بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Graduate Studies

Improvement of The Nutritive Value of Groundnut Hulls

رفع القيمة الغذائية لقشر الفول السوداني

By:

Ali Mohammed Ali Alnour

B.Sc. (Agricultural Science), Faculty of Agriculture & Natural Resources , Specialization of Animal Production

University of Gezira, (1999).

A Thesis Submitted to The Sudan University of Science and Technology in Partial Fulfillment for The Requirements for The Degree of Master Of Science In Animal Production.

Supervisor :

Dr. Bhagiel Tiafour Bhagiel

Sudan University 0f Science and Technology – Collage Of Agricultural Studies Department Of Animal Production

December - 2016

DEDICATION

To my dear father, to my dear mother.

To my brothers and sisters.

To my small family.

With love and respect.

ACKNOWLEDGEMENTS

My thanks at first and now to Allah whose will made everything possible. And to my donor "The Agricultural Bank Of Sudan". I wish to express my thanks and appreciation to my supervisor *Dr. Bhagiel Tiafour Bhagiel* for his guidance and valuable advices over the whole period spent in this study. I have had the opportunity to learn from his experience and knowledge. My acknowledgement and gratitude to *Dr. Salaheldeen Sidehmed Ahmed* for his valuable support and directions. I have had benefited from his experiences. My thanks are also extended to all staff of Department of Animal Production,College of Agricultural Studies (Shambat), and *Mr. Mahgoub Sayed* from the Laboratory of Animal Nutrition, Faculty of Animal Production, University of Khartoum-Shambat for the chemical analysis referred to this study. My thanks are extended to my all partners for their benefit and support.

ABSTRACT

The objective of this study was to Improve the nutritive value of groundnut hulls and comparative between the chemical composition of untreated groundnut hulls (UGH) and treated groundnut hulls (TGH) by three ways of treatments for different durations. Treatment A: groundnut hulls with water - Treatment B: groundnut hulls with water and urea - Treatment C: groundnut hulls with water , urea and molasses This treatments was replicated three time for each and ensiled in plastic bags and stored under shade for three periods (two, three and four weeks).

The samples collected from each treatments during the experiments were analyzed for their proximate components according to (A.O.A.C .1999), The analyses were concerned the determination of dry matter (DM), fat content (Fat), crude protein (CP), crude fiber (CF), ash content (Ash), nitrogen free extract (NFE) and metabolisable energy (ME). The result showed that there were a significant ($p<0.05$) differences between treatments; whereas, the decreased in DM content was lower with $\mathbf{T_C}$ 84.10% at 4th week , compared with control 92.90% and decreased in FAT content was lower with $\mathbf{T_A}$ 0.040% at 3rd week compared with control 0.68% and increased in CP content was greater with $\mathbf{T_B}$ 13.81% at 4th week compared with control 4.99% and decreased in CF content was lower with $\mathbf{T_C}$ 24.11% at 2nd week compared with control 35.17% and increased in Ash content was greater with $\mathbf{T_C}$ 9.40% at 4th week compared with control 5.66% and increased in NFE was greater with $\mathbf{T_C}$ 40.36% at 2nd week compared with control 46.41% and increased in ME was greater with $\mathbf{T_C}$ 8.52 kcal/kg at 2nd week compared with control 9.07 kcal/kg.

This study concluded that, chemical composition of groundnut hulls would be improved by all treatments. And treatment with water , urea and molasses and ensiling period for 3 weeks give the best results compared with other treatments**.** The results under this experiment offer additional and practical data on the use of low quality roughage such as groundnut hulls with effective chemical treatment and lower cost as well as its applicability for use under practical farm conditions.

الملخص

الهدف من هذه الدراسة هو تحسين القيمة الغذائية لقشر الفول السوداني والمقارنة بين التركيب الكيميائي لقشر الفول السوداني غير المعامل (UGH) وقشر الفول السوداني المعامل (TGH)من خلال ثلاث طرق للمعاملة لفترات مختلفة.

المعاملة أ : قشر الفول السوداني بالماء , المعاملة ب : قشر الفول السوداني بالماء واليوريا ,المعاملة ج : قشر الفول السوداني مع الماء واليوريا والمولاس , هذه المعاملات تكرر ثلاث مرات لكل وتخمر في أكياس بلاستيكية وتخزن في الظل لمدة ثلاث فترات (اثنين، ثلاثة وأربعة أسابيع).

وقد تم تحليل العينات التي تم جمعها من كل المعاملات خلال التجارب لمكوناتها المباشرة وفقا لـ (AOAC .1999) ، والتحليل يستهدف حساب المادة الجافة (DM) ، نسبة الدهون (Fat) والبروتين الخام (CP) ، الألياف الخام (CF) ، نسبة الرماد (Ash)، المستخلص الخالي من النتروجين (NFE) والطاقة المتمثلة (ME) وأظهرت النتيجة أن هنالك فروق معنوية ($p<0.05$) بين المعاملات. في حين،ان الانخفاض في محتوى DM كان أقل مع المعاملة ج 84.10% في الأسبوع الرابع ، مقارنة مع الغير معامل 92.90٪ والانخفاض في نسبة الدهون أقل مع المعاملة أ 0.040% في الأسبوع الثالث مقارنة مع الغير معامل 0.68٪ وزيادة في محتوى CP كان أكبر بالمعاملة ب 13.81٪ في الأسبوع الرابع مقارنة مع الغير معامل 4.99٪ والانخفاض في محتوى CF كان أقل مع المعاملة ج 24.11% في الأسبوع الثاني مقارنة مع الغير معامل 35.17٪ والزيادة في محتوى الرماد كان أكبر مع المعاملة ج9.40% في الأسبوع الرابع مقارنة مع الغير معامل 5.66٪ والارتفاع في المستخلص الخالي من النتروجين NFE كان أكبر مع المعاملة ج 40.36% في الأسبوع الثاني مقارنة مع الغير معامل 46.41٪ وزيادة في ME أكبر مع المعاملة ج 8.52 كيلو كالوري / كجم في الأسبوع الثاني مقارنة مع الغير معامل 9.07 كيلو كالوري / كجم.

وخلصت هذه الدراسة إلى أن التركيب الكيميائي لقشر الفول السوداني سيتحسن مع جميع المعاملات. والمعاملة بالماء واليوريا والمولاس لفترة تخمير لمدة 3 أسابيع تعطي أفضل النتائج مقارنة مع المعاملات الأخرى. النتائج تحت هذه التجربة توفر بيانات إضافية وعملية على استخدام العلف الخشن ذو الجودة المنخفضة مثل قشر الفول السوداني مع المعاملة الكيميائية الفعالة وأقل تكلفة وكذلك قابلية تطبيقها عمليا للاستخدام في ظل ظروف المزرعة.

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CHAPTER ONE

INTRODUCTION

Sudan has a large agricultural land with diversified climatic zones which creates a variety of animal resources and recognizes Sudan as one of the countries that promising agricultural potentials with largest population of livestock in Arab World and is second to Ethiopia in Africa. According to recent estimates of livestock there are about **104,911,762** heads of animals consist of **4,751,000** camel, **29,840,000** cattle, **39,484,092** sheep and **30836670** goat (M.A.R.F.R ,2012).

Livestock form an important component of the agricultural sector, with production mainly based on traditional pastoral systems (90% of the livestock in the country belong to the traditional pastoral production systems). Livestock provide milk, meat, hides and skins, hair, manure, animal draught and transport, subsistence and income.(Zaroug,2000).

Feed constitutes the largest single factor in the cost of production of animal of all kinds. Feeding practices and feeds in use today ranged from excessively costly to nutritionally inadequate and from highly efficient to wasteful materials. In order to achieve a successful feeding program, one should be able to provide proper nutrients at the lowest cost. (Khattak *et al* .,2009).

Free grazing of rangelands is the most common feeding system for livestock, during the short wet season grasses grow and mature rapidly producing abundant biomass. The body condition of the grazing animal is at its best during this period, but with the onset of the dry season both quantity and quality of the pasture herbage decline and fail to meet the maintenance requirement of grazing animals. The nutritional inadequacy of the dry season grazing imposes a major constraint on sustainable livestock production under traditional systems where grazing constitutes the only

source of feed for livestock. The non-availability of forage during the dry season affects sedentary livestock more, as they lack the advantage of mobility exercised in the transhumant and nomadic systems.

The past few years have witnessed an increase in supplementation of natural forage grazing, by collection and storage of hay, utilization of crop residues and agro-industrial by-products and irrigated fodder. The role of fodder trees and shrubs (*Acacia*, *Cadaba*, *Maerua* etc) as a dry season source of feed (pods, leaves and twigs) should not be under-estimated. They are particularly valuable in the Semi-desert and Low Rainfall Savanna zones. The cut-and-carry feeding system is associated with small scale irrigated farms, where fodder crops (sorghum and alfalfa) are harvested to feed farm animals. Surplus green fodder is sold in nearby towns and villages to other livestock owners. Weeds and crop residues may also contribute to livestock feed in these farms. In large scale dairy farms irrigated fodder crops such as sorghum, alfalfa and limited areas of maize, Rhodes grass, *clitoria* and lablab are produced. Mechanical harvesting (chopping) and hand cutting are both practised and green fodder is fed to the dairy herd, while any surplus may be made into hay which is baled and stored. Locally made concentrates or processed feeds are also fed to maintain high milk yield. Crop residues are available from irrigated as well as dry land crops. They include cereal straws and stovers (wheat, sorghum, millet, maize), cereal stubble, legume haulms (groundnuts, cowpea, lablab) sugar cane tops and baggasse, and water melon residues. Agro-industrial by-products include molasses, oil seed cakes (cotton, groundnuts, sesame, sunflower), grains and by-products of cereal milling. (Zaroug,2000).

A survey done by (M.A.R. 2008), indicated that more than 7 million tones of residues and by-product were produced annually over the last 4 years consisting of groundnut hulls and hulums, cereal straw (sorghum and wheat), sugar-cane (tops and baggasse) and oil seeds cakes of cotton,

sesame and groundnut. major biological constraints for using poor quality roughages is related to the low crude protein and low accessibility of cell-wall polysaccharides by both cellfree and microbial enzymes and this often results in low voluntary intake (Preston and Leng, 1987).

Various physical, chemical and biological treatments have been used to improve utilization of low quality forages such as crop residues. The most popular alkali for treatment has been sodium hydroxide, but its use is associated with health hazards. In parts of the world where small farms predominate, treatment with a urea solution followed by a period of storage under air-tight conditions may be more practical. Treatment of crop residues with urea has three primary interrelated benefits, namely increased nitrogen concentration, digestibility and feed intake (Hadjipanayiotou, 1984; Djajanegara and Doyle, 1989).

Therefore, the Objective of this study is to Improve the nutritive value of groundnut hulls by three ways of treatments for different durations of fermentation and compare between the chemical composition of treated groundnut hulls (TGH) and untreated groundnut hulls (UGH).

CHAPTER TOW
LITERATURE REVIEW

2.1. The Animal And It's Food

Food is material that, after ingestion by animals, is capable of being digested, absorbed and utilized. In a more general sense we use the term ‘food’ to describe edible material. Grass and hay, for example, are described as foods, but not all their components are digestible. Where the term ‘food’ is used in the general sense, those components capable of being utilized by animals are described as *nutrients*. The animals associated with humans cover the spectrum from herbivores, the plant eaters (ruminants, horses and small animals such as rabbits and guinea pigs); through omnivores, which eat all types of food (pigs and poultry); to carnivores, which eat chiefly meat(dogs and cats). Plants and plant products form the major source of nutrients in animal nutrition. The diet of farm animals in particular consists of plants and plant products, although some foods of animal origin such as fishmeal and milk are used in limited amounts. Animals depend upon plants for their existence and consequently a study of animal nutrition must necessarily begin with the plant itself. Plants are able to synthesize complex materials from simple substances such as carbon dioxide from the air, and water and inorganic elements from the soil. By means of photosynthesis, energy from sunlight is trapped and used in these synthetic processes. The greater part of the energy, however, is stored as chemical energy within the plant itself and it synthesis of its own body tissues. Plants and animals contain similar types of chemical substances, and we can group these into classes according to constitution, properties and function.(McDonald.P *et al* .,2010).

The main components of foods, plants and animals are:

2.1.1 Water

The water content of the animal body varies with age. The newborn animal contains 750–800 g/kg water but this falls to about 500 g/kg in the mature fat animal. It is vital to the life of the organism that the water content of the body be maintained: an animal will die more rapidly if deprived of water than if deprived of food. Water functions in the body as a solvent in which nutrients are transported about the body and in which waste products are excreted. Water also has a high latent heat of evaporation, and its evaporation from the lungs and skin gives it a further role in the regulation of body temperature. The animal obtains its water from three sources: drinking water, water present in its food, and metabolic water, this last being formed during metabolism by the oxidation of hydrogen-containing organic nutrients. The water content of foods is variable and can range from as little as 60 g/kg in concentrates to over 900 g/kg in some root crops. Because of this great variation in water content, the composition of foods is often expressed on a dry matter basis, which allows a more valid comparison of nutrient content. (McDonald.P *et al* .,2010).

2.1.2 Dry Matter And It's Components

The dry matter (DM) of foods is conveniently divided into organic and inorganic material, although in living organisms there is no such sharp distinction. Many organic compounds contain mineral elements as structural components. Proteins, for example, contain sulphur, and many lipids and carbohydrates contain phosphorus. The main component of the DM of pasture grass is carbohydrate, and this is true of all plants and many

seeds. The oilseeds, such as groundnuts, are exceptional in containing large amounts of protein and lipid material. (McDonald.P *et al* .,2010).

In contrast, the carbohydrate content of the animal body is very low. One of the main reasons for the difference between plants and animals is that, whereas the cell walls of plants consist of carbohydrate material, mainly cellulose, the walls of animal cells are composed almost entirely of lipid and protein. Furthermore, plants store energy largely in the form of carbohydrates such as starch and fructans, whereas an animal's main energy store is in the form of lipid. The lipid content of the animal body is variable and is related to age, the older animal containing a much greater proportion than the young animal.The lipid content of living plants is relatively low, that of pasture grass, for example, being 40–50 g/kg DM.(McDonald.P *et al* .,2010).

In both plants and animals, proteins are the major nitrogen-containing compounds. In plants, in which most of the protein is present as enzymes, the concentration is high in the young growing plant and falls as the plant matures. In animals, muscle, skin, hair, feathers, wool and nails consist mainly of protein. Like proteins, nucleic acids are also nitrogen-containing compounds and they play a basic role in the synthesis of proteins in all living organisms. They also carry the genetic information of the living cell. The organic acids that occur in plants and animals include citric, malic, fumaric, succinic and pyruvic acids. Although these are normally present in small quantities, they nevertheless play an important role as intermediates in the general metabolism of the cell. Other organic acids occur as fermentation products in the rumen, or ensilage, and these include acetic, propionic, butyric and lactic acids. (McDonald.P *et al* .,2010).

Vitamins are present in plants and animals in minute amounts, and many of them are important as components of enzyme systems. An important difference between plants and animals is that, whereas the former can synthesize all the vitamins they require for metabolism, animals cannot, or have very limited powers of synthesis, and are dependent upon an external supply. The inorganic matter contains all those elements present in plants and animals other than carbon, hydrogen, oxygen and nitrogen. Calcium and phosphorus are the major inorganic components of animals, whereas potassium and silicon are the main inorganic elements in plants. (McDonald.P *et al* .,2010).

2.2 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).

2.2.1 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).

2.2.2 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). 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).

2.3 Animal Feed Resources

The main animal feed resources are:

- Natural grasslands (permanent pastures).
- Planted established pasture (forage crops, either rain fed or irrigated).
- Crop residues.
- Agro-industrial byproducts (sugarcane industry byproducts, oilcakes, milling byproducts).
- Manufactured animal feed (animal feed industry). (Izeldin, 2008).

2.4 Animal Feed Resources In Sudan

In Sudan livestock obtain feed from:

- Grazing and browsing on natural pastures.
- Crop residues and agro-industrial byproducts.
- Cultivated pastures and forage crops. (Izeldin, 2008).

2.4.1 Natural Rangelands

The availability and quality of native rangelands available to livestock vary with altitude, rainfall, soil type and cropping intensity. Total range area in Sudan is 279 million feddan. The productivity of this area is estimated as 78 million tons of dry matter (DM) and constitutes about 87% of the animal feed resources (AOAD, 2001). This feed resource is not

enough to supply nutrients required by 65 million livestock units (LU), (1 LU is equivalent to a 250 kg animal), available in the country. This shortage is due to deterioration of grasslands particularly in the semi-desert and low rainfall savannah regions, expansion of agricultural mechanized schemes and destruction of pastoral resources through fire and overgrazing (Abu Swar and Darag, 2002).

2.4.2 Irrigated Fodder

The irrigated fodder constitutes about 5% of the feed resources. This area yields about 4 million tons of dry matter (DM) that represent 4.36% of the total dry matter produced in Sudan (Abu Swar and Darag, 2002). The irrigated fodders in Sudan are alfalfa (94%), Abu 70 (5%), *phelebsera, doliches lablab* and *clitoria,* all together represent 1% (NCS, 1992).

2.4.3 Crop Residues

Crop residues are produced in abundance. They include cereal straw (sorghum, wheat and millet straws), sugarcane byproducts (sugarcane tops) groundnut and cotton byproducts. Crop residues according to Abu Swar and Darag (2002) yield about 22 million tons of dry matter. In spite of the availability of these byproducts in Sudan, they are not fully utilized. Crop residues and agricultural byproducts could be used as an alternative animal feed. However the energy content of these byproducts is poorly utilized by rumen microbes due to the presence of the lignocellulosic components which are either indigestible lignin or acting as a barrier between the potentially digestible fraction (cellulose and hemicelluloses) and the digestible enzyme (McDonald *et al*., 2002). Recently, the enzyme lignose is produced from fungi and yeasts in abundance, this provide the evidence for the feasibility of developing a composite microbial system with high capability of degrading straw lignocelluloses in order to make reasonable use of straw resources as reported by Zhang *et al.* (2004).

2.4.4 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's difficult to estimate annual production of these by-products as cropping area varies annually (Abu Swar *et al*., 2008).

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).The 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, where the by-products are owned by the farmers who lack the modern technology to treat and utilize these by-products, The high cost of collection and transportation of by-product specially they have low density

and low nutritive value, The absence of agricultural grazing co-operation, The production area is very far from the marketing area so the cost of transportation is very high, Unawareness on the environmental benefits by using agro-industrial byproducts as animal feeds, The absence of the techniques of binding pressing and treatment of these by-products.

2.5 Groundnut or Peanuts (*Arachis hypogaea*)

The groundnut (peanut), (*Arachis hypogaea*), is an annual legume originating from South America (Hammons, 1982). *A. hypogaea* is a member of the Leguminosae family and can be divided into two subspecies, *A. hypogaea* subspecies *hypogaea* and *A.hypogaea* subsp. *fastigiata*, based on branching pattern and lateral stem distribution (Moss and Rao, 1995). Groundnut (peanut) are cultivated in tropical, sub-tropical, and temperate climates throughout the world with the highest production occurring in India, China, and the United States (Stalker 1997). Groundnut (peanut) were used for oil, food, and a cocoa substitute. (National Peanut Board, 2010).

(Abu Suwar and Drag, 2002a) reported that Sudan produces 1.1 million tons of the groundnut annually.

2.5.1 Groundnut By-products

(Hill, 2002) concluded That groundnut industry supplies many by-products. Groundnut hay is available after groundnut are harvested and is composed of the vines and groundnut missed by harvesting equipment. The bulk of groundnut by-products arise from groundnut processing, which include broken and cull groundnuts, groundnut meal, groundnut skins, and groundnut hulls which composed of :

2.5.1.1 Groundnut Hay

Groundnut hay is produced wherever groundnuts are produced and is typically utilized as animal feed.The nutrient content is as follows: 13 to 17 % CP, 52 to 57 % TDN, and the ash content is typically around 8% because of the attached dirt (Rankins, 2004).

2.5.1.2 Cull Groundnut

Cull groundnut are groundnut that for whatever reason are turned down for human consumption and make it into livestock diets. Some of the more common reasons for groundnut being culled are broken shells, abnormal size, or high aflatoxin content (Hill, 2002). Whole groundnut are high in energy because of their high oil content.

2.5.1.3 Groundnut Skins

Groundnut skins, along with the remainder of the groundnut plant, are currently considered a byproduct of groundnut production with annual skin production estimated around 750,000 tons worldwide (Ballard *et al*., 2009). They represent 3 – 7% of the groundnut seed kernel by weight depending on the variety and size of the groundnut. Compositionally, groundnut skins contain approximately 12% protein, 72% carbohydrate, and can range in fat content from 8-35% depending on the variety (Sobolev and Cole 2003; Yu *et al*., 2005). Additionally, of the carbohydrates present in groundnut skin, approximately 14% exists as crude fiber (Hill 2002).

2.5.1.4 Groundnut Hulls

After harvesting groundnut, they are then transported to a processing facility where they are dried and stored. At this point they are sent to a sheller, where the shell or hull is separated from the nut. groundnut hulls account for approximately 20% of the dried peanut pod by weight, meaning

there is a substantial amount of hull residual left after groundnut processing (Hill,2002). groundnut hulls have been used as fuel for running boilers in manufacturing processes, mulch, bedding in poultry houses, soil conditioners, kitty litter, carriers for chemicals and fertilizers, groundnut hulls are often used as a roughage source in cattle diets (Hill, 2002).

As Waller, (2009) analyzed, The groundnut hulls contains: 22% TDN, 8 to 10% CP, 76% NDF, 65% ADF, and 5% ash.

The nutrient content of the feedstuff varies with different shelling facilities, and comes about with the addition of groundnut skins, shriveled nuts, and amount of debris left in the feed. Once again with most by-product feeds there is an issue with transported peanut hulls because of their low bulk density. With that being said many processors will grind and pellet the feed. This tremendously increases the hauling capacity; however, it is thought to decrease the usefulness of the feedstuff as a roughage source. (Hill, 2002).

2.6 Possible Strategies To Improve Crop Residues Utilization

(Ibrahim, 1983) studied the improvement of the use of crop residues for ruminants is to overcome their inherent barriers to rumen microbial fermentation. The important factors that restrict bacterial degradation in the rumen are its high levels of lignification and silicification, and its low contents of nitrogen, vitamins and minerals. To improve the feeding value of crop residues, the residues can be treated with different means and methods and other required nutrients can be supplied to the ration of the animal. Strategies to improve the utilization of crop residues are summarized in :

2.6.1 Physical treatment

Crop residues can be grounded, soaked, pelleted or chopped to reduce particle size or can be treated with steam or X-rays or pressure cooked. Uden (1988) observed that grinding and pelleting of grass hay decreased dry matter degradability in cows from 73 to 67%, which was mainly due to a decreased fermentation rate (9.4-5.1%/h) and decreased total retention time of the solids from 73 to 54 hours, resulting in an increased intake (Stensig *et al*., 1994).

Liu *et al.* (1999) reported that the use of steam treatment in a high pressure vessel at different pressures and for a range of different treatment times increased the degradation *in vitro* in rumen fluid after 24h and the rate of degradation, but could not enhance the potential degradability of the fibrous fractions (NDF, ADF and hemicellulose). Physical treatments of crop residues have received an appreciable amount of research. Many of these treatments are not practical for use on small-scale farms, as they require machines or industrial processing. This makes these treatments in many cases economically unprofitable for farmers as the benefits may be too low or even negative (Schiere and Ibrahim, 1989).

2.6.2 Chemical treatment

Chenost and Kayouli, (1997) investigated the ues of chemicals to improve the utilization of crop residues may be alkaline, acidic or oxidative agents. Among these, alkali agents have been most widely studied and practically accepted for application on farms. Basically, these alkali agents can be absorbed into the cell wall and chemically break down the ester bonds between lignin and hemicellulose and cellulose, and physically make the structural fibers swollen (Lam *et al*., 2001).

These processes enable the rumen microorganisms to attack more easily the structural carbohydrates, enhancing degradability and palatability of the crop residues (Prasad *et al*., 1998; Shen *et al*., 1999; Selim *et al*.,

2004). The most commonly used alkaline agents are sodium hydroxide (NaOH), ammonia (NH_3) and urea.

Chemical treatments appear to be the most practical for use on-farm, as no expensive machinery is required, the chemicals are relatively cheap and the procedures to use them are relatively simple. However, the chemicals themselves are not harmless and safety precautions are needed for their use as follows :

2.6.2.1 NaOH treatment

Several NaOH treatment methods to improve the use of crop residues for ruminant feeding have been developed as reviewed by Jackson (1977), Berger et al. (1994) and Arieli (1997). The principal advantages of the different NaOH treatment methods are increased degradability and palatability of treated crop residues, compared to untreated crop residues (Chaudhry and Miller, 1996; Vadiveloo, 2000). However, NaOH is not widely available as a resource for small-scale farmers and may be too expensive to use. In addition, the application of NaOH can be a cause of environmental pollution, resulting in a high content of sodium in the environment (Sundstøl and Coxworth, 1984).

2.6.2.2 NH_3 treatment

Treatment of crop residues with anhydrous and aqueous ammonia, urea or other ammonia-releasing compounds has been widely investigated to improve degradability (Abou-EL-Enin *et al*., 1999; Selim *et al*., 2002; Fadel-Elseed *et al*., 2003). The principle of ammonia treatment is supposed to be similar to that of NaOH treatment. Ammonia treatment not only increases the degradability of the straw, but also adds nitrogen (Abou-EL-Enin *et al*., 1999) and preserves the straw by inhibiting mould growth (Calzado and Rolz, 1990). Besides, improvement in degradability of structural carbohydrates, ammonia treatment is an effective means of reducing the amount of supplemental nitrogen, reducing the costs of

purchasing protein-rich feedstuffs, and enhancing acceptability and voluntary intake of the treated straw by ruminants.

Although comparative studies in improving the energy value of straw have shown that ammonia treatment is less efficient than NaOH (Liu *et al*., 2002), its use may be more profitable for farmers as the added ammonia serves as a source of nitrogen. In a previous study using sheep, (Selim *et al*., 2004) treated rice straw packed in polyethylene bags for 4 weeks with gaseous ammonia (3 g NH_3 per 100 g dry matter). The excess ammonia was removed before offering the straw to animals. The ammonia treatment increased the N content in the rice straw from 8.16 to 18.4 g kg-1 (CP content increased from 51 to 115 g kg-1). The ammonia treatment slightly decreased the NDF content from 571 to 551 g kg-1, because of dilution with the additional N, but increased the ADF content from 303 to 327 g kg-1, indicating that the cell wall properties were changed. Moreover, the physical strength of ammoniated rice straw was significantly lower than that of the untreated straw. In addition, the proportion of small feed particles tended to be higher and stimulated more attachment and growth of the rumen bacteria (Selim *et al*., 2002). The reduced particle size and the increased attachment sites could lead to

subsequent increased microbial colonization and digestion. So, ammonia treatment increases feed value by making the cell wall more available for the rumen microorganisms and also the increased N content improves microbial growth.

2.6.2.3 Urea treatment

Crop residues can also be treated with urea, which releases ammonia after dissolving in water. For practical use by farmers, urea is safer than using anhydrous or aqueous ammonia and also provides a source of nitrogen (crude protein) in which straw is deficient (Schiere and Ibrahim, 1989). Since urea is a solid chemical, it is also easy to handle and transport

(Sundstøl and Coxworth, 1984) and urea can be obtained easily in many developing countries.

Using urea is regarded as a practical and available method in livestock production, especially in developing countries, as it is relatively cheap, adds nitrogen to the ration and is relatively safe to work with.

2.6.3 Biological Methods

The use of fungi and/or their enzymes that metabolize lignocelluloses is a potential biological treatment to improve the nutritional value of straw by selective delignification, as mentioned in the review by Jalc (2002). Nevertheless, it is currently too early to apply this method in developing countries due to the difficulties and lack of technology to produce large quantities of fungi or their enzymes to meet the requirements. There are also a number of serious problems to consider and overcome (Schiere and Ibrahim, 1989). For example, the fungi may produce toxic substances. It is also difficult to control the optimal conditions for fungal growth, such as pH, temperature, pressure, O_2 and CO_2 concentration when treating the fodder. With recent developments in fermentation technology and alternative enzyme production system, the costs of these materials are expected to decline in the future. Hence, new commercial products could play important roles in future ruminant production systems(Beauchemin et al., 2004).

2.7 Silage, Ensilage and Silos

Silage is the material produced by the controlled fermentation of a crop of high moisture content. Ensilage is the name given to the process, and the container, if used, is called the silo. Almost any crop can be preserved as silage, but the commonest are grasses, legumes and whole cereals, especially wheat and maize. The first essential objective in preserving crops by natural fermentation is the achievement of anaerobic

conditions. In practice this is done by chopping the crop during harvesting, by rapid filling of the silo, and by adequate consolidation and sealing. The main aim of sealing is to prevent re-entry and circulation of air during storage. Where oxygen is in contact with herbage for any period of time, aerobic microbial activity occurs and the material decays to a useless, inedible and frequently toxic product.The second essential objective is to discourage the activities of undesirable microorganisms such as clostridia and enterobacteria, which produce objectionable fermentation products. These microorganisms can be inhibited either by encouraging the growth of lactic acid bacteria or by using chemical additives. Lactic acid bacteria ferment the naturally occurring sugars (mainly glucose and fructose) in the crop to a mixture of acids, but predominantly lactic acid. The acids produced increase the hydrogen ion concentration to a level at which the undesirable bacteria are inhibited. The critical pH at which inhibition occurs varies with the dry matter content of the crop ensiled. The attainment of the critical pH is more difficult with crops of high buffering capacity. Legumes are more highly buffered than grasses and are consequently more difficult to ensile satisfactorily. With grass crops having a dry matter content of about 200g/kg, the achievement of a pH of about 4.0 will normally preserve the crop satisfactorily, as long as the silo remains airtight and is free from penetration by rain. Wet crops are very difficult to ensile satisfactorily and should either be prewilted under good weather conditions or treated with a suitable additive. Similarly, crops low in water-soluble carbohydrates, and those that are highly buffered, must also be treated with an effective additive before ensiling. In the tropical regions, conservation of forage is difficult owing to the short rainy season and high temperatures. Crops have to be harvested at an early stage of growth and often in wet conditions. Therefore, haymaking is difficult and ensilage of the crop is often the only option. Tropical grasses and legumes

are difficult to ensile as they have a low water-soluble carbohydrate content and a high buffering capacity. Therefore, steps must be taken to ensure satisfactory ensilage. Options include wilting of very wet crops, the use of acid or inoculant additives, mixing of legumes with cereal crops, and adding cereals or molasses at ensilage to provide a source of water soluble carbohydrates (McDonald.P *et al* .,2010).

The types of silo in which the farmer may choose to ferment the crop are very varied, ranging from small plastic bags to large cylindrical towers built of concrete, steel or wood. In recent years the amount of silage conserved as big bales, usually weighing 0.5–0.75 tonnes and encased in plastic bags or wrapped in plastic film, has increased dramatically. Provided the bags are well sealed and not punctured during storage, this method of conserving grass is satisfactory.The development of effective chopper balers has increased the efficiency of the technique and improved the preservation and nutritional quality of the silage. Currently, about 20–25 per cent of UK silages are made by this method, but the commonest silo used is still of the clamp or bunker type. This generally consists of three solid walls some 2–3 m in height and often built beneath a Dutch barn to protect the silage from the weather. When full, the surface of these silos is covered with plastic sheeting and weighted with some suitable material such as tyres or bales of straw. (McDonald.P *et al* .,2010).

2.8 Urea

It’s a fertilizer and a chemical compound with the formula $CO(NH_2)_2$ (or $H_2N.CO.NH_2$). The molecule has two $–NH_2$ groups joined by a C=O or carbonyl functional group. It is also called carbamide. It is very soluble in water but insoluble in ether, with a melting point at 132°C (Walker 1988).

Aside from its common use as fertilizer, there are other descriptions of urea. It is an industrial product that is used as feed additive for livestocks. Urea is the most common nonprotein nitrogen (NPN) compound used as feed ingredient for ruminant animals. It serves as source of nitrogen for the biosynthesis of protein with the mediation of bacteria and other microorganisms. However, its use as such must consider, among others, its lack of energy and its deficiency in minerals including sulfur. It is readily converted to ammonia in the rumen. When fed in excessive doses, it can result to fatal toxicity due to ammonia accumulation in the rumen which will in turn led to a rise in the level of blood ammonia (Maynard et al. 1979).

These non-fertilizer uses as a feed additive for ruminants, used to stimulate gut microbial flora. This application represents about 10% of non-fertilizer usage (Constant and Shedrick 1992). Urea can be added directly to feed, such as in urea-treated wheat or rice straw (Celik *et al*. 2003), or mixed with molasses (‘urea– molasses licks’ or ‘urea multi-nutrient blocks’) for sheep, cattle, water buffalo, and horses (Tiwari *et al*. 1990; Sansoucy 1995; Salman 1996; Celik *et al*. 2003).

2.9 Urea Treatment: Principles And Factors Of Success

The "urea treatment" is the result of two processes which occur simultaneously within the mass of forage to be treated: ureolysis which turns urea into ammonia, and the subsequently generated effect of the ammonia on the cell walls of the forage. As they have already been described and discussed in many review articles out of which Chenost and Besle (1993)

2.9.1 Ureolysis *(Need for a ureolytic medium)*

Ureolysis is an enzymatic reaction that requires the presence of the urease enzyme in the treatment medium. Urease is practically absent in straw which is a dead graminaceous material. According to research work (Williams *et al*.,1984; Hassoun,1987; Yameogo- Bougouma *et al*.,1993;.) and the numerous field experience acquired during the last decade, urease produced by the telluric ureolytic bacteria during the treatment of residues such as straw or maize stalks, is sufficient, at least under conditions where humidity imposes no limits. Only in the specific case of intentional reduction of water (20 to 25 l added to 100kg straw) for mechanization purpose (Besle *et al*, 1990) will addition of urease be necessary.

The physico-chemical conditions of treatment, namely humidity and temperature, and their interactions, must therefore favour the activity of these bacteria and that of their enzyme.

2.9.1.1 Humidity

The ideal humidity of ureolysis is 100% (water solution), of course impossible to reach in a complex (heterogenous) medium composed of plant material and water. This is why, nevertheless, water content of the medium is one key factor of success of the "urea treatment". This also why there are so many contradictory statements amongst people practising this treatment. More than the amount of water to add (which will depend on the water content of the material to be treated), the humidity percentage of the treatment medium to reach will be the best informative criteria. (Chenost, 1995)

Results of both experimental and practical works achieved until now show that this percentage, should never be less than 30%, and not greater than 60%. Below 30%, ureolysis may be severely reduced and, even, not

take place. On top of that it will be more difficult to compress the mass of forage and expell the air when the former is in the loose form (of course less problems with bales since the plant is already pressed). As a result, not enough NH3, too much oxygen in, still, a somehow moistened medium, will lead to a bad alkali treatment and to mould development. Beyond the (arbitrary) upper limit (50 to 60%) the problems encountered will be,

- inadequate compaction of the forage mass,

- leaching of the urea solution downward the bottom layers

(urea/ammonia overdosage with its associated toxicity risks),

- insufficient diffusion of the generated NH3 within the forage mass, in view of its hygroscopic characteristic (ammonia would bind on the water instead of the plant cell-walls),

- development of moulds, because of the moisture and an inadequate ammonia environment (trapped by the excessive water).

Within this recommended range, there are no fixed rules and the amount of water to add will be left to one's own judgment according to the prevailing local conditions, eg, availability and cost of water, hygrometry of the ambient air, water tightness of the enclosure, type of forage to treat (structure/easiness to compact it), etc. 50kg water to add is an easy figure to remind and is generally applied at the practical level. Added to 100 kg of a 90% DM straw it leads to a final moisture content of 30%.(Chenost, 1995)

2.9.1.2 Temperature And Duration

The optimal temperature of ureolysis would lie between 30 and 60 C, according to the type of urease. The speed of the reaction is multiplied (or divided) by 2 for any increase (or decrease) in temperature of 10 C. Within

the range of temperature of 20 to 45 C the ureolysis can be completed after one week or even 24 hours. The temperature is therefore not a concern in tropical climates. However the activity of urease is either severely reduced or even cancelled out for temperatures below 5 to 10 C. (Chenost, 1995)

2.10 Molasses

Initially the term molasses referred specifically to the final effluent obtained in the preparation of sucrose by repeated evaporation, crystallization and centrifugation of juices from sugar cane and from sugar beets. Today, several types of molasses are recognized and in general, any liquid feed ingredient that contains in excess of 43% sugars is termed molasses (Curtin, Leo. V. 1983).

Cane Molasses is a by-product of the manufacture or refining of sucrose from sugar cane. From each ton of sugarcane approximately 100kg of refined sugar and 25–50kg of molasses are produced (McDonald et al., 2002). Liquid molasses contains 15 – 25% water. It is black, syrupy sweet solution containing at least 46% sugars. It is very low in protein content.

The use of molasses in livestock and poultry feeds dates back into the nineteenth century and has been the subject of several excellent review articles (Scott, 1953; Cleasby, 1963; Van Niekerk, 1980; Waldroup, 1981). The extent to which molasses has been used in animal feeds varies from a small amount used to eliminate dust and feed wastage to serving as the major source of dietary energy.

Molasses functions primarily as an energy source and can be fed at levels up to 30 percent of the diet. El Khidir et al. (1995) had reached up to 52% of the diet successfully in feeding Sudan Baggara bulls. At higher levels, it has a laxative property because of its high mineral content (particularly potassium). Bayley et al. (1983) fed cane molasses at 68.5

percent of the diet of pigs, as the sole source of dietary carbohydrates, the faeces were black and liquid, but there were no more other adverse effect. Molasses analysis on (DM) base contains 73.5% DM, 11.62 MJ/kg ME, CP 4.75 g/kg (Sulieman and Mubrouk 1999).

In study of groundnut hulls were treated with three different levels of urea 2, 4 or 6% and ensiled for a period of 2, 4 or 6 weeks for each treatment. Abdel Hameed *et al.*(2102). Reported that the CP contents increased while cells wall diminished significantly ($p<0.05$) in all the treatments. Among the TGH there were a significant ($p<0.05$) differences in CP content between treatments; whereas, the increased in CP content was greater with 6% urea (10.89%) and 4% urea (10.70%) compared with 2% (8.13%) urea treatments. No differences were found in CP contents at the same level of urea due to ensiling periods of time.The increase in CP content 10.7 and 10.9% for 4 and 6% urea treatment levels in this study respectively were similar with the finding Sirohi and Rai (1999), 10.27% for wheat straw treated with 5% urea. The increase in CP content in urea-treated straw over control has also been reported earlier (Jayasuriya and Perrera, 1982; Jai Kishan *et al*., 1986; Dass *et al*., 2000) This increase partially may be due to enhanced its nitrogen content which contributed by the addition of nitrogenous substrate as reported by (Ngyuen *et al*., 2001). CP content of TGH was increased significantly with increasing urea level (from 2 to 4 and 6%) may be attributed to their increased solubilization due to higher NH3 retention (Sarwar *et al*., 2005).

Another study by Midau *et al.*(2015).The rice straw were treated. The sample contains three treatments. Treatment one (T1) under goes nofermentation process i.e. control, Treatment two (T2) was fermented for 14 days, while treatment three (T3) was fermented for 21 days.This study were resulted that treatment of rice straw with urea has significantly at ($P<0.05$) reduced its dry matter content by 75.56 to 61.02 %.Therefore, the

value treated dry matter is lower than untreated by 14.54%.The results showed that both feeds sample have comparable nutrient profile although the urea treated rice straw had a higher crude protein value (12.35%) than the untreated rice straw (3.22%). This suggests that urea treatment increased the crude protein content of rice straw. The treatment of rice straw with urea increased its nitrogen content due to the addition of non-protein nitrogen. The chemical analysis showed that treatment of rice straw with urea increased ash content of straw from 12.34% to 13.55% and decreased the NDF content from 68.18% to 62.26%.Treating the rice straw with urea improve the nutritive value, increase the digestibility of DM, OM,CP, NDF and ADF. The dry matter, organic matter, crude protein, ether extract, Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF),and Ash values are 60.62, 84.01, 12.29,1.07, 62.78, 41.48 and 13.40 for the urea treated rice straw and 75.56, 87.11, 3.22, 0.63, 68.18, 40.70 and 12.34% for the untreated rice straw respectively. The urea treated rice straw had slightly higher organic matter and Neutral Detergent Fibre contents but lower ether extract and ash contents than the untreated rice straw.

CHAPTER THREE

MATERIALS AND METHOD

3.1 Location And Study Area:

This study was conducted at the Department of Animal Production farm, college of Agricultural Studies (Shambat), Sudan University of Science and Technology. Khartoum North. Sudan.

3.2 Materials:

- Groundnut hulls (raw) 18kg
- Urea 480g
- Molasses 1800g
- Water 1800 ml
- Equipment : electronic balance , bucket, plastic bottles, plastic sheets, plastic bags and rope .

The agro- industrial byproducts under study were groundnut hulls, which it brought from the local market (Hellat Kuku) with urea and molasses.

3.3 Preparation of treated groundnut hulls:

A quantity of 18kg of groundnut hulls were divided in 9 parts (by using the electronic balance and the bucket) each one content 2kg, and deposit on the plastic sheets and treated with three different ways:

3.3.1 Treatment (A):

Tow kg of groundnut hulls mixed manually with 200ml water to rich a sympathy mixture and deposit in plastic bag with compress by hand to expulsion an air from the bag and joint tightly with rope. This treatment was replicated three times as (A_1,A_2 and A_3).

3.3.2 Treatment (B):

Tow kg of groundnut hulls, 80g of urea were dissolved in 200ml water mixed manually to rich a sympathy mixture and deposit in plastic

bag with compress by hand to expulsion an air from the bag and joint tightly with rope.This treatment was replicated three times as (B_1,B_2 and B_3).

3.3.3 Treatment (C):

Tow kg of groundnut hulls,600g of molasses, 80g of urea were dissolved in 200ml water mixed manually to rich a sympathy mixture and deposit in plastic bag with compress by hand to expulsion an air from the bag and joint tightly with rope. This treatment was replicated three times as (C_1,C_2 and C_3).

3.4 Duration of Treatments:

This treatments was replicated three time for each and stored under shade for a period of tow, three and four weeks. The first sample taken from raw groundnut hulls as a control, after tow weeks we opened a rope bags A_1,B_1 and C_1 and collected a sample (100g), from each treatments and send it to the Laboratory of Animal Production, Faculty Of Animal Production, University of Khartoum, and collected this same samples from each treatments after third and fourth week.

3.5 Chemical Analysis:

The samples collected during the experiments were analyzed for their proximate components according to (A.O.A.C .1999), The analyses were concerned the determination of dry matter (DM), fat content (Fat), crude protein (CP), crude fiber (CF), ash content (Ash), nitrogen free extract (NFE) and metabolisable energy (ME), as follows :

3.5.1 Moisture (dry matter)

Sample is dried in an oven to obtain a constant weight. The loss in weight is the moisture. Moistures may be determined in two stages: drying at60c which yields air dry sample and dryingat105 overnight135c for 2h which yield a total dry sample.

3.5.1.1Procedure

1-place marked dishes in an oven set at 135cfor 2h: cool in a dessicator (about 20 min)and record the weight (X 2-place about 2g of sample (in duplicate)in the dishes and record the weight of dish + sample (y)

3-Place the dishes containing samples in an over set at 135c for 2h. Remove and cool in a desiccator (about 20 min) and record the weight (z) .Calculate loss in wt as water.

3.5.1.2 Calculation the dry matter:

Lastly the dry matter was Calculate as ((z-x)-(y-x)) x 100/wt of sample according to (A.O.A.C .1999)

3.5.2 Fat:

In determining of lipids (ether extract) where analysis as according to (A.O.A.C .1999), sample is placed in continuous extractor for about 16h and subjected to extraction using petroleum ether. Weigh increased is the lipid, which is expressed as percentage.

Determination of total volatile fatty acids by steam distillation is described. Distillate titrated against 0.05N NaOH**.**

3.5.2.1 Procedure:

1\ Connect the distillation apparatus.

2\ Heat the large flask containing distilled water and(KMno4)

3\Pipette 5ml of rumen fluid into the semi macro kjeldahl flask and add 30ml distilled water-followed by 10ml (MGSO4) and(H2SO4).

4\Open up the cooling system and distil by heating at the large flask (No2 above) and bottom of kjeldahl flask.

5\ Collect 150ml of distillate in one flask and in another collect 150ml.

6\ Place 1-2 drops of phenolphthalein indicator into the 2 flask and titrate using 0.05N NaOH solution.

3.5.2.2 Calculation of fat content:

Calculate Ether Extract percentage as (y-x) x 100/wt of dry matter.

3.5.3 Nitrogen and Crude protein:

Kjeldahl method is used to determine the total nitrogen content and then the crude protein by multiplying with a factor 6.25. The sample is digested in H2SO4 using CuSo4 as a catalyst converting N to NH3 which is distilled and titrated**.**

3.5.3.1 Procedure:

1\ Weight about 1.2g of air dry sample into kjeldahl flasks.

2\ add about 5g (2spatula) of CuSo4 and wash down with some distilled water .

3\ carefully add 20ml of (H2So4).

4\ Place the flasks on digestion racks heat. Swirl the flasks gently and continue heating ion about 2h.

5\ Cool and cautiously add 20ml distilled water.

6\ Place 25ml of boric acid into Erlenmeyer flask and add 3-4 drops of methyl red indicator.

7\ Open the water tap to the cooling system and switch on the heaters of distillation apparatus.

8\ Add 2-3 pieces of zinc mossy granules followed by 70ml of (NaOH) into kjeldahl flask.

9\ Immediately connect flask to distilled apparatus, mix completely and distilled for about 20 minutes or until you collect about 100ml distillate. The distillate tarns from red/pink to green, according to (A.O.A.C .1999)

3.5.3.2 Calculation of nitrogen (crude protein):

Calculate nitrogen percentage as titrate NH x acid factor x 0001.0 x100/wt of dry matter.

3.5.4 Fiber:

The total fiber in fibrous feed is determined using the neutral detergent procedure. The fiber includes cellulose, hemicelluloses and lignin as major

component. Sample is boiled in fiber solution for 1h and later a shing at 550c**.**

3.5.4.1 Procedure:

1\ Weight 1-2g air dry sample (duplicate) ground to pass though a 1mm mesh into a600ml refluxing beakers.

2\ Add70ml neutral detergent fiber and place the beaker on hot refluxing apparatus and put the condenser in place.

3\ Heat to boiling (5-10min)and adjust onset of boiling to about 60c and reflux ion 1h from onset of boiling.

4\ Place previously tarred crucibles (x) on the filtering apparatus.

5\ Swirl beakers to suspend the solids and fill the crucibles. Filter using a low vacuums initially and increases when necessary.

6\ Rinse sample in the beaker into the crucible with minimum hot water (100c), and filter again. Repeat it twice with acetone.

7\ Dry the crucible at 135c for 2h. Cool in Dessicator and weight (y).

8\ Ash the residue in the crucible for 3h at 550c and weight (z), according to (A.O.A.C .1999).

3.5.4.2 Calculation of fiber content:

Calculate NDF percentage as (y-z) x 100/wt of sample.

3.5.5 Ash:

Ash was analysis according to (A.O.A.C .1999), by burning sample in a muffle furnace set at 550c gives a total mineral content. As a result the organic constituent such as protein carbohydrate and lipids disappear**.**

3.5.5.1 Procedure:

1\Place marked porcelain crucibles in an oven set at 135c for 2h.Cool in a dissecator and record the weight (x).

2\ Place about 2g of the sample (in duplicate) in to the crucible and record the weight of crucible and sample (y).

3\Place the crucible with samples into a muffle furnace set at 550c for 3h.

4\Set the furnace temperature to 135c and let the crucible cool in this temperature ,then transfer to Desiccators and cool.

5\weight the crucible immediately and record the weight (z).

3.5.5.2 Calculate the ash content:

Calculate the Ash percentage as(y-x)-(z-x) x 100/wt of sample.

3.5.6 Metabolizable Energy (**ME):**

The estimate of the metabolizable energy (MJ/Kg) and organic matter digestibility dry roughage feed from the following equations Menke and Steingass, (1988) :

Calculation of the metabolizable energy as

ME (MJ/Kg DM) =14.78 - 0147 ADF

OMD (%) = 18.53 + 0.9239GP + 0.0540CP.

*Where:

GP = gas production (ml/200mg).

CP = crude protein.

ADF = Acid detergent fiber.

3.6 Statistical Analysis:

Data obtained from the experiment were subjected to analysis of variance for two factor completely randomized design by using SPSS computer programmed (1999). The treatments means were compared by the Duncan‟s multiple range test (1955).

CHAPTER FOUR

RESULTS

The chemical analysis of Untreated Groundnut Hulls (UGH) and Treated Groundnut Hulls (TGH) showed :

4.1 Dry Matter:

The result in table and figure (1/1) showed that there were a significant ($p<0.05$) differences in dry matter DM content between UGH and TGH. Among the TGH there were a significant ($p<0.05$) differences in DM content between treatments; whereas, the decreased in DM content was lower with $\mathbf{T_C}$ 84.10% at 4th week , $\mathbf{T_A}$ 86.31% at 2nd week and $\mathbf{T_B}$ 86.71% at 2nd week compared with control 92.90%.

Table (1): Dry matter (%)

Treatment	Weeks		
	2	3	4
Control	92.90^{a}		
A	86.31^{g}	87.60^{e}	88.36^{c}
B	86.71^{f}	87.71^{d}	89.22^{b}
C	85.06^{h}	84.50^{i}	84.10^{j}
$Lsd_{0.05}$	0.0689^{**}		
SE±	0.02236		

Treatment A: groundnut hulls with water - **Treatment B:** groundnut hulls with water and urea - **Treatment C:** groundnut hulls with water , urea and molasses
Mean(s) sharing same superscript(s) are not differ significantly (P>0.05) according to DMRT.

4.2 Fat Content:

The result in table and figure (2/2) showed that there were a significant ($p<0.05$) differences in fat content FAT between UGH and TGH. Among the TGH there were a significant ($p<0.05$) differences in FAT content between treatments; whereas, the decreased in FAT content was lower with $\mathbf{T_A}$ 0.040% at 3rd week , $\mathbf{T_B}$ 0.260% at 3rd week and $\mathbf{T_C}$ 0.265% at 3rd week compared with control 0.68%.

Table (2): Fat content (%)

Treatment	Weeks		
	2	3	4
Control	0.68^{a}		
A	0.560^{c}	0.040^{i}	0.450^{d}
B	0.300^{f}	0.260^{h}	0.580^{b}
C	0.315^{e}	0.265^{g}	0.580^{b}
$Lsd_{0.05}$	0.000689^{*}		
SE±	0.0002236		

Treatment A: groundnut hulls with water - **Treatment B:** groundnut hulls with water and urea - **Treatment C:** groundnut hulls with water , urea and molasses

Mean(s) sharing same superscript(s) are not differ significantly (P>0.05) according to DMRT

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4.3 Crude Protein:

The result in table and figure (3/3) showed that there were a significant ($p<0.05$) differences in crud protein CP between UGH and TGH. Among the TGH there were a significant ($p<0.05$) differences in CP content between treatments; whereas, the increased in CP content was greater with $\mathbf{T_B}$ 13.81% at 4th week , $\mathbf{T_C}$ 13.13% at 3rd week and $\mathbf{T_A}$ 7.36% at 2nd week compared with control 4.99%.

Table (3): Crude protein (%)

Treatment	Weeks		
	2	3	4
Control	4.99^{j}		
A	7.36^{g}	6.07^{i}	6.66^{h}
B	9.97^{f}	12.05^{d}	13.81^{a}
C	11.23^{e}	12.40^{c}	13.13^{b}
$Lsd_{0.05}$	0.2484^{*}		
SE±	0.08062		

Treatment A: groundnut hulls with water - **Treatment B:** groundnut hulls with water and urea - **Treatment C:** groundnut hulls with water , urea and molasses
Mean(s) sharing same superscript(s) are not differ significantly (P>0.05) according to DMRT.

4.4 Crude fiber:

The result in table and figure (4/4) showed that there were a significant ($p<0.05$) differences in crud fiber CF between UGH and TGH. Among the TGH there were a significant ($p<0.05$) differences in CF content between treatments; whereas, the decreased in CF content was lower with $\mathbf{T_C}$ 24.11% at 2nd week , $\mathbf{T_B}$ 36.64% at 3rd week and $\mathbf{T_A}$ 44.95% at 4th week compared with control 35.17%.

Table (4): Crude fiber (%)

Treatment	Weeks		
	2	3	4
Control	35.17^{f}		
A	46.04^{b}	46.97^{a}	44.95^{c}
B	36.85^{e}	36.64^{e}	38.13^{d}
C	24.11^{h}	30.06^{g}	24.60^{h}
$Lsd_{0.05}$	0.6427^{**}		
SE±	0.2086		

Treatment A: groundnut hulls with water - **Treatment B:** groundnut hulls with water and urea - **Treatment C:** groundnut hulls with water , urea and molasses
Mean(s) sharing same superscript(s) are not differ significantly (P>0.05) according to DMRT

4.5 Ash Content:

The result in table and figure (5/5) showed that there were a significant ($p<0.05$) differences in ash content Ash between UGH and TGH. Among the TGH there were a significant ($p<0.05$) differences in Ash content between treatments; whereas, the increased in Ash content was greater with $\mathbf{T_C}$ 9.40% at 4th week , $\mathbf{T_A}$ 4.89% at 4th week and $\mathbf{T_B}$ 4.30 % at 2nd week compared with control 5.66%.

Table (5): Ash content (%)

Treatment	Weeks		
	2	3	4
Control	5.66^{d}		
A	3.55^{h}	3.13^{j}	4.89^{e}
B	4.30^{f}	3.86^{g}	3.26^{i}
C	9.05^{b}	7.58^{c}	9.40^{a}
$Lsd_{0.05}$	0.000689^{*}		
SE±	0.0002236		

Treatment A: groundnut hulls with water - **Treatment B:** groundnut hulls with water and urea - **Treatment C:** groundnut hulls with water , urea and molasses
Mean(s) sharing same superscript(s) are not differ significantly (P>0.05) according to DMRT.

4.6 Nitrogen Free Extract:

The result in table and figure (6/6) showed that there were a significant ($p<0.05$) differences in nitrogen free extract NFE between UGH and TGH. Among the TGH there were a significant ($p<0.05$) differences in NFE between treatments; whereas, the increased in NFE was greater with $\mathbf{T_C}$ 40.36% at 2nd week , $\mathbf{T_B}$ 35.32% at 2nd week and $\mathbf{T_A}$ 31.39 % at 3rd week compared with control 46.41%.

Table (6): NFE (%)

Treatment	Weeks		
	2	3	4
Control	46.41^{a}		
A	28.53^{h}	31.39^{g}	31.39^{g}
B	35.32^{d}	34.93^{d}	33.44^{f}
C	40.36^{b}	34.18^{e}	36.41^{c}
$Lsd_{0.05}$	0.5247^{**}		
SE±	0.1703		

Treatment **A:** groundnut hulls with water - Treatment **B:** groundnut hulls with water and urea - Treatment **C**: groundnut hulls with water , urea and molasses
Mean(s) sharing same superscript(s) are not differ significantly (P>0.05) according to DMRT.

4.7 Metabolisable Energy:

The result in table and figure (7/7) showed that there were a significant ($p<0.05$) differences in metabolisable energy ME between UGH and TGH. Among the TGH there were a significant ($p<0.05$) differences in ME between treatments; whereas, the increased in ME was greater with $\mathbf{T_C}$ 8.52 kcal/kg at 2nd week , $\mathbf{T_B}$ 8.43 kcal/kg at 4th week kcal/kg s and $\mathbf{T_A}$ 7.58 kcal/kg at 4th week compared with control 9.07 kcal/kg.

Table (7): ME (kcal/kg)

Treatment	Weeks		
	2	3	4
Control	9.07^{a}		
A	7.39^{g}	7.48^{g}	7.58^{g}
B	7.39^{g}	8.25^{de}	8.43^{cd}
C	8.52^{b}	7.84^{f}	8.08^{ef}
$Lsd_{0.05}$	0.2578^{*}		
SE±	0.08367		

Treatment **A:** groundnut hulls with water - Treatment **B:** groundnut hulls with water and urea - Treatment **C**: groundnut hulls with water , urea and molasses
Mean(s) sharing same superscript(s) are not differ significantly (P>0.05) according to DMRT.

CHAPTER FIVE
DISCUSSION, CONCLUSION AND RECOMMENDATIONS

The treatments of groundnut hulls ; **Treatment A:** groundnut hulls with water - **Treatment B:** groundnut hulls with water and urea - **Treatment C:** groundnut hulls with water , urea and Molasses were significantly at ($P<0.05$) reduced its DM content by 92.90% to $\mathbf{T_C}$ 84.10% at 4th week , $\mathbf{T_A}$ 86.31% at 3rd week and $\mathbf{T_B}$ 86.71% at 2nd week. Therefore, the value treated dry matter is lower than untreated by 8.8% , 6.59% , 6.19 which is similar to the report of Midau *et al.*(2015). Saadullah *et al.*(1981) Report That chemical composition of ammoniated rice straw had a lower dry matter than the untreated straw.

The results showed that treatments of groundnut hulls has been reduced The fat content FAT by 0.10% to 0.64 % units compared with control. This reduce was observed by Midau *et al.*(2015).

The results showed that treatments of groundnut hulls have increased in CP contents significantly ($p<0.05$) in all the treatments. whereas, the increased in CP content was greater with $\mathbf{T_B}$ 13.81% at 4th week. Differences were found in CP contents at the same treatment due to ensiling periods of time. The $\mathbf{T_B}$ had a higher crude protein value (13.81%) than the untreated groundnut hulls (4.99%). This suggests that urea treatment increased the crude protein content of groundnut hulls due to the addition of non-protein nitrogen. This collaborate the reports of other studies that urea ammoniation increases the crude protein content of feed materials (Abdel Hameed *et al,* 2012 and Midau *et al,* 2015).

The crude fiber CF content has been reduced by 10.57% to 11.6 % units at $\mathbf{T_C}$ of the groundnut hulls compared with control. This was in agreement with Saadullah *et al.*(1981)

The ash content has been reduced by 2.53% units at $\mathbf{T_A}$ and 2.40% unit at $\mathbf{T_B}$ and increased by 3.74% units at $\mathbf{T_C}$ of the groundnut hulls compared with control. The reduce in Ash content was in agreement with Saadullah *et al*.(1981). The increase in Ash content it maybe due to high content of minerals in molasses.

The result showed that there was increased in the percentage of nitrogen free extract NFE Among the Treatments of the groundnut hulls compared with control.

Treatments of the groundnut hulls increases the metabolizable energy concentration (ME) in terms of MJ/kg DM

Conclusion

This study concluded that, chemical composition of groundnut hulls would be improved by all treatments. While treatment with water , urea and molasses and ensiling period for three weeks give the best results compared with other treatments.

The results under this experiment offer additional and practical data on the use of low quality roughage such as groundnut hulls with effective chemical treatment and lower cost as well as its applicability for use under practical farm conditions.

Recommendations

In Sudan, future research should concentrate on finding other forms of cheap "ideal supplements„ and alternative techniques to improve the feeding value for agro by-products such as physical and chemical means.

Further studies on groundnut hulls fermentation with different periods of time using different ratios of urea and molasses is needed.

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Appendices

Fig. (1): Dry matter

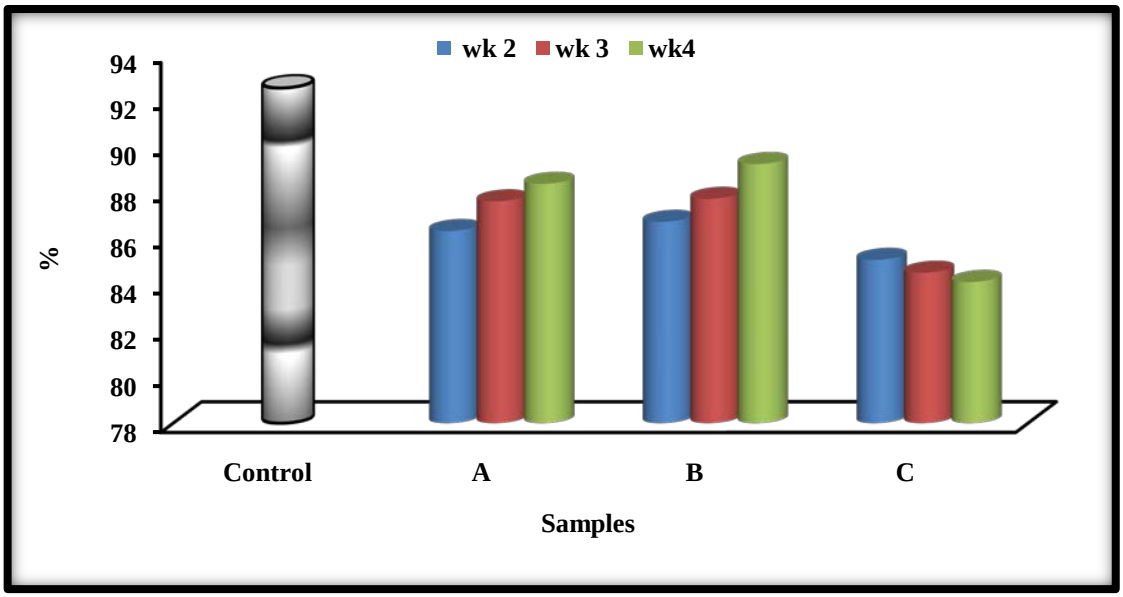

Fig. (2): Fat content

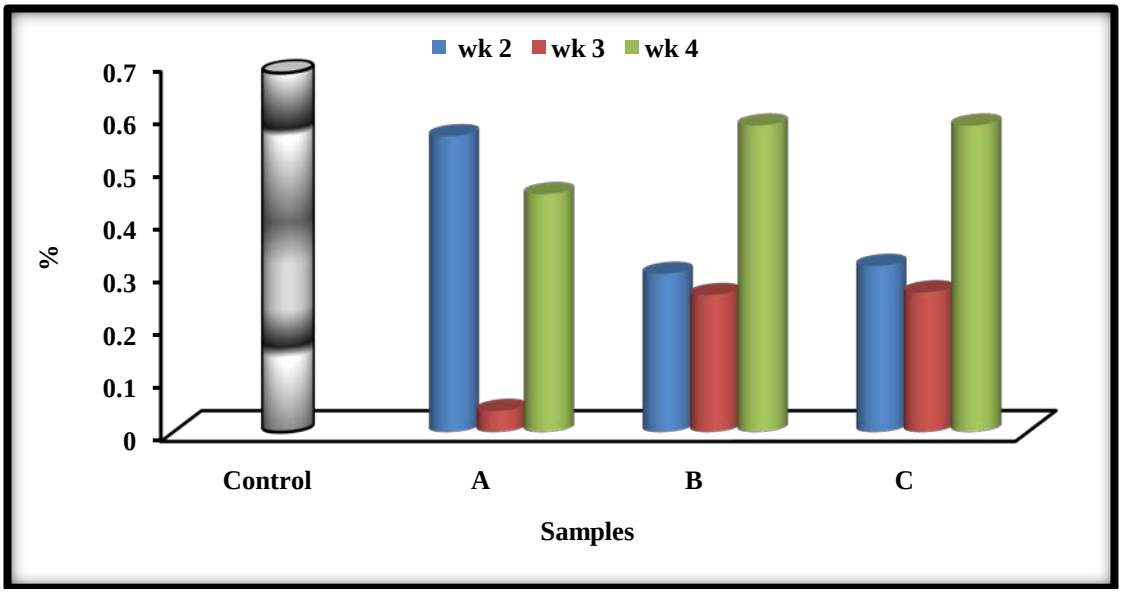

Fig. (3): Crude protein

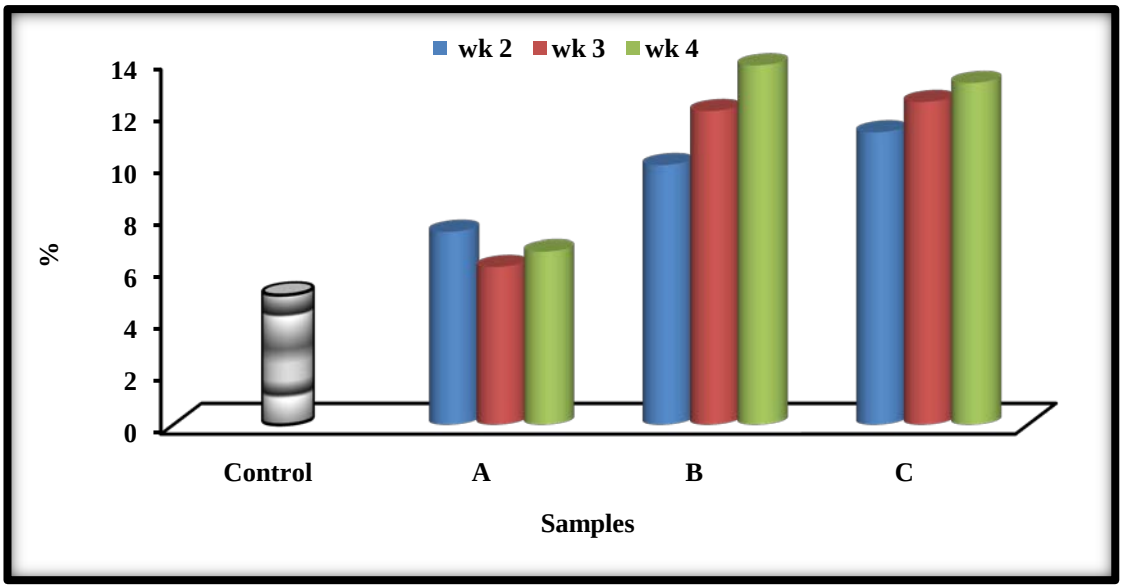

Fig. (4): Crude fibre

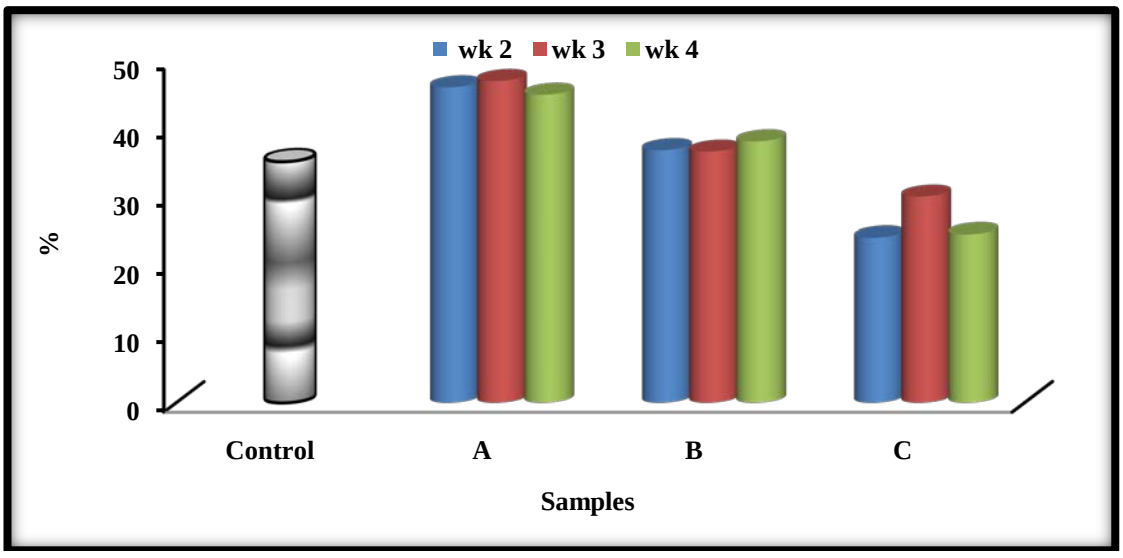

Fig. (5): Ash content

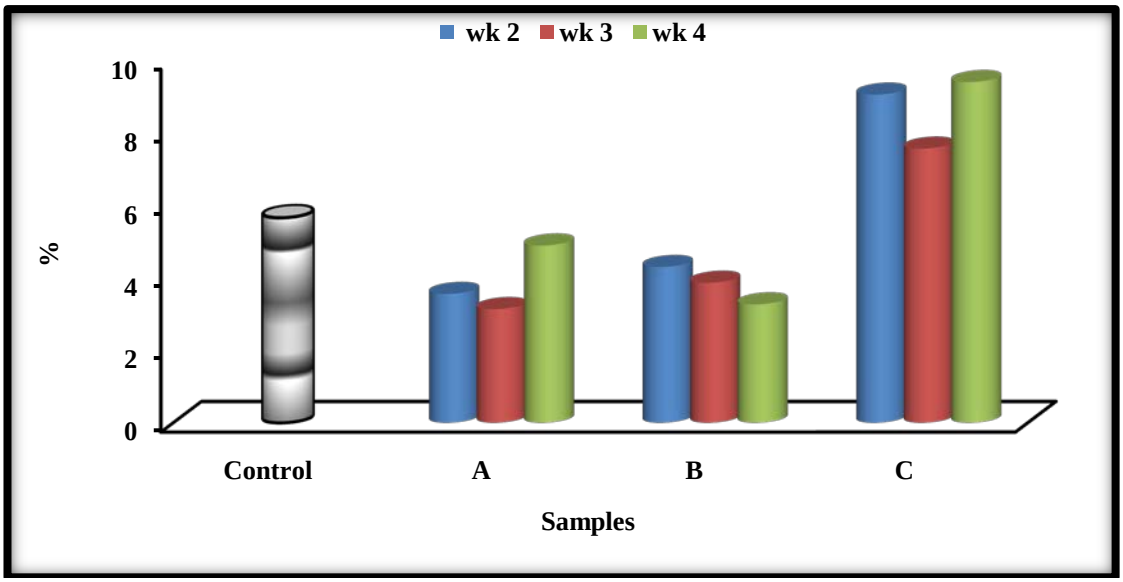

Fig. (6): NEF

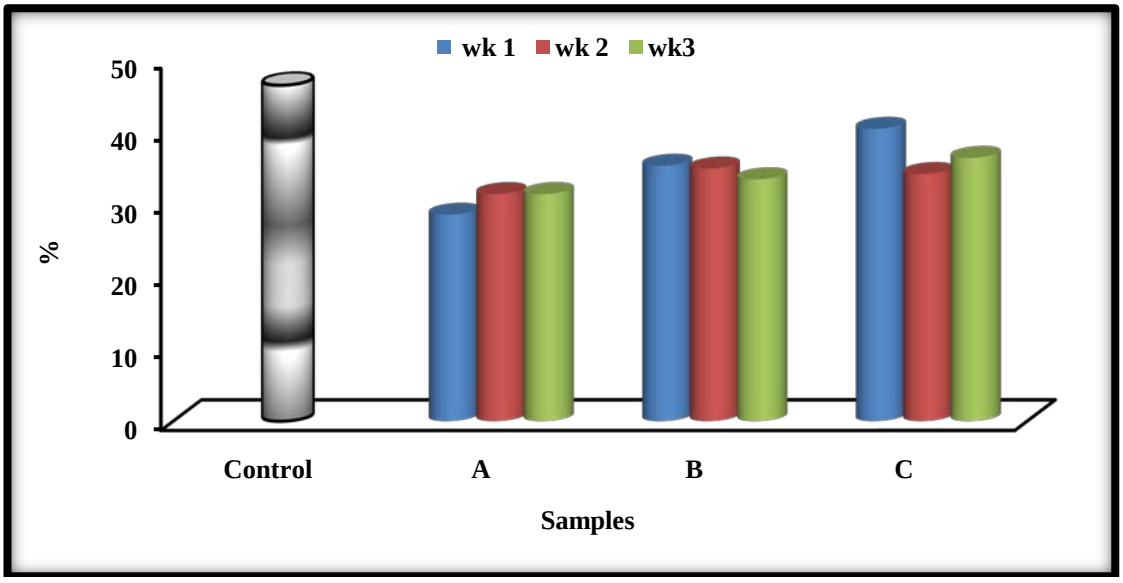

Fig. (7): ME