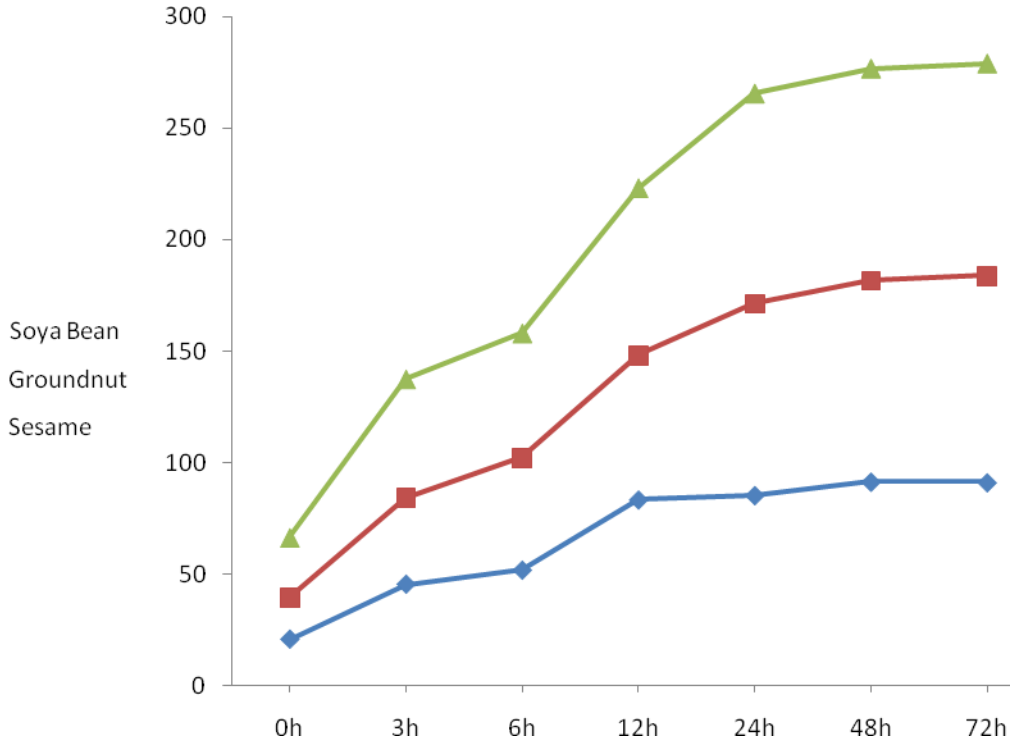

Figure (4):In situ Protein degradability(%)disappearance between Different samples (Sesame, GNC and Soya Bean).

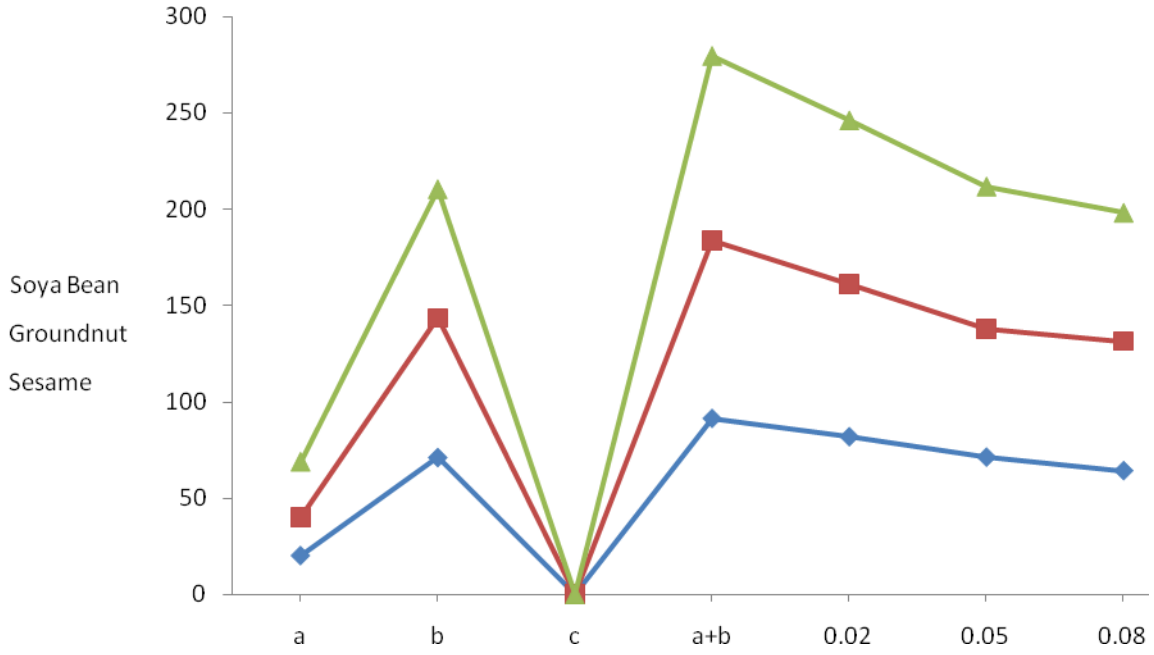

Figure (5): In situ crude Protein rumen degradability characteristics from Fitted between different samples (Sesame, GNC and Soya Bean).