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RESEARCH ARTICLE

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INFLUENCE OF UREA AND CHICKEN MANURE TREATMENTS ON THE NUTRITIVE VALUES OF SORGHUM HUSK

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ABSTRACT

This study aimed to improve the nutritional value and digestibility of Sorghum Husk (SH) using urea and chicken manure treatments. SH was exposed to chemical (5% urea), (5 % urea and 10 % molasses) and biological (chicken manure 10 %) treatments. A study was performed to investigate the effects of the different treatments on chemical composition and in vitro dry matter digestibility (IVDMD), Metabolizable energy (ME), neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL), digestible energy (DE), digestibledry matter (DDM), relative feed value (RFV).The obtained data were subjected to analysis of variance (ANOVA) for a completely randomized design The results showed signification variation (P< 0.05) on the nutritive value among different treatments of sorghum husk. The highest value of CP (11.27%), NFE (51.42%), IVDMD, (69.16), DDM (49.07), RFV (59.51) and ME (12MJ/Kg) were found in chicken manure treatment, while the highest value of Ash (7.41 %), and EE (1.32). were obtained in urea treatment. the lowest value of CF (29.13%), NDF (76.62 %)and ADL (4.55), were recorded for chicken manure treatment, while the lowest value of ADF (44.17%) were obtained for untreated sample. It could be concluded that chicken manure improve the nutritive value of sorghum husk by increasing the crude protein and IVDMD and decreasing all fibre fraction.

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INTRODUCTION

The animal production sector in Sudan suffer from many problems, the health and nutritional status and the administration accounting for about 70% of the problems facing this sector, the most important rising prices feed concentrated and fillers have forced the farmers to the introduce some feed of low nutritional value, these feed do not meet the animal requirements for the production, which may need some interventions of researchers to solve these problems. From the total feed available for the livestock in Sudan, the natural range supplies 62 million tones, agriculture and industrial by-products supplies 19 million tones, cultivated green fodders crops 4 million tones and feed-milled concentrate 1 million tone (Khari, 1999). Treatment of the by-products to increase the nutritive value, feed intake and digestibility, includes physical, biological, and Chemical treatment. Chemical treatment has been reported to disrupt the amount of lignin present in various byproducts thus increasing their digestibility while Biological treatment of some agricultural by - products become essential to degrade lignocelluloses material and improve the crude protein and thus increase digestibility. Sankpal and Naikwade (2013) reported that Sorghum is one of the principle crops for human and animals in arid and semiarid area.

The nutritional value of sorghum byproducts, such as SH, was low due to its anti-nutritional factors containing phytic acid, polyphenol, tannin, etc. The SH might be classed as a low protein and low energy roughage feed for cattle, sheep and goat (Gaur and Taparia 1991). The target of the present study was to overcome the animal's feed shortage through improving the nutritive values of sorghum husk and to investigate the effect of chemical (urea or urea molasses) or biological (chicken manure) treatments on nutrients composition, in vitro dry matter digestibility, of sorghum husk.

MATERIAL AND METHODS

Sample collection and Preparation: The study was conducted at the Department of Animal Nutrition, Faculty of Animal Production, University of Khartoum. Sorghum husk (SH) was brought from the market – Khartoum bahri - Shambat and subjected to the following treatments.

Sorghum Husk Treatments: Three treatments were executed to sorghum Husk (SH):

First: Urea Treatment Only: The treatment was made by adding (5%) urea in which 10 g of urea was dissolved in 60 ml distilled water and sprayed on 200g DM of ground SH.

Second: Urea Molasses Treatment: the treatment was made by adding 5% urea and 10 % molasses to SH. 10 g of the urea was dissolved in 50 ml distilled water and mixed with the molasses solution 1: 2, molasses: water .and sprayed on 200 g of ground SH.

Third Chicken Manure Molasses Treatment: SH was treated by (chicken manure10%), chicken manure obtained from Poultry Unit, University of Khartoum then heated in 60◦ C for 45 minute. 20.7 g of chicken manure was mixed with 20.7 of diluted molasses (molasses1: distilled water 2), then spread on 200 g of ground SH. Sample of each treatment was thoroughly mixed to be homogenous and incubated in glasses jar for four weeks with three replications of each treatment.

Chemical Analysis: The experimental samples in this study were analyzed for their proximate compon, Dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE), ash and nitrogen free extract (NFE), according to the methods of AOAC (2003). Neutral Detergent Fiber (NDF), Acid detergent fiber (ADF), Acid detergent Lignin (ADL), was determined according to Georing and Van Soest (1970).

In vitro dry matter digestibility: In vitro dry matter (DM) digestibility (IVDMD) was conducted using the procedure demonstrated by Tilley and Terry (1963).

Relative feed value (RFV): The relative feed value (RFV) was calculated according to Stallings (2005) following the equation:

RFV = [(88.9 - 0.78 x ADF %)) x (120/NDF %)]/1.29

Metabolizable energy (ME): The Metabolizable energy ME (M J/ Kg DM) content was calculated using equations suggested by (Ellis, 1981) As follows:

ME (MJ/Kg DM) =0.012CP+0.031EE+0.005CF+0.014NFE.

Digestible energy (DE): The Digestible energy DE, (Mcal/kg) content was calculated using equations suggested by (Noblet and Perez. 1993.) as follows:

DE, (Mcal/kg) = 4.22-(0.11*ADF) + (0.0332*CP) + (0.00112*ADF2)

Digestible Dry Matter (DDM): The Digestible Dry Matter content was calculated using equations suggested by (Noblet and Perez. 1993.) as follows:

DDM = 88.9 - (0.779 x ADF).

Statistical analysis: Data obtained from experiment were subjected to analysis of variance (ANOVA) according to a completely randomized with single factor arrangement design. Means between treatments were compared using the least significant difference (LSD).

RESULTS AND DISCUSSION

A Proximate Composition

Crude protein content (CP): Table (4-1) illustrated the Effects of sorghum husk treated with urea, Urea and molasses and chicken manure on dry matter (DM), crude Ash, crude protein (CP), crude fiber (CF), natural free extract (NFE), Metabolizable energy (ME), and in vitro dry matter digestibility (IDVDM). For CP, significant increase ($P \leq 0.05$) was found between treatments. Chicken manure recorded the highest CP value (11.27%) while the lowest value was recorded for untreated sorghum husk (4.92). It was obvious that the crude protein value increased by treatment from 4.92 to 11. 27 %. The increased in crude protein content of treated SH in this study may be attributed to ammoniating process. This results were supported by Tesfaye (2006), Ali et al. (2012) and (Egbu, 2014), who reported an increased in crude protein content of various crop residues as a results of the ammoniation.Atta Elmnan et al (2015) repoeted that the increment of CP for sugar cane bagasse may be due to enhanced its nitrogen content, which was induced by the addition of nitrogenous substrate, also this result was similar to the result reported by Atta Elmnan et al., (2007) who showed that urea and ammonia treatments increased CP content for SCB. Similar results were obtained by Ambaye (2009) who revealed thatUrea treatment increased CP content of the straw 3.35% to 7.54%, this increase is due to binding of ammonia to the straw.

Crude Fiber Content (CF): Crude fiber content of treated sorghum husk in this study was summarized in table (4-1). Significate differences were found between treatments. The lowest CF content was recorded when the chicken manure treatment was applied (29.13 %), while the highest CF content was noticed for the un treated sample (80.37%). The rank of the CF content from the lowest to the highest was found to be as follows: 29.13%,32.47%,32.62% and 80.37% for chicken manure, urea, urea and molasses and raw sorghum husk. The reduction in crude fiber contents which was detected for sorghum husk in this study as a result of the treatment, may be attributed to the fact that the CF had become more digestible after treatment with urea. Also it indicates cellulose and hemicellulose breakdown as effect of the treatment. These results came in agreement with some previous works (Saenger et al., 1982, and Egbu, 2014). The decrease in CF content by urea treatment may be also due to the liberation of cellulose from its bonds with lignin (delignification) which increased the solubility (Abd El-Ghani et al., 1999). Moreover, El-Ashry et al. (2002) reported that cellulose contents of the silages were significantly reduced due to the biological treatments at the higher rate of enzymes.

Ether Extract: In table (4-1) the results illustrated that the treatments increased the EE significantly ($P \leq 0.05$), which were found to be (0.79 %, 1.3%, 1.1% and 0.96%) for untreated SH, urea, urea and molasses and chicken manure treatments respectively. The highest increase was observed with urea treatment. This result was lower than (2.54%) which reported by (Aruwayo et al 2019) for untreated sorghum husk and in agreement with Salman et al (2011) who reported that, different biochemical treatments led to increase EE contents. These increment in EE may be due to synthesis of fatty acids through growth of bacteria (Gado et al., 2007). (Zadrazil et al. 1995).

Ash content: Table (4-1) noted that the ash content was increased with the treatments. These results were lower than the result obtained by Gaboush (2010) who recorded the values of (5.79%and 7.55%) for treated and untreated sorghum husk, and also lower than the results obtained by Aruwayo et al (2019).This increment may be resulted from the addition of bacteria which led to degradation of DM into ash and organic matter. In addition to that, Chandra et al. (1991) found that the increment in total ash on may be a reflection to the decrease in CF and NFE contents.

Nitrogen Free Extract content (NFE): Nitrogen free extract (NFE) was calculated in table (4-1) the nitrogen Free Extract increased in treated sorghum husk. The highest value was found for chicken manure treatment (51.42%) followed by urea treatment (49.69%), urea and molasses treatment (48.74%), and the least value recorded with untreated sorghum husk which was (8.81%). The low NFE content for the untreated sorghum husk is expected because of its high cell wall component and low soluble fraction like protein and starch. The results were agrees with that obtained by Gado et al (2007) who found 42.61% and 43.07% for untreated and treated rice straw. In addition, The results were different from those obtained by Hassouna et al (2019) who reported that NFE was not affected by urea treatment for all five sorghum residue except for grain sorghum stalks, it was reduced significantly.

Metabolizable Energy (ME): Calculated Metabolizable Energy (MJ/KgDM) of sorghum husk was presented in table (4-1). The highest value was reported when treated by chicken manure 12.10 (MJ/KgDM) and the lowest value was found in untreated SH 5.40 (MJ/KgDM). These results were in the line of the results obtained by Ambaye (2009) who reported 7.30 and 8.37 (MJ/kg DM) for untreated and yreated rice straw**.** The results obtained were higher than the mimimum requirement of goats and cattle which was repoeted by Kirchgessher (1981) to be 4.9 (MJ/KgDM) Metabolizable Energy.

In Vitro Dry Matter Digestibility (IVDMD): As table 4-1 showthat the treatment with Urea, urea and molasses, and chicken manure all increased the IVDMD of SH, resulting in values of 65.29 %, 67.84 %, and 69.19 %, respectively, while control recorded the lowest value of 58.33 %. The IVDMD was positively affected by different treatments compared with the control; chicken manure treatments had the largest impact followed by urea, molasses, and urea treatments. Increasing IVDMD for SH with different treatments may be due to an increased degradability, structural carbohydrate of SH cell walls are susceptible to fermentation, in addition to more energy and nitrogen being available for microbial growth, Fibrous materials are modified, then their cell walls are partially cleared, making colonization and degradation easier, (Ngyuen ,2002). These results agreed with those obtained by Shoukry (1992), who found that IVDMD of corn cobs and sugarcane bagasse significantly ($P\leq0.05$) increased by 3% urea treatment. Swidan et al. (1996) reported that IVDMD of corn cobs improved by 3 and 5% NH_3 treatment. Bassuny et al. (2003) found that rice and bean straw treated with biological treatment significantly ($P<0.05$) improved IVDMD and IVOMD. Singh (2004) found that 4% urea and fungi when treated with wheat and rice straw, the values in IVDMD and IVOMD were significantly higher for urea treated straw ($P<0.01$) than untreated and fungi treated straw. Salman et al., (2011), Atta Elmnan et al., (2007, 2009) and Atta Elmnan et al., (2007) also obtained similar results According to them, the increase in digestibility of CF, CP, and DM from treated crop residues may be due to changes in their chemical composition, especially with CP and CF after biological and biochemical treatments.

by causing cellulose to be liberated from its lignin bonds. The solubility increased as a result (Fiordos et al., 1989).Atta Elmnan et al et al (2016) reported that Chemical and biological treatments significantly ($P<0.05$) decreased DM, NDF, ADF and ADL content of un-ground and ground SCB. The results obtained in this study confirmed by that obtained by Badr(2001), Mahala et al., (2005) and Shwahona et al., (2007) for biological treatment, as well as by Atta Elmnan et al., (2007) for chemical treatment.

Digestible Dry Matter (DDM): Table (4-3) noted the mean values of DDM for treated SH. It was found to be as follows: 47.75% for Urea, 48.00% for Urea and molasses and 49.07% for chicken manure.The difference between treatments was found to be significant($P\leq0.05$). This results were similar to Mattoni et al (2010) who reported that the effect of the treatment on sorghum and millet strawincreased dry matter digestibility (DMD) of treated vs. non treated. Bani et al (2007) recorded an inverse relationship between forage fiber fractions and DM digestibility, Nitrogen content and cell wall polysaccharides are major determinants of digestibility (Barriere et al., 2003; Seven and Cerci, 2006).

Digestible Energy (DE): Concerning the DE of different treatments of Sorghum Husk table (4-3), a significant variation ($P\leq0.05$) was found. The mean values of DE laid within the range of 1.71 MJ/Kg raw sorghum husk 9.23 MJ/Kg for urea and molasses and urea and chicken manure (2.11and 1.84) MJ/Kg. this results similar to Singh et al (2017) which ranged from 1.8 to 3.0) MJ/Kg for straw. There is a limited amount of research on the net energy efficiency of sorghum hybrids for different animal production functions, but some work has been reported (Colombo et al., 2007; Singh and Shukla, 2010) on the net energy value of sorghum hybrids, corn silage, and Sudan grass silage. The DE and ME values recorded by Neumann et al. (2002) in silage of sorghum hybrids (9.75 and 7.99 KJ/g DM) were higher than those in the present study but similar to those recorded by Singh and Shukla (2010). In general, Energy values of a feed for different functions vary with the carbohydrate contents and composition with OM digestibility.

Table 1. Effect of urea and chicken manure treatments on chemical composition and IVDMD of sorghum husk

Item	DM	CP	CF	EE	ASH	NFE	IVDMD	ME(MJ/Kg)
RSH	95.73^a	4.92^d	80.37^a	0.79^b	6.17^b	8.81^d	58.33^d	$\mathbf{5.40^d}$
SHBU	83.27^c	9.11^c	32.47^b	1.32^a	7.41^a	49.69^b	65.29^c	$\mathbf{9.32^c}$
SHBUM	83.35^c	10.20^b	32.62^b	1.1^a	7.34^a	48.74^c	67.84^b	$\mathbf{9.11^b}$
SHBCHM	85.04^b	11.27^a	29.13^c	0.96^b	7.22^a	51.42^a	69.16^a	$\mathbf{12.10^a}$
SEM±	0.46	0.15	0.43	0.024	0.011	5.00	0.17	**0.11**

RSH= RAW Sorghum Husk, SHBU =Sorghum husk treated by urea, SHBUM=Sorghum husk treated by urea and molasses, SHBCHM=Sorghum husk treated by chicken manure, a-d. Means with different superscripts in the same column were significantly different ($P< 0.05$) SEM= standard error of a mean

Table 2. Effect of Urea and Chicken manure treatments on cell wall constituents of Sorghum Husk

Item	NDF	ADF	ADL
RSH	78.25^a	44.17^c	9.00^a
SHBU	78.21^{ab}	52.83^a	5.10^b
SHBUM	78.01^{ab}	52.63^a	5.03^b
SHBCHM	76.62^b	51.13^b	4.55^c
SEM±	0.49	0.16	0.03

NDF=Neutral detergent fiber, ADF=Acid detergent fiber, ADL=Acid detergent lignin, RSH= RAW Sorghum Husk, SHBU =Sorghum husk treated by urea, SHBUM=Sorghum husk treated by urea and molasses, SHBCHM=Sorghum husk treated by chicken manure, a-c. Means with different superscripts in the same column were significantly different ($P< 0.05$) SEM= standard error of a mean

Neutral Detergent Fiber, Acid Detergent Fiber and acid Detergent Lignin: The contents of NDF, ADF and ADL for treated SH were presented in Table (4-2). The results obtained showed that ADL and NDF were decreased significantly among treatments except in chicken manure treatment while ADF was increased.ADL percentage was found to be 9.00%, 5.10%, 5.03% and 4.55% for untreated sample, urea, urea and molasses and chicken manure treatments, while ADF was found to be 52.83% for urea treatment, 52.63% for urea and molasses and 51.13 % for chicken manure treatment. As a result of urea or chicken manure treatments, the NDF and ADL content were decreased for SH. this reduction of concentration among chemical treatments is due to a generic alkaline effect, which occurs

Relative feed value (RFV): The RFV index as a rule is used to rank feeds relative to full bloom alfalfa hay known to have RFV index of 100 and considered to be a standard value against which other feeds are compared Accordingly, feeds with RFV index higher than 100 are considered to be of higher quality compared to full bloom alfalfa hay and those with a value lower than 100 are of lower value. (Diriba et al 2013).Although RFV can provide a general idea about forage quality, it does not give an estimate of how closely the hay will satisfy an animal's nutrient requirements. The mean RFV of the present study index is illustrated in table (4-3). RFVs vary between 56.72 for Urea, and 64.58 for untreated sorghum husk, urea and molasses and chicken manure was shown as (57.06, 59.51) respectively. These results are lower value according to RFV index, these was higher than the results reported by Sneath (2011) in which theybstated that, Relative feed value of some forages Lucerne, pre-bud 164, Sorghum-Sudan grass vegetative 112, Lucerne, mature 100, Sorghum-Sudan grass headed 83, Wheat straw 51. and lower from the result found by Amasaib et al., (2016) who found that the RFV for genotypes of guar forage found to be 159. The variability in the RFV of sorghum husk in the present study, may be attributed tothe differences in cell wall composition before and after treatments.

Table 4.3. Calculated digestible energy (DE), dry matter digestibility (DDM), and relative feed value (RFV) of Sorghum Husk

Sample	DDM%	DE(MJ/Kg)	RFV
RSH	44.49[c]	1.71[c]	64.58[a]
SHBU	47.75[b]	1.84[c]	56.72[d]
SHBUM	48.00[b]	9.23[a]	57.06[c]
SHBCHM	49.07[a]	2.11[b]	59.51[b]
SEM	1.36	1.59	1.57

DDMDigestible Dry Matter, DE Digestible Energy, RFV Relative feed value ME estimated, RSH= RAW Sorghum Husk, SHBU =Sorghum husk treated by urea, SHBUM=Sorghum husk treated by urea and molasses, SHBCHM=Sorghum husk treated by chicken manure, SEM: Standard Error of Means.

Conclusions and Recommendations

The results from this study demonstrate that urea and chicken manure can be used to increase crude protein and IVDMD in Sorghum Husk as agricultural byproduct. Treated sorghum husk by chicken manure from recorded the highest value of CP, IVDMD compared to urea and urea and molasses treatments.

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