Sudan University of Science and Technology

College of Agricultural Studies

Department of Animal Production

Effect of Adding Urea and Molasses on The Chemical Composition of Rain Fed and Irrigated Sorghum Straw

أثر إضافة اليوريا والمولاس على المكونات الكيميائية لقصب الذرة الرفيعة المروية والمطرية

A dissertation Submitted in partial Fulfillment of the Requirements for the Degree of M.Sc.in Animal Production

By

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Dedication

My respectful parents, who teach me meaning of love and who devoted their life to knowledge and wisdom.

All of you in my heart…

To All my friends in Sudan University of Science and Technology,

All my colleagues in ministry of agricultural and animals wealth.

Acknowledgment

I am greatly indebted to my supervisor DR.AHMED KHALIL AHMED for this constructive guidance, support and encouragement all throughout this study.

All appreciations are extended to the staff members of Animal Production Department and all colleagues in the College of Agricultural Studies, Sudan University of Science and Technology.

My ultimate thanks to my family for the support for provided me through my entire life and for their sincere encouragement to pursue my academic interests and fulfill my dreams.

Hesham

Abstract

This work is conducted to evaluate the chemical composition of two samples of sorghum straw rain-fed and irrigated, by adding urea 4%, molasses 5%, and mixture of urea and molasses 2.5% to evaluate protein, starch, fat, ash, fiber, and moisture percentages.The Duncan multiple range test was used to test differences between means. The samples were analyzed in the laboratory of Ministry of Agriculture, Animal Wealth and Irrigation, Khartoum state, during July, 2015. The results of the analysis revealed that using urea had significant effect to increase protein percentage 15.77% in rain fed sorghum straw were recorded, while in irrigated sorghum straw there were no significant difference, in adding urea or molasses 16.76 % and 16.58 % respectively. The result showed that adding molasses had significant increase of starch percentage in the two samples of sorghum straw, but adding mixture molasses and urea decrease starch percentage compare with control in irrigated sorghum straw, while adding urea or molasses had the same effect in rain fed sorghum straw. Also using molasses shown significant effect of fat percentage in rain-fed straw, while there were no significant differences between using urea or molasses in irrigated sorghum straw. Using molasses had significant effect to reduce Ash percentages in both types of sorghum straw and recorded 4.25 %, and 1.75 % in irrigated and rainy sorghum respectively, compared with other additives. The result revealed that fiber percentage was decreased in all treatments in rain-fed sorghum straw, but there were no significant differences between treatments in irrigated sorghum straw. Also molasses had significant effect to increase moisture percentage in the two samples of sorghum straw, and the other treatments had the same effects.

ملخص الاطروحة

هذه الدراسة أجريت لتقيم التركيب الكيميائي لعينتان من قصب الذرة المطري والمروي باضافة 4% يوريا ، 5% مولاس و خليط من اليوريا والمولاس بنسبة 2.5% لكل واحد ، لتقيم نسبة البروتين ، النشا ، الدهون ،الرماد ،الألياف والرطوبة فيهما . وقد تم التحليل الأحصائي للعينات بعد التحليل الكيميائي بمعمل وزارة الزراعة والثروة الحيوانية والري ولاية الخرطوم في مايو 2015 م .

وقد خلصت الدراسة على أن إضافة اليوريا لها تأثير معنوي في زيادة نسبة البروتين في قصب الذرة المطري وقد سجلت 15.77% ، بينما في قصب الذرة المروي ليس لها أثر معنوي عند معاملته بإضافة اليوريا أو المولاس وكانت نسبته 16.76% ، 16.58% على التوالي . كذلك أوضحت الدراسة أن إضافة المولاس يزيد من نسبة النشا في العينتان ، ولكن تقل نسبة النشا عند معاملة القصب المروي بالخليط مقارنة بالقصب المروي الغير معامل ، بينما إضافة اليوريا أو المولاس لهما نفس التأثير في القصب المطري . أيضاَ عند إضافة المولاس أظهرت التجربة إختلافا معنويا في نسبة الدهن في قصب الذرة المطري ، بينما لم تظهر إضافة اليوريا أو المولاس أي فروقات في قصب الذرة المروي . إضافة المولاس له أثر معنوي بتقليل نسبة الرماد في كلا النوعين المروي والمطري وكانت النتائج 4.25% و 1.75%على التوالي مقارنة بالمعاملات الأخرى . النتائج أوضحت أن نسبة الألياف قلت في كل المعاملات في عينة القصب المطري ، بينما هناك إختلاف بين نتائج المعاملات في عينة القصب المروي . كما أن المولاس له تأثير معنوي في زيادة نسبة الرطوبة في العينتان لقصب الذرة وكذلك باقي المعاملات لها نفس الأثر المعنوي .

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Chapter one

Introduction

Introduction:

Animal feeds are usually produced from agricultural products or by-products such as grains, cereals and their residues. However, it is necessary to add micro-ingredients to improve levels of essential amino acids, vitamins and minerals (Edelstein, 1982). Utilization of crop residues as feed has been the subject of intense research and developments worldwide since the mid-1970s. It began with technological developments for upgrading straw in Europe and North America and then moved rapidly to the developing tropics where something akin to an Asides Revolution has taken place in the 1980s. Despite this there appears little evidence that the large research effort has resulted in greater utilization of crop residues in developing countries. (Owen *et al*, 1989).Generally it is important to determine the nutritive value of alternative locally available feeds and to develop new technologies for processing and storing of feed to improve animal farming. Therefore, trials were done to make silage by using sorghum plant and bagasse which is a byproduct of sugar cane after sugar juice has been squeezed from it. (Kawashima, 2000). There is no doubt that the main basal feeds for ruminants in warm climate developing countries are essentially crop residues and poor quality grasses from rangelands either grazed or, even manually collected at a very advanced vegetation stage, when mature, during the dry season. What is less obvious are the ways and means for optimal use of these feed resources at both the nutritional and economical levels. (Chenost, 1993). Sorghum production in Sudan is 4,500.000 tones (U.S grains council, 2008). However, the quality of sorghum straw varies with the verity of sorghum cultivated in the country. Generally straw and Stover are known to have high fiber content, low in key nutrients such as nitrogen and minerals such as sculpture (Leng and Preston, 1984), beside their low fat content (NRC, 2001). Also their feeding value differs among cereal species reflecting difference in the proportion of leaves and stem (Flashowsky*et al*., 1991). Both roughage level and source influence dry matter intake (DMI) and there by net energy for gain (NEg) intake (Defoor*et al*., 2002).

Sorghum straw is considered the main type of crop residues which grow either by rain fed or irrigated in Gadarif state in eastern Sudan. With the very high quantity availability of this plant, sorghum straw can be a good alternative of feed instead of concentrates for animal feed during the long dry season.

There are a lot of studies are available investigating the nutritive value of Sorghum straw as animal feed. Therefore, this study is concerned to differentiate between the nutritional value of the rain fed sorghum hay and irrigated sorghum straw for ruminant, when treated with urea or supplemented with molasses.

Despite the rapid growing number of animal resources in Sudan. But main problem is how to avail economical animal feed with high nutritive value. Assess the improvement of chemical composition of sorghum straw from both irrigated and rain fed sources therefore treatment with urea, molasses and combination of both.

The study objectives were to:-

1. Quantify the nutritive value of sorghum straw under both rain-fed and irrigated agricultural systems.
2. Evaluate treatment of added urea, molasses and urea plus molasses to sorghum straw.

Chapter Two

Literature Review

2.1. Livestock in Sudan

Livestock industry is of great importance to Sudanese economy as it is one of the main sources of food, employment and foreign currency. Sheep population is estimated at 39483 thousand heads, goats 30837 thousand, cattle 29840 thousand and4751 camels (Ministry of Animal Resources, 2012).

2.2. Plant Characteristics:

2.2.1. Forage Characteristics and Quality:

The plant consists of cell contents and the cell wall. The cell contents are the most readily and highly digested components of the plant and include organic acids, proteins, lipids, and carbohydrates (Barnes *et al*. 2003). The fibrous portion, or cell wall of the plant, contains the structural carbohydrates including cellulose, hemicellulose, and lignin. The fibrous portion is represented by neutral detergent fiber (NDF) content, which is the forage's total fiber content, and acid detergent fiber (ADF), which is an estimate of the cellulose and lignin in forage (Barnes *et al*. 2003). The ruminant animals are unique in its ability to use this fibrous material to meet their energy needs (Burns, 2008).

Forage quality is the physical and chemical characteristics of forage that make it nutritionally valuable for animal productivity (Barnes *et al*, 2003). Productivity is the effect of intake, digestion, and utilization efficiency of absorbed nutrients (Smith *et al*, 1972). Forage quality is highly variable and plant species, plant maturity, climate, elevation, management, soil moisture, soil fertility, and weather all affect the forage quality factors which include digestibility, crude protein content, and palatability (Bohnert*et al*., 2011; Barnes *et al,* 2003). Quality of a forage is greatest while the plant is young and in the vegetative growth stage. As the plant develops and matures, ADF and NDF content increase in concentration to provide additional structure while digestibility and crude protein values decline (Barnes et al., 2003). With maturity, the leaf: stem ratio declines (Burns, 2008), which contributes to mature forages being lower quality (Fontenot *et al*, 1965).

Voluntary intake in a forage situation is regulated by gut fill. Cellulose and hemicellulose digestion rate limits intake (Burns, 2008), as forages of greater fibrous Thus, mature forages of lower digestibility cause lower intakes compared to grasses in the vegetative state (Oba and Allen, 1999).

Treatment with ammonia has some advantages over NaOH. After treatment excess ammonia evaporates, while ammonia bound to the straw during treatment can serve as a source of nitrogen for microbial protein synthesis in the rumen. Ammonia is also a good fungicide and freshly harvested straw can be preserved by ammonia treatment during the monsoon season. (Coxworth*et al*, 1978). Preserved 37%moisture green Harmon oats for 60 days without spoilage with 5.3% urea. Digestibility in vitro increased from 47% to 53%, and- protein content from 11.1% to 16%. Increased apparent digestibility of dry and organic matter of roughages treated with ammonia was also observed by (Oji and Mowat 1979, and Garret *et al* 1979). Many workers have confirmed the effect of urea and ammonia treatment on increasing intake of straw. (Lawlor and O'Shea 1979);(Gadre 1980; Rashiq 1980).

2.3. Importance of Sorghum:

All Sudan/Sorghum forages are good choices for dairy and beef cattle feed. The choice of forage will be heavily dependent on seasonal needs and intended harvest management silage, pasture, green-chop, etc. Sudan grass and Sudan grass hybrids should probably be the first choice over sorghum-Sudan hybrids for sheep pasturybe. (Brian, 2001*)*. Sorghum is a drought resistant crop with a very efficient, well-branched root system containing considerable amounts of silica that prevent the plant from collapsing in dry soils. Sorghum can also reduce its transpiration during periods of water shortage by rolling its leaves and by stomata closure; in these conditions, it can remain dormant while other crops perish, and when the rains resume it recovers rapidly. Sorghum needs at least 300- 380 mm water during the growing period. It is one of a few crops that can withstand short periods of water logging; therefore it is popular on heavy clay soils. (Mustafa, 2006). Forage sorghums should be harvested at the mid dough stage of development and stored as silage contains 28 % Dry matter, 52 to 65 % dry matter digestibility, 8 to 12% Crude protein, 2.8% Ether Extract, Fiber content 34to40%. (Alhag, 2001).

2.4. Crop by-products

Farm crops are grown for one or more main product: for example grain, pulse, sugar and oil. Straw and crop leftovers after harvesting and after processing are ‘by-products’ of the main crop. Whether left in the field or harvested, these by-products have value and farmers have traditionally used them in many ways. Sometimes the by-product is even more impor- tant than the crop itself, especially for mixed crop-livestock farmers in semi-arid regions. ‘Crop by-products’ is a general term used to refer to both fibrous by-prod- ucts (e.g. straws, mature grass and tree leaves) and crop residues that are richer in nutrients, such as broken grain, bran, oil and seed cakes (Vink2015).

2.4.1. Straws

Fibrous crop by-products – also referred to as crop left overs or crop residues come in different forms and have different names. Grain crops yield either slender straws (barley, rice, rye and wheat) or coarse straws (maize, millet and sorghums). But sugar cane tops may also serve as animal feed, as can banana leaves and bean ‘straws’, all of which are also fibrous crop by-products. In some countries maize, sorghum or soybean stalks are referred to as ‘stover’. The stalks or stems left over from peas, beans or potatoes are known as ‘haulms’.

Straw can be used as animal feed if the following points are taken into account:

- Only ruminants can eat straw.
- Straw is low-quality feed, to be avoided if possible in favor of grasses, tree leaves and/or concentrated feeds made from grain waste, bran, oilseed cakes (if affordable).
- Straw can be useful, in specific conditions and/or for specific livestock, for example when there is a shortage of better feed, for low-production animals, or as special feed for highly productive animals. (Vink2015).

2.4.2. Sorghum:

Sorghums in general can be classified into two types: Forage types (mainly for forage or animal feed) and grain types (mainly for human consumption). The forage sorghums are further grouped into four types: (a) hybrid forage sorghum, (b) Sudan grass, (c) sorghum x Sudan hybrids (also known as Sudan hybrids), and (d) sweet sorghum. The latter is used mainly for molasses but more recently for biofuel production as well (Newman et al., 2010).Sorghum as a crop originated as far back as 3,000 years ago. The selection in those early times was for grain more than for forage. However, selection for forage varieties has been occurring for the last hundred years. Forage sorghums are similar to grain types but are taller and have higher forage quality (Newman et al., 2010). Forage sorghums are used primarily as silage for livestock. They are sometimes grown and harvested with soybeans to improve the protein content of the silage. Sudan grasses and sorghum- Sudan grass hybrids are grazed by livestock or fed as green chop or hay (Doggett, 1988). However, irrespective of the cultivar, (Fontaneli*et al*. 2001) determined a 134 to 150 g kg-1 concentration of crude proteins in sorghum. However, green mass and dry matter yields and nutritional value of forage sorghum depend on the development stage at which cutting was carried out (Pospisil*et al* 2009).

Problems. Haying the crop will reduce prussic acid problems, and ensiling the crop will reduce prussic acid and nitrate risks. Generally, when the green plant is hit with a killing frost it is advisable to remove grazing cattle until the plant has dried, during which time the prussic acid in the plant volatilizes. Dried plants normally contain very little prussic acid, but monitor cattle closely the first few days after turning them back into the field. The problem develops when the plant is not completely killed by the frost. If the weather turns warm and the plants start to re growth, pull the cattle out until another killing frost dries the plants. Prussic acid (cyanide) poisoning is very rapid and clinical signs last only minutes before the animal dies. Signs of poisoning are nervousness, abnormal breathing, generalized muscle tremors, gasping for breath and convulsions. Distinguishing characteristics are bright and cherry red color of the blood. There is no known treatment. (Greg *et al*, 2003, EL Nile 2014).

2.5. Additives:

2.5.1. Molasses:

Using 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; VanNiekerk, 1980; Waldroup, 1981).

2. 5. 1.1. Molasses as Feed for Ruminants:

Molasses is a product of the sugar-refining industry. The principal types are cane and beet molasses refined from sugarcane and sugar beets, respectively. They are similar in composition and feeding value. McDonalds *et al.* (2002) reported that sugarcane (Saccarumofficinarum) is produced in tropical and subtropical regions. Sugar-cane is a perennial grass, with thick - sugar rich stems and abundant leaves. The cane is harvested when sugar content is at a maximum and transported to the refining plant. The stems are pressed to squeeze out the juice, containing the sugar. The fibrous residue of the stalk is called (bagasse) which is burned or used as low quality roughage for animal feed. The juice is concentrated by boiling, and then sugar crystallizes out of the concentrated juice and is collected as raw sugar. The juice residue is the molasses. From each ton of sugarcane approximately 100 kg of refined sugar and 25 – 50 kg of molasses are produced (McDonald *et al*., 2002).

2.5.2. Urea:

It is a non-protein nitrogen compound (NPN) which contains 46 % nitrogen. It is the most common source of NPN used in ruminant feeding because of its lower cost and easiness of use compared to other sources (Santon and Whitter, 2008). (M. Atta *et al*, (2007) reported that molasses and urea are good alternative to sorghum grains and oil seed cakes, as energy and protein sources respectively, as being of low production cost and non-competitive with human and poultry.

2.5.2.1 Urea Treatment:

Urea treatment improves the nutritive value of cereal straws by increasing crude protein content, palatability and digestibility. This technology is considered a proven technology to improve the nutritive value of roughages. Opinions on its utility and application in the field, however, are varied among animal nutritionists, farmers and extension workers. Notwithstanding the enormous research and technology-transfer efforts, this technology, in many countries including India, has remained a ‘hardly used technology’ at farmer level. An increasing number of workers believe that this technology, in its present format, does not have a future. (FAO, 2011).

To improve the nutritive value of fibrous crop residues, urea treatment of straw was developed\as an alternative to caustic/corrosive sodium hydroxide treatment, for use mostly in tropical countries. A large number of on-stati+on and on-farm trials conducted in several countries under different conditions have shown that feeding urea-treated straw vis-à-vis untreated straw increases feed intake by 10 to 15 percent, growth rate of calves by 100 to 150 g/day and milk yield by 0.5 to 1.5 litters/day. Urea-treated straw is more palatable and digestible. The dry matter (DM) digestibility increases by approximately 10 percentage units, the total digestible nutrient (TDN) value increases by 10 to 15 percentage units and the CP content increases almost three times. The feedback received +from the farmers involved in on-farm trials has been largely positive. In spite of the technology appearing to be quite sound, it was almost entirely rejected by livestock farmers in the tropical region, barring some exceptional situations (Wall et al., 1988; Schiere and Nell, 1993). The ammonization of straw with urea has proved to be a simple, economical and more viable process for its farm level application (Saadullah*et al*...1981; Dias –da-Silva and Sundstol .1986 Makkar and Singh,1987;Joy *et al*.;1992;Schiere and Nell ,1993;Taiwo *et al* .,1995).

Ammonia (urea) treatment is the available chemical treatment techniques; ammonia (urea) treatment (Sundstol and Owen, 1984) has the most practical relevance to small scale farmers. It was the promises contained in this possibility which caused a flurry of research activities on treatment of crop residues in developing countries (Doyle *et al*, 1986).

2.5.2.2 Precautions when using Urea:

There is no question but that urea and certain other non-protein nitrogen substances can be fed safely to ruminants to replace part of the dietary vegetable protein. Favorable results can be expected when cereal grains are also included in the ration, but performance may be less satisfactory on forage alone.

Urea may cause toxicity and even death in ruminants if it is fed inadequately mixed with other feeds or in too large a dose. The toxic signs can easily be recognized. High urea supplements should be withdrawn at least one half day before and after the administration of carbon tetrachloride, if the latter is being given as treatment against liver flukes and *Haemonchuscontortus* infestations, because a concomitant absorption of ammonia increases the risks of toxic effects resulting from the drug. Animals should never be permitted access to urea not mixed with other feeds. (Lossli, 1968).

2.6.Treated Straws:

Any treatment that can increase the digestibility intake and crude protein of these feeds should result in improved animal performance. (Ffolkes and Preston, 1978)

Straw, like all mature plant tissue, is relatively indigestible by the micro-organisms that inhabit the digestive tract of ruminants; this is because straw cell walls are heavily lignified or silicified. These methods may be classified as chemical, physical, and biological. The chemical methods all involve the use of alkali solutions and are the most widely tested methods at present. Among the physical treatments, only pressure cooking alters the cell wall; simple grinding does not increase digestibility. A promising method of biological treatment is the growing of lignin-digesting fungi on straw. In the Indian village context, the feeding of alkali-treated straw will usually require the simultaneous feeding of additional nitrogen, as it will be the limiting nutrient in straw for both ruminant digestion and growth and production of the animal. As feed nitrogen is extremely scarce, the use of a urea supplement is an essential adjunct to straw treatment (Wilson, 1978).

(A) 1 % urea, 5% molasses or 5% molasses + 0.5, 1, 1.5 or 2% urea (B) 5% molasses, 0.5% urea and 0. 10. 20. 30 or 40% fresh cattle manure. (Alhag, 2001).

Farmers may decide to treat straws rather than feeding it ‘as it is’ to their animals. The decision will depend on the price of feeds and the production levels of the animals. Straws, whether green, yellow or dry, can be treated in several ways to increase sweetness, greenness, intake and/or palatability.

The main treatments are:

• Physical treatments – chopping, soaking, grinding, pellet-making, steaming.

• Chemical treatments – using caustic soda or ammonia compounds (especially urea).

• More complex treatments – using fungi, enzymes or other agents.

Some of these treatments are well known and practical; others are in- effective, impractical or too costly. Chopping and/or soaking methods have been used for many centuries. Chemical treatments have been used for the last fifty years. Some chemicals, while they are likely to be impractical in field conditions, are mentioned here simply for the sake of completeness (Vink, 2015).

2.7 Treatment Time:

Treatment time may vary from one to four weeks. In the intensive work undertaken in Bangladesh and Sri Lanka in the early 1980s, seven to ten days were normally used with no benefits in animal performance obtained by treating for a longer duration (Perdok et *al* 1984). However, temperature and treatment time are inversely correlated and more time is required in the winter or in a colder climate. In well-compacted straw the temperature rises, the extent being subject to quantity of straw and temperature, but already by the second day it may be five Celsius degrees and on day seven as much as ten degrees above ambient temperature (Saadullah*et al* 1981). The specific, practical method of treatment is best worked out locally within the guidelines outlined above. Simple tests of successful treatment are: a browning in the color of the straw, a strong smell of ammonia and absence of rotten and moulded straw.

2.8. How the Technique Works:

Ammonia is released through urea degradation done by the action of microorganisms. These microorganisms are normal inhabitants of low quality roughages (LQR) that produce urease in the presence of moisture. With adequate moisture and suitable temperature, urea is degraded to ammonia which then permeates through the straw. Nitrogen released through this process is bound to the straw, thus increasing the total nitrogen content. Digestibility of the fibrous low quality roughages (LQR) is also increased by the action of the treatment. (Meskel, 2007). Silage is the feedstuff resulting from the preservation of green forage crops by acidification. There are two main phases in the ensiling process. The first is the aerobic phase, which occurs in the presence of oxygen (air). The oxygen that is present in the forage, as it is placed into storage, is consumed by the plant material through the process of respiration. Under aerobic conditions, plant enzymes and microorganisms consume oxygen and burn up plant water-soluble carbohydrates (sugars), producing carbon dioxide and heat. The first phase should be as brief as possible to maintain the quality of the silage. Excessive aerobic fermentation reduces the energy content of the silage and may cause heat damage to proteins. The second or anaerobic phase begins when available oxygen is used up by respiration and aerobic bacteria cease to function. Anaerobic bacteria (bacteria that grow in the absence of oxygen) then begin to multiply rapidly and the fermentation process begins. The best silage is produced when the most rapidly growing microorganisms are predominately of the lactobacilli species, as they produce lactic acid from the fermented plant material. Lactic acid lowers the pH of the silage. Fermentation completely ceases after three to four weeks when the pH becomes so low that all microbial growth is inhibited**.**R. Bras. (Zootec, 2010).

2.9. Storage Methods of Silage:

There are several ensiling/storage methods that will accomplish the ensiling process. All methods have advantages and disadvantages, and have widely ranging capital costs. Some methods of storing silage include trench, bunker, concrete silos, oxygen-limiting silos, heap silage, and bale silage. Whatever the system, the ensiling and storage system's main functions are to exclude air during the ensiling process and to prevent air from entering the silage during storage. Limiting air present in the silage will enhance feed quality and reduce spoilage. Slow silo filling, forage that is not chopped finely enough, inadequate packing and allowing air to enter stored silage will all reduce quality (Zootec, 2010).

2.10. The Entry Point - Type of Animal:

There has to be a good economic reason for a farmer to feed treated straw -and the effect has to be visible. For these reasons straw treatment has been most successfully taken up when fed to crossbred milking cows or used in beef fattening programmers. A feasible rationale for feeding limited quantities of treated straw to working animals has only recently become an option based on work in Thailand (Wanapat, 1991) in which it was demonstrated that during the four-month dry season feeding working animals a small, fixed amount in the morning before grazing, led to improved work by the animals and a higher sale price after the ploughing season was over. This research demonstrates the importance of both research and extension being problem-led - a point that has been absent in much straw research work so far. When animals are fed ammoniated straw ad libitum, they will typically increase their dry matter intake by 30% or more (Han and Garrett, 1986).

Chapter three
Materials and Methods

3.1. Experimental Site:

The experiment was conducted at the Department of Animal Production, college of Agricultural studies, Sudan University of Sciences and Technology.

3.2. The Crop Residues Description:

The crop residues under study were collected from tow site of sorghum straw one of them was rain fed and other was irrigated, which they brought from eastern Sudan Al Gadarif Stat exactly from Doka and Al Rahad area respectively.

3.3. Treatment Methods of Sorghum Straw:

3.3.1 Physical Method:

Rain fed Sorghum straw was chopped to a maximum particle length of 5 cm using a hand chopper irrigated Sorghum straw was chopped to a maximum particle length of 5 cm using a hand chopper.

3.3.2. Chemical Method:

10 kg of irrigated Sorghum straw was treated with 400g of urea so that urea proportion in the straw was to be 4 %. The measured amount of urea was dissolved in 5 liters of water to bring the moisture value.

10 kg of irrigated Sorghum straw was treated with 250g of urea and 250g molasses so that urea proportion in the Sorghum straw was to be 2.5%. The measured amount of urea was dissolved in 5 liters of water to bring the moisture value.

10 kg of irrigated Sorghum straw was treated with 500g of molasses so that molasses proportion in the straw was to be 5 %. The measured amount of molasses was dissolved in 5 liters of water to bring the moisture value. 10 kg of rain fed Sorghum straw was treated with 400g of urea so that urea proportion in

the straw was to be 4 %. The measured amount of urea was dissolved in 5 liters of water to bring the moisture value.

10 kg of rain fed Sorghum straw was treated with 250g of urea and 250g molasses so that urea proportion in the straw was to be 2.5%. The measured amount of urea was dissolved in 5 liters of water to bring the moisture value.

10 kg of rain fed Sorghum straw was treated with 500g of molasses so that molasses proportion in the straw was to be 5 %. The measured amount of molasses was dissolved in 5 liters of water to bring the moisture value. And control without treatment from etches type (irrigated) (rain fed).

3.4. Storage Time:

The experiment was conducted in summer season from day 27of June to day 27 of July 2015.

3.5 .Storage Methods:

The samples were stored by two ways:

Half of each sample was stored in Stack plastic with tidily closed then buried underground, and half of each samples was stored in pail with closed.

3.6. Methods of Analysis:

Sorghum straw samples were collected after four weeks and submitted for analysis by NIRS DS to determine the ratio of the Ash contents, Fiber contents, Protein contents, Fat contents, Starch contents and Moisture.

NIRS DS device which uses modern technology to analysis the target sample, by largest different waves graded between 400 - 2500 nm in eta 25 position in the samples where feed ingredients absorb the infrared. In the anther hand the device keeps the sample without any change. The sample analyzed through 40 seconds.

3.7. Chemical Analysis:

We report chemical composition to untreated rain fed sorghum straw on ash11.7%, fat1.75%fiber, 21.47%, protein5.24%, starch5.3%, moisture 6.54%. We report chemical composition to untreated irrigated sorghum straw in ash 12.34%, fat 2.00%, fiber 19.82%, protein 7.24%, starch 3.94%, and moisture 7.34%.

3.8. Statistics Analysis:

The obtained data is analyzed statistically by using analysis of variance (ANOVA) SPSS program (Version 21). And Duncan multiple range test was used to test the significance between means using standard error (S.E).

Chapter Four

Results

4.1. Effects of Additives on Sorghum Straw in Ash:

According to the data in table (1) in Ash, there were significant difference ($P < 0.05$), between two types of sorghum straw (irrigated), (rain fed), highest in (irrigated), lowest in the (rain fed), and there were significant difference ($P < 0.05$) after treated with urea, highest in irrigated compared with rainy. But there no significant difference when add molasses. There was significant difference when added urea molasses high on irrigated low on rain fed.

Table (1) Effects of Additives on Sorghum Straw in Ash

Type of treat	Rain fed samples	Irrigated samples
Control	$11.7^{a}\pm0.160$	$12.34^{a}\pm0.050$
Urea	$8.78^{b}\pm0.835$	$9.64^{c}\pm0.058$
Molasses	$1.75^{d}\pm0.592$	$4.25^{d}\pm0.264$
Molasses + urea	$6.34^{c}\pm0.136$	$10.64^{b}\pm0.090$
Sig	**	**

NS = Not significant

*= significant (p≤ 0.5).

**= high significant (p≥0.01)

- Means±SE values having different superscript letters in the same are significant different (p≤0.05).

4.2. Effects of Additives on Sorghum Straw in Fat:

According to the data in table (2) in fat content, there were significant difference ($P < 0.05$), between two type of sorghum straw (irrigated), (rain fed), lowest in rainfall, highest in the irrigated. After treated with urea, highest in irrigated compared with rain fed. But there significant difference when add molasses high in rain fed low in irrigated. There was significant difference when added urea molasses high on rain fed low on irrigated.

Table (2) Effects of Additives on Sorghum Straw in Fat:

Type of treat	**Rain fed samples**	**Irrigated samples**
Control	1.7550 ^{d} ±0.145	2.0000 ^{c} ±0.0600
Urea	3.6575 ^{c} ±0.483	4.5675 ^{a} ±0.1212
Molasses	6.0175 ^{a} ±.0165	4.6800 ^{a} ±0.0922
Molasses + urea	4.8200 ^{b} ±0.168	3.7000 ^{b} ±0.0928
Sig	**	**

NS = Not significant

*= significant ($p \leq 0.5$).

**= high significant ($p \geq 0.01$)

- Means±SE values having different superscript letters in the same are significant different ($p \leq 0.05$).

4.3. Effects of Additives on Sorghum Straw in Fiber:

Data in table (3) showed fiber content, there were significant difference ($P < 0.05$), between two type of sorghum straw (irrigated), (rain fed), highest in (rain fed), lowest in the (irrigated). After treated with urea, highest in irrigated compared with rain fed. But there significant difference when add molasses high in irrigated low in rain fed. There was significant difference when added urea molasses high on irrigated low on rain fed.

Table (3) Effects of Additives on Sorghum Straw in Fiber**:**

Type of treat	**Rain fed samples**	**Irrigated samples**
Control	21.4700 ^{a} ±0.0100	19.8200±0.0100
Urea	17.1825 ^{b} ±1.057	19.0150±0.0512
Molasses	17.5700 ^{b} ±0.5774	19.0900±0.3740
Molasses + urea	17.922 ^{b} ±0.3688	19.6775±0.7192
Sig	*	NS

NS = Not significant

*= significant (p≤ 0.5).

**= high significant (p≥0.01)

- Means±SE values having different superscript letters in the same are significant different (p≤0.05).

4.4. Effects of Additives on Sorghum Straw in Protein:

Data in table (4) showed protein content, there were significant difference ($P < 0.05$), between two type of sorghum straw (irrigated), (rain fed), highest in (irrigated), lowest in the (rain fed). After treated with urea, highest in irrigated compared with rain fed. But there significant difference when add molasses high in irrigated and increase in rain fed. There was no significant difference when added urea molasses between irrigated and rain fed.

Table (4) Effects of Additives on Sorghum Straw in Protein:

Type of treat	Rain fed samples	Irrigated samples
Control	5.2400 ^{d} ±0.1500	7.4700 ^{c} ±0.02828
Urea	15.7650 ^{a} ±1.7879	16.7575 ^{a} ±0.4821
Molasses	9.6975 ^{c} ±1.2187	16.5800 ^{a} ±1.0595
Molasses + urea	11.5900 ^{b} ±1.6741	11.7400 ^{b} ±0.2896
Sig	*	**

NS = Not significant

*= significant (p≤ 0.5).

**= high significant (p≥0.01)

- Means±SE values having different superscript letters in the same are significant different (p≤0.05).

4.5. Effects of Additives on Sorghum Straw in Moisture:

Data in table (5) showed moisture content, there were no significant difference ($P < 0.05$), between two type of sorghum straw highly in irrigated low in rain fed. Moisture content there were no significant difference between three treatment (molasses), (urea +molasses) (urea).

Table (5) Effects of Additives on Sorghum Straw in Moisture:

Type of treat	Rain fed samples	Irrigated samples
Control	6.5400±0.2600	7.3450±0.1450
Urea	24.0850±0.8139	24.8925±0.0166
Molasses	25.3100±0.3046	25.2925±0.0771
Molasses + urea	24.9075±0.2046	24.1475±0.1198
Sig	**	**

NS = Not significant

*= significant ($p \leq 0.5$).

**= high significant ($p \geq 0.01$)

- Means±SE values having different superscript letters in the same are significant different ($p \leq 0.05$).

4.6. Effects of Additives on Sorghum Straw in Starch:

Data in table (6) showed starch content, there were significant difference ($P < 0.05$), between two type of sorghum straw (irrigated), (rain fed), highest in (rain fed), lowest in the (irrigated). After treated with urea, highest in rainy compared with irrigated. After add molasses increases on rain fed and irrigated but high in rain fed. There was difference when added urea molasses low in irrigated and high in rain fed.

Table (6): Effects of **Additives on** Sorghum Straw in Starch

Type of treat	**Rain fed samples**	**Irrigated samples**
Control	5.3000 ^{c} ±0.2200	3.9450 ^{c} ±03150
Urea	9.4075 ^{b} ±0.7912	4.4050 ^{b} ±0.0792
Molasses	12.0950 ^{a} ±0.6832	5.5525 ^{a} ±0.1615
Molasses + urea	9.0075 ^{b} ±0.6601	2.5975 ^{d} ±0.1054
Sig	**	**

NS = Not significant

*= significant (p≤ 0.5).

**= high significant (p≥0.01)

- Means±SE values having different superscript letters in the same are significant different (p≤0.05).

Table (7) Effect of Chemical Treatment on Composition of Irrigated and Rain Fed Straw:

Parameter	Treatment	Mean ±SE	
		Rain fed samples	Irrigated samples
Ash	Control	11.7 [a] ±0.160	12.34 [a] ±.050
	Urea	8.78 [b] ± 0.835	9.64 [c] ±.058
	Molasses	1.75 [d] ±0.592	4.25 [d] ±0.264
	Urea+ Molasses	6.34 [c] ±0.136	10.64 [b] ±0.090
Fat	Control	1.7550 [d] ±0.145	2.0000 [c] ±0.0600
	Urea	3.6575 [c] ±0.483	4.5675 [a] ±0.1212
	Molasses	6.0175 [a] ±.0165	4.6800 [a] ±0.0922
	Urea+ Molasses	4.8200 [b] ±0.168	3.7000 [b] ±0.0928
Protein	Control	5.2400 [d] ±0.1500	7.4700 [c] ±0.02828
	Urea	15.7650 [a] ±1.787	16.7575 [a] ±0.4821
	Molasses	9.6975 [c] ±1.2187	16.5800 [a] ±1.0595
	Urea+ Molasses	11.5900 [b] ±1.674	11.7400 [b] ±0.2896
Moisture	Control	6.5400±0.2600	7.3450±0.1450
	Urea	24.0850±0.8139	24.8925±0.0166
	Molasses	25.3100±0.3046	25.2925±0.0771
	Urea+ Molasses	24.9075±0.2046	24.1475±0.1198
Fiber	Control	21.4700 [a] ±0.010	19.8200±0.0100
	Urea	17.1825 [b] ±1.057	19.0150±0.0512
	Molasses	17.5700 [b] ±0.577	19.0900±0.3740
	Urea+ Molasses	17.922 [b] ±0.3688	19.6775±0.7192
Starch	Control	5.3000 [c] ±0.2200	3.9450 [c] ±03150
	Urea	9.4075 [b] ±0.7912	4.4050 [b] ±0.0792
	Molasses	12.0950 [a] ±0.683	5.5525 [a] ±0.1615
	Urea+ Molasses	9.0075 [b] ±0.6601	2.5975 [d] ±0.1054

Chapter Five

Discussions

It must be known that there was different in areas of samples collection in Doka and ALRahad area in environments factors (temperature, moisture, soil type and components,…etc.) and type of irrigation which sequentially variation between samples of sorghum straw in their chemical composition**.**

Ash content in rain fed sorghum straw decreases when treated by urea 8.78% compared with irrigated sorghum straw (9.64%), and there was differences also between the two samples when molasses was added decreased in rain fed, irrigated as fallowed (1.75%), (4.25%). The treated (urea/molasses) reported increases on Ash for the two samples in rain fed was 6.34% and (10.6%) in irrigated straw.

These results in agreement with El Nile (2014) in Ash content (8.28 b $\pm$ 0.00), and with Rash (2014) as she reported (9.7- 10.0) %. Al hag (2005) reported the ash content of treated sorghum were 9.9%.

Crud Fiber content in rain fed sorghum straw decreased when treated by urea (17.18%) compared with irrigated sorghum straw (19.01%) ,and there was a differences between the two samples when added molasses decreased in rain fed, irrigated samples (17.57%, 19.09%). The treated (urea/ molasses) reported on increase in Crud Fiber for two the samples in rain fed straw was (17.92%) and (19.7%) in irrigated sample.

These results dis agreed with El Nile (2014) who reports the CF (40.00), and Rash (2014) who reported CF (46.6%, 39.0%). Al Hag (2005) found that the mean values of crude fiber of untreated sorghum was 38.2 was higher in the study which was 21.4 in rain fed, 19.8 in irrigated sorghum straw,

The Crud Protein in rain fed sorghum straw increased when treated by urea (15.77 %) and also increased irrigated sorghum straw (16.75%), and there was differences between the two samples when added molasses decreased in rain fed, irrigated as fallowed (15.8%, 16.6%). The treated (urea/ molasses) reported increased Crud Protein for the two samples compared with control in rain fed was (11.6%) and (11.7%) in irrigated.

In this study crude protein contents in control in rain fed, and irrigated were 5.2 % and 7.4 % respectively. This value of CP were higher than the founding of Alhag (2005) who found that crude protein in untreated sorghum were 2.8 %

Such result disagreed with Rash (2014) when reported CP (3.6%), (3.4 %,) also El Nile (2014) resulted (5.50%) Curd Protein. The current result found that crude protein range from (5.24-15.80) in rain fed and were (7.47-16.75) in irrigated sorghum straw, theses value were higher than the results of Sander (2001) who reported that the crude protein of sorghum silage ranged between 8.5-12%.

The Fat content in rain fed sorghum straw increases when treated by urea (3.7%) and the irrigated sorghum straw (4.6%), and there was different also between the two types when added molasses increased in rain fed, irrigated as fallowed (6.01%, 4.7%), the treated (urea molasses) reported increased on Fat for two types in rain fed was (4.8% and 3.7%) in irrigated.

Moisture content in rain fed sorghum straw increased when treated by urea (24.08%) irrigated sorghum straw(24.9%), and there was no different also between the two types when added molasses increased in rain fed, irrigated as fallowed(25.3%, 25.3%).The treated (urea molasses) reported increased on Moisture for two samples in rain fed was (24.9% and 24.1%) in irrigated.

Starch in rain fed sorghum straw increased when treated by urea (9.4%)and irrigated sorghum straw (4.4%), but there was no differences between the two samples when added molasses increased in rain fed, irrigated as fallowed (12.09%, 5.55%).The treated (urea molasses) reported an increase in Starch in rain fed was (9.00%) and decreases in irrigated (2.6%). The rain fed straw resulted high in starch than irrigated when add urea, molasses and urea molasses.

Conclusion and Recommendations:

Conclusion:

1- It was concluded that according to the study, irrigated sorghum straw is the best on chemical composition than rain fed sorghum straw.

2- Using of molasses had improve the chemical composition of two samples of sorghum straw.

Recommendations:

The following recommendations are suggested:

- Use molasses in sorghum straw to increase their protein, fat, moisture and starch contents.
- Develop new technologies for processing and storing of feed to improve making silage from crop residues as generals and sorghum straw special.
- More detailed and large studies are needed in sorghum straw to contribute more in economical and nutritive animals feed.

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Plates

Plate (1): Adding Molasses to sorghum straw:

Plate (2): Mixing sorghum straw with additives:

Plate (3): Samles of types of sorghum straw:

Plate (4): Chemical analysis of samples in laboratory of Ministry of Agriculture, Animal Wealth and Irrigation, Khartoum state:

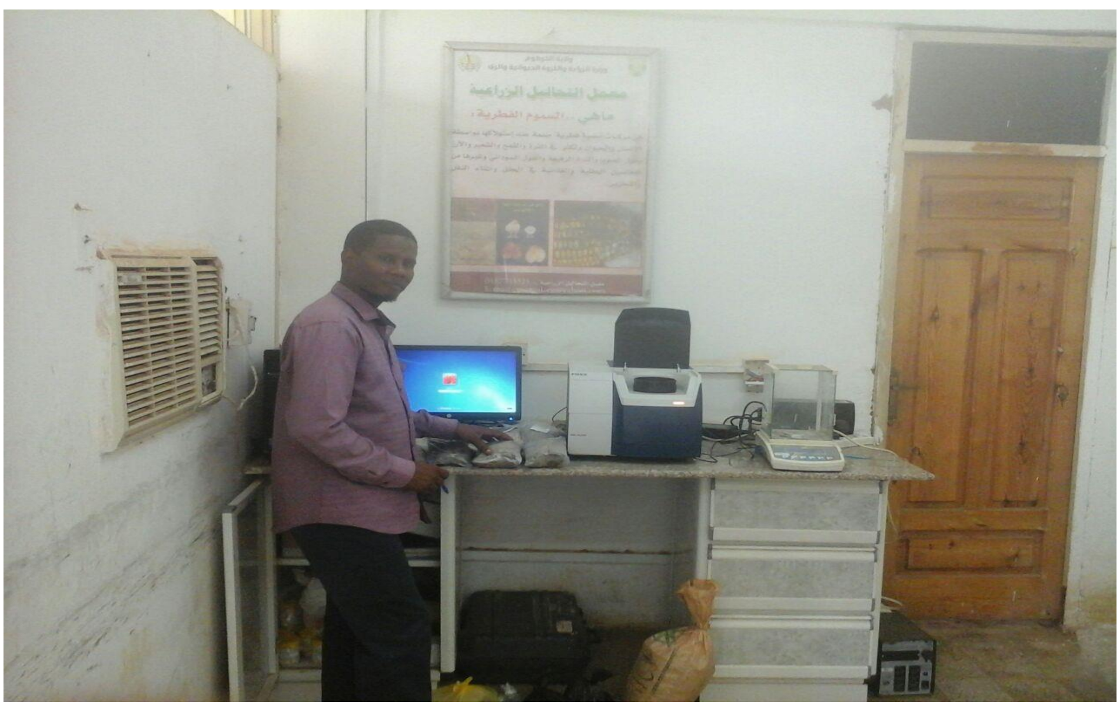

Plate (5): NIR feed analyzer: