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EFFECTS OF REPLACEMENT OF SORGHUM GRAINS WITH WATERMELON BUG MEAL ON DESERT LAMBS PERFORMANCE

[1]Idris Adam Idris Abdalla, [2]Alnazir Adam Makki Ageb, [3]Salah Abdul Gabar Salah Bukhari, [1]Jumaa Barram Jadalla, [1,]* Mohammed Alhadi Ebahiem

[1]Depatment of Animal Production, Faculty of Natural Resourced and Environmental Studies, University of Kordofan, Sudan.
[2]Ministry of Production and Economic Resources, North Kordofan State, Sudan.
[3]Depatment of Animal Production, Faculty of Natural Resourced and Environmental Studies, University of Alsallam alfula Sudan.

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ABSTRACT

This study was conducted during the period from March to May 2019 with the aim of studying the effect of replacing sorghum grains with watermelon bug meal in the rations of Desert sheep. A total of 15 lambs were used at the age of 6-8 months with an average weight of 17.500 + 0.500 kg. The animals were divided into three groups with five animals. Feed intake, weight change, dry matter and organic matter digestibility were monitored for in vitro and in vivo digestion was estimated by total feces collection method. Data collected on weight change rates and nutrient digestibility were treated as a complete randomized design and statistically analyzed using variance analysis. The results showed that the intake of dry matter was significantly (P<0.05) increased in the group that consumed a ration containing 40% of watermelon bugs meal instead of sorghum grains with the same percentage, followed by the group that consumed a ration with sorghum grains while the lambs intake depended on the natural grazing without supplementation. The feed was 0.870, 0.804 and 0.786 kg for the group consuming the ration consisting 40% meal watermelon bugs and similar % of sorghum grains and natural grazing, respectively. The differences were significant (P<0.05). The digestibility of dry matter and organic matter was significant (P<0.05) the highest in the diet formulated by replacing sorghum grains with watermelon bug meal. The dry matter digestibility coefficients were significant (P<0.05) and amounted to 65.67, 56.45 and 51.45% of the group intake of watermelon; sorghum grains and natural grazing, respectively. The weight gain of lambs was 166, 108 and 40 grams per day for the groups of lambs that consumed the ration of watermelon, sorghum grains and natural grazing, respectively. The study concluded that it is possible to replace sorghum grains with watermelon bugs meal to reduce the cost of feeding without negatively affecting the performance of lambs.

Keywords: Desert Lambs, nutrition, sorghum grains, watermelon bug meal

INTRODUCTION

The livestock sector in Sudan is one of the pillars of the national economy of the country where it occupies an advanced position in the national income and the animal sector occupies the second rank in the national income where it contributes 25% of the national production and about 20% of the gross domestic production, especially sheep (Wolz and DeLucia, 2018 and Wilson, 2018). In Sudan there are many pure breeds with high productivity of the most important of the Desert sheep breeds, which represents about 67% of the total sheep population in Sudan and the majority of herds of these sheep owned by nomadic pastoral tribes and spread in large areas of the country. The breed has adapted to harsh environments difficult for other breeds to live. Although it has originated semi arid areas it has the ability to adapt in different environments (Sulieman *et al.,* 1990). There are tribal ecotypes of the breed that are named after some of the tribes raise them, such as Hamari, and kabbashi and Beja and Meidobi and others. Desert sheep is bred mainly for meat production. Some ecotypes can also give substantial amount of the milk (Behnke, 2012). Desert sheep ecotypes are characterized by the production of good types of leather, which are included in many industries (Behnke, 2012 and IGAD, 2013). The desert sheep are one of the best breeds that can graze in dry and semi-arid areas with modern reclamation because of their important role in the exploitation of natural pasture lands that are not suitable for agriculture and thus improve the properties of agricultural soils where it is characterized by rapid decomposition of organic fertilizer and characterized by tolerance of difficult climatic conditions especially thirst and feed scarcity (Behnke, 2012). Sheep are mainly grazers animals and are considered to be fed on the residues of agricultural crops and are characterized by high reproductive efficiency in the production of twins also can be raised with small capital and speed of its production cycle to increase the capital of the novice 'as well as being able to be kept as herds and not individual, which reduces production costs and do not need high-costly pens and barns Desert sheep is considered a source of the best type of meat and therefore it is the accepted by communities and with increased demand for it a increasing rates (Pilar *et al.,* 2011 and Czerkawski, 2021). Despite the tolerance of sheep to the climatic conditions and the diversity of the foundations of care, but there are still problems in raising sheep and improve the qualities of produced of meat and milk. The reproductive is restricted as feed is only sufficient at certain times of the year or otherwise low fertility and lambs and mature animals mortality rates will threaten production. Hence the idea of improving pastures and resorting to supplementary feeding, concentrates and crop residues to alleviate and maintain production under the natural pasture production (Allen *et al.,* 2015 and Déborah and Xavier, 2020). Therefore, the idea is adopt integrated solutions for animal nutrition on under natural pasture with food supplementary feed to meet the requirements of production and this is a problem that requires scientific research to find solutions to these constraints. To prepare ration for meeting animal requires, ingredients with high cost are used such as sorghum grains. This ingredient is also competed by animals and humans. In this research, an alternative ingredient is selected to animal feeding where black bug or watermelon bug was selected. The scientific name of insect is Coridius viduatus and it was added in the diet of desert lambs in

***Corresponding Author: Mohammed Alhadi Ebahiem,**
1Depatment of Animal Production, Faculty of Natural Resourced and Environmental Studies, University of Kordofan, Sudan.

replacement of sorghum grains and evaluate the effects of this insect on the performance and to find new feed as solutions in production reducing efforts and take advantage of this insect that damages agricultural crops and thus can be incorporated in the animal diets to reduce the cost of feed materials instead of leaving the damage to the crop.

The objectives of the research

This study aimed to remove the obstacles that hinder the development of sustainable productivity based on natural pastures and in particular the purpose of this study is to:

1. To know the effect of adding different levels of the meal of watermelon bugs instead of sorghum grains on feed intake of desert.
2. Effect of adding watermelon bugs meal on the nutrients digestibility.
3. Effect of adding watermelon bug meal on the daily weight gain of the lambs

MATERIALS AND METHODS

Study area

North Kordofan is one of the central states of Sudan and its capital is white and located in the dry and semi-arid region and the main craft of the population is diversified agriculture, where 79% of them depend on agriculture and produce 15 million tons of feed, agricultural residues contribute about 2.9 million tons according to estimates of agricultural planning and statistics livestock sector, 2015, General Directorate of Livestock, Information Center, 2016 (Mahgoub, 2018). Shikan locality is located in the southern part of the state (local projections Shikan Information Center 2017) and includes nine administrations, Kazgil, Umm Semeema, Abu Harraz, Umm al-Qura clan, Baraka, Alouba, Taqat, New Alban, as well as around the city of White. The number of cattle is estimated at 85,375 head according to AAR (2018), and the number of traditional cattle breeders is about 7215 (WSRP, 2018). Elobeid is the largest city in western Sudan and the capital of North Kordofan State. North Kordofan State is located between latitudes 12-40-17-20 North and Longitudes 28.40-32.20. , State of West Kordofan, Northern State, North Darfur State, White Nile State. The state includes six localities Shikan, Umm Rawaba, Rahad, Barra, Sodri, Jabra al-Sheikh and Umm Dam. The most important tribes are Kababish, Jawama, Shuweihat, Badiriya, Darhamid, Masba'at, Kwahleh and Maritime tribes, as well as the Nuba and various South Sudan tribes (FEWS, 2013). According to Salih (2015), the state is generally characterized by its occurrence in the Sahel and can be divided into the following climatic regions:

Experimental animals

The experiment used 15 heads of sheep lambs 6 months old on an average weight of 18kg ±300 grams. The lambs were divided into three homogeneous groups, each with five lambs. The lambs were administered with internal and external parasitic antibiotics and each lamb was housed in a separate barn with a drinking pot and food. The lambs were vaccinated against endemic diseases in the area. An initial weight was carried out before the commencement of the transactions and once a week for sixty days. The first group (the control group) was fed concentrated feed for small ruminants traditionally used at a rate of 500 grams per day with the provision of natural pasture in sufficient quantity throughout the day. The second group was given concentrated fodder containing watermelon bugs instead of corn in the composition, while the third group was left to be fed by natural pasture feed. At the end of the last ten days, manure was collected by attaching a specially designed bag to collect daily manure to estimate feed digestion by total manure collection.

Experimental Feed

The three components of the diets are shown in Table 1. Table 2 shows the chemical composition of the foods used in the diet. The nutritional value of the three diets is given in Table 3.

The Experimental Feed

The experimental ration were formulated using Sorghum grains, watermelon bug mail, wheat bran, limestone, common salt, natural grazing and groundnut seed cake. The first ration contained Sorghum grains, groundnut seed cake, wheat bran, limestone and common Salt at 40, 26, 30, 4 and % respectively without adding watermelon bug meal while natural grazing was offered as basal feed. The second one was similar to the first one expect replacement of sorghum with watermelon bug meal. The third feed was the natural grazing alone. The percent ingredients for the three rations are presented in table (1).

Table 1. percent feed ingredients used in formulation of the experimental rations

Ingredients	Ration I	Ration II	Ration III
Sorghum grains	40	0	0
Watermelon bug mal	0	40	0
Groundnut seed cake	25	25	0
Wheat bran	30	30	0
Limestone	4	4	0
Salt	1	1	0
Natural grazing	-	-	100

The chemical composition of the ingredients used in rations are presented in table was found being in table 2 below.

Table 2. chemical composition of the ingredients used in rations

Ingredients	DM	OM	CP	CF	EE	NFE	ASH
Sorghum grains	92.52	88.77	14.47	2.3	2	2	3.8
Watermelon bug mal	-	-	10.9	-	15.1	-	3.75
Groundnut seed cake	90.52	79.55	33.30	6.5	4.5	1.44	10.97
Wheat bran	90.38	85.38	16.92	12.5	4	0.13	5.4
Limestone	95	-	-	-	-	-	95
Salt	97	-	-	-	-	-	97
Natural grazing	90.84	77.89	8.40	35.13	1.23	19.38	12.95

Table 3. The chemical composition of the rations used in feeding lambs

Nutrients	I	II	III
DM	91.514	92.51	90.84
OM	89.66	81.88	77.89
CP	19.19	17.76	8.40
CF	6.30	5.38	35.13
EE	3.13	8.37	1.23
NFE	62.89	50.37	19.38
ASH	10.65	10.63	12.95

DM: Dry matter OM: Organic matter CP: Crude protein CF: Crude fibre EE: Ether extraction NFE: Nitrogen free extraction ASH: Minerals

Chemical analysis

Chemical analysis of watermelon bug meal, natural pasture and concentrated diets were carried out by approximate analysis according to AOAC (2010). The in vitro digestibility was done by preparing the rumen liquor of slaughtered sheep and placed incubator at 37°C and added samples of feed to estimate its degradability. The procedure is described by Tassone *et al.,* (2020) to study in vitro digestibility of feed samples outside the digestive tract for dry matter as well as digestibility organic matter. Apparent digestibility of nutrients was estimated by total feces collection (Safwat et al., 2015). In This method canvas bags are attached to the rear side of the animal by harness and daily feces output is collected for at least for seven days, dried under shade and sampled , chemically analyzed.

Amount of all ingredients are subtracted from the amount of feed consumed. Digestibility of dry matter for instance is calculated as follows:

$$\text{DM Digestibility} = \frac{\text{Feed consumed- feces voided}}{\text{Feed consumed}}$$

Statistical Analysis

The experiment was designed as complete randomized design according to Seltman (2018). Data on feed intake, nutrients digestibility coefficients and live body weight was analyzed via variance analysis method. Differences among means were detected using Least Significant Difference test (LSD).

RESUTS AND DISCUSSION

Feed Intake as Affected by the Level of Watermelon Bug Meal

Feed intake of lambs as affected by the level of watermelon bug meal in their ration is presented in table (1). The result showed that there have been significant differences (P<0.01) between lamb groups on the natural grazing only and that one fed natural grazing supplemented with a ration formulated using 40% sorghum grains or similar percentage of watermelon bug meal. The animal groups fed the concentrated rations containing sorghum grains or watermelon bug meal consumed amount of feed that was not significantly (P>0.05) different. The total feed intake during the experimental period was for the group on rations I. II and III respectively while weekly feed intake was also respectively daily feed was for the group on natural grazing and supplemented with ration formulated using 40% sorghum grains and similar amount of watermelon bug meal and that on the natural gracing only was respectively.

Table 1. Feed intake of lambs fed watermelon bug meal at varying % in rations

	Weeks							
Groups	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
A	17.600	19.000	19.000	19.000	19.000	19.400	20.000	20.000
B	19.800	19.750	20.250	21.250	23.000	25.000	25.200	26.250
C	19.000	19.000	19.00	19.000	19.000	20.200	20.000	20.400

In vitro Dry Matter and Organic Digestibility

In vitro digestibility of dry matter and organic matter of rations according to the amount of watermelon bug meal is presented in table (2). Ration I that had no water melon bug meal and formulated by adding 40% sorghum grains had DMD 56.45% and DMD at of 59.55% while the second ration with 40% water melon bug meal had 65. 67% dry matter digestibility.

The third ration (natural grazing alone had 51.45% .there were significant (p0<0.1) among coefficients of the three ration where ration had highest DMD value followed by ration I and the lowest %was for ration III .

Organic matter digestibility also followed the same trend where ration II had highest organic matter digestibility followed by ration I and lowest DMD for ration III . In vitro organic matter digestibility coefficients were 59.55, 68.61 and 54.65% for ration I, II and III respectively.

Table 2. In vitro dry matter and organic Matter digestibility of rations as affected level of watermelon bug meal hay

Feed ration	Dry matter	Organic matter	SE+
I	**56.45**	**59.55**	3.44
II	**65.67**	**68.61**	2.16
III	**51.45**	**54.65**	4.32

Nutrients Apparent Digestibility

Nutrient apparent digestibility of the rations as affected by the level of water melon bug meal is shown in table (3) .ration II that was formulated using water melon bug meal at 40% in replacement of sorghum grains had highest dry matter digestibility followed by ration I that was the traditionally formulated ration for feeding small ruminant using sorghum grain and lastly the dry matter digestibility of the natural grazing without supplementation.

The DMD of ration I, II, and III amounted to 50.45, 59.45, and 56.45% respectively.

Organic matter digestibility OMD coefficients were 63.67, 61.48, and 57.58 % for ration II, I and III respectively.

Crude protein digestibility coefficients were 65.45, 63.57 and 57.58% for ration II, I and III respectively.

Significant difference (p≤0.05) were observed among the three ration in this constituents digestibility coefficients .the CPD of the ration with water melon bug meal in place of sorghum grains had the highest digestibility coefficient followed by ration I that had CPD higher than that of the natural grazing.

No significant different (p≥0.05) could be detected in crude fiber digestibility coefficients that could be attributed to inclusion of w m b m in the rations their values amounted to be 56 53 L57 45 and 54 35% respectively for ration I, II and III. The apparent digestibility ether extracts (EED) of ration is also shown in table (3) the coefficients varied from ration to another there the highest EED value was observed in ration formulated with 40% WMBM followed by that ration which contained sorghum grams and lastly the value of EED OF the natural grazing the EED values for the ration that was formulated using 40% sorghum grains, 40% watermelon bug meal and natural grazing only.

Also nitrogen free extract digestibility is presented in table (3). The digestibility coefficients for this fraction varied among the three groups. The group that was fed a ration formulated using sorghum grains and watermelon bug meal were similar in their values i. e. were not significantly (P>o.o5) and they were 68.25 and 69.45% respectively. The natural grazing had significantly lower NFE digestibility coefficients and amounted to 55.15.% Energy values the three rations were 60.73, 55.45 and 35.93 kilogram TDN/ 100 kilogram DM for ration I, II and respectively. The energy intake was 2672.12, 2439.8 and 1580.92 kilo calories respectively. The energy values of the rations and energy intake was significantly different among the three rations.

Table 3. Nutrients digestibility of ration as affected by the level of watermelon bug meal in their ration

Nutrients	I	II	III	SE±
DM	59.45	60.45	56.45	4.43
OM	61.48	63.67	57.58	2.16
CP	63.57	65.45	56.45	4.38
CF	56.53	57.45	54.35	3.59
DEE	65.45	68.67	47.67	3.38
NFE	68.25	69.45	55.15	5.47
Ration TDN	60.73	55.45	35.93.	3.45
Energy intake	2672.12	2439.8	1580.92	

DM: Dry matter. OM: Organic matter. CP: Crude protein. CF: Crude fibre. DEE: Digestible ether extraction NFE: Nitrogen free extraction TDN: Total Digestible Nutrients

General Performance of Lambs on rations with watermelon bug meal

The study used three groups each with five animals for sixty days with initial weight of 18+0.5kg. The final weight of the first group that was fed a ration formulated using sorghum grains as it is the case in the fattening practice followed at feedlots reached to 25.230 kg with a daily increase of 233.5 grams per a day while those fed a ration where sorghum grains were replaced by watermelon bug meal reached to 26.250kg with as daily increase of 254.6 grams per a day. Lastly the group on natural grazing gained only one kg (from 1900kg t o 20kg) or 178.4 g per a day.

Those results had to compare with the amount of dry matter consumed by each group where the intake was 0.786, 0.804 and 0.870g per a day for the group on natural grazing supplemented with a ration with sorghum grain, watermelon bug meal and natural grazing only.

Table (2) summarizes the results of total consumption of lambs fed the rations presented in table (4) During the trial period the three groups each with five lambs totally consumed in the first, second and third groups consumed about 47.160 kg in average per head, 44.1 and 39.06 kg within two months with an average daily consumption of 786, 735 and 651g per head per a day.

Table 4. b General performance of sheep fed on rations with watermelon bug meal

Rations	Groups				
	1	2	3	4	5
A	47.200	45.300	50.400	40.000	42.100
B	48.250	49.000	50.000	47.800	53.100
C	52.200	49.800	55.200	54.200	51.600

DISCUSSION

Effect of Supplementation Rations with of Watermelon Bug Meal on Lambs' Dry Matter Intake

The results showed that the dry matter intake significantly increased when desert sheep lambs were fed natural grazing with a ration formulated where sorghum grains were replaced by watermelon bug meal as source of energy in conventional ration for fattening sheep. This improved dry matter intake could be attributed to improved level of energy and might be also increased and good quality of protein from the bug meal. was higher in the group that dealt with watermelon bugs. Similarly Dessie *et al.,* (2019) reported that supplementation with concentrated two rations and increased (P≤0.001) total DM and organic matter intake than the control treatment of dry season grazing. Overall, supplementation improved (P≤0.001) crude protein intake, digestibility, feed conversion efficiency, BW gain, and profitability compared to the control, whereas sheep on the high than the low and medium level of supplementation performed better in these parameters among the supplemented treatment which reached 65.67% compared to the group on concentrated rations 56.45%.. The increase in the intake of dry matter in the bedbugs group can be justified by the higher percentage of energy and raw protein on the consumed material than in the center. According to McDonald et al. (2002), supplementation leads to faster digestion in ruminants and increased consumption of food and thus leads to a rapid transformation of the substance intake and increase the digestive ratio. While concentrates sometimes lead to a decrease in fiber digestion, but this is significant when these concentrates are high in starch feed such as grains.

Effect of Supplementation with a Ration Containing Watermelon Bug Meal on Nutrients Digestibility

The study showed that the digestibility coefficients of dry matter and organic matter were higher in the ration formulated with replacement of sorghum grains with watermelon bug meal than that of the natural grazing group and lower than in the total group where it reached 65.67% and 56.45% respectively. Also, the digestibility of the organic matter was higher in the group fed a ration containing watermelon bug meal group 68.61% and the group on a ration formulated using sorghum grains to 59.55%. Protein digestibility, nitrogen-free extract, ether extract and crude fiber digestibility coefficients were all increased similarly compared to the group fed natural grazing only. The increased rate of nutrients is attributed to improvement brought about by increased level of protein and energy from supplementation with sorghum ration or watermelon bug meal. Watermelon bug meal. Similarly it was reported by Salem et al. (2015) that the increase in dry matter consumed and increased digestion of nutrients in feed leads to a significant increase in weight and daily gain in lambs when supplemented.

Effect of Supplementation with Watermelon Bugs Ration on Live Body Weight of Lambs

Lambs fed on watermelon bugs ration were better in their weights than that group fed on the sorghum ration and on the natural grazing alone from the beginning of the experiment to the end gained weight less than those group fed natural grazing supplemented with concentrated ration either formulated using sorghum grains or watermelon bug meal. The later groups were the best. The superiority of the group on the supplement with watermelon bug meal might be attributed to good source of energy and more and high quality of protein from insect meal. This is also attributed to increased dry matter intake as result of supplementation with watermelon bugs meal than sorghum and high feed content of nutrient elements, especially energy, crude protein, ether extract, nitrogen-free extract and other sources of energy necessary for growth and fattening. These results confirm that feeding lambs on the diet of watermelon bugs leads to increased dry matter consumed and organic digestion of nutrients and thus gain weight gain in the day is excellent. The overall performance of the experimental animal groups as affected by the level of watermelon bug meal in ration offered has shown that the groups that had no significant differences (P≥0.05) in their initial live body weight there showed significant differences (P≤0.01) among groups according to the type of supplement. The treatment groups and their feedlot performance and live body weight gain has shown that the group on natural grazing consumed smaller amount of feed with lower digestion of nutrient that led to lower weight gains at the end. The final body weight were 0.04, 0.108 and 0166 respectively as

the affects of inclusion of watermelon meal replacement of sorghum grains is sheep rations. Weight gain was better when lambs were supplemented with watermelon meal ration that that of the group of natural grazing alone or supplemented with sorghum grains supplement.

CONCLUSIONS

This study concluded that watermelon bugs meal was found being of high nutrients content from the results of chemical proximate analysis. It was found that the replacement of sorghum grains that are used in the conventional rations by watermelon bug meal led to an increase in feed consumption and improved digestion of nutrients.

All these factors led to a better live weight gain than the concentrated diets in the field of fattening. This is also in concomitant with decreased feeding cost. No detrimental effects were observed though it is argued that this meal might be harmful. Advanced chemical analysis of feed and products are required. This increase is considered a significant increase if we know that the maximum increase of Desert lambs in Sudan is 250 g a day compared with 108g in this study. The lamb can reach the highest weight in a very short period and the low cost of fattening and the speed of the productive cycle in achieving a significant increase compared to concentrates**.**

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