American Journal of Zoology
2025, Vol. 8, No. 3, pp. 66-75
https://doi.org/10.11648/j.ajz.20250803.12

Research Article

Incidence of Disorders Due to Ball Formation in the Stomach of Sheep Grazing Natural Grassland Under Rainfed Conditions of Sudan

Jumaa Buram Jadalla[1], Muna Mahjoub Mohamed Ahmed[2, *]

[1]Faculty of Natural Resources and Environmental Studies, Department of Animal Production, University of Kordofan, West Kordofan, Sudan

[2]Institute of Environmental Studies, University of Khartoum, Khartoum, Sudan

Abstract

This study was carried out in Western Sudan (Kordofan State) with the objective of investigating the causes and degree of infestation of sheep raised on rangelands with ball-shaped bodies (Phytobezoars). Indigenous knowledge among sheep producers on the disorder was also investigated. The data were collected via a questionnaire at six sites. Range inventory, herbarium collection and identification of plant species, diagnosis of animals for ball-shaped bodies by palpation and calculation of % incidence were carried out among herds brought to a central livestock market. Feeding trials were conducted to examine the incidence of sheep with ball-shaped bodies upon ingestion of *Merrimia emarginata* at four stages of growth (before flowering, at flowering, plants with immature pods and at late-maturity stages) and at four levels of feeding in the late mature stage (15, 30, 45%). The physical properties of the balls removed from sheep were studied. The occurrence of incidents as reported by 92.5% of the respondents showed the capability of diagnosing the balls. Sheep arriving at the central market showed incidences that ranged from 0 or 1% of some areas to 56.67% for others. Feeding trials indicated that 2 sheep fed on *Merrimia emarginata* at seed formation and late maturity stages developed 3 balls.

Keywords

Sheep, Phytobezoars Disorder, Rangelands, Sudan

1. Introduction

Animal production is of great importance in Sudan. It accounts for more than 21% of the gross domestic products, GDP, [9]. According to the same source, the sector was reported to grow at a range of 5.6-20.5% per annum compared with 7.3% for the agricultural sector in general [7]. Despite the decline of all sectors' contribution to the GDP of the country due to exploitation and export of petroleum, livestock production retained its vital role as source of food, labor, foreign hard currency, meat and other important means of livelihood for the rural population of western Sudan, in particular. Sheep were estimated at 42.5 million heads [8]. Western Sudan is the home land of the Desert ecotype exported mainly to Saudi Arabia and Gulf countries at relatively high prices. Some rangeland plant species are reported to

*Corresponding author: munamm789@.com (Muna Mahjoub Mohamed Ahmed)

Received: 9 May 2025; **Accepted:** 27 May 2025; **Published:** 13 September 2025

Copyright: © The Author(s), 2025. Published by Science Publishing Group. This is an **Open Access** article, distributed under the terms of the Creative Commons Attribution 4.0 License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

cause bloat, diarrhea, grass tetany and toxicity. In western Sudan, it is observed that sheep grazing plant species at a certain stage developed ball-shaped bodies retained at different parts of the digestive system causing obstruction and death [12]. Complications due to ball formation in the gut of sheep, leading to limited intake and digestibility had never been investigated in Sudan The Objectives of the study are to investigate incidence of ball formation upon ingestion of *Merrimia emarginata* and its correlation with its abundance in rangelands and stage of maturity responsible for ball formation. The physical and chemical characteristics of the balls and their relation to their site of formation in the gastrointestinal tract was also examined. Feeding trials were conducted to study performance sheep *fed Merrimia emarginata* at different stages of maturity or included within a concentrate diet.

2. Materials and Methods

2.1. The Study Area

This study was conducted in the western Sudan (West Kordofan State, latitude 27 °29ˈEast, Longitude 14 °20ˈ North). The State extends from semi-desert on sand in the north to low rainfall savanna on sand and clay in its central parts, with limited clay plains in the south. The south-eastern part is within hill catena of the Nuba Mountains. The main vegetation forms on sand in west Kordofan are: *Leptadenia pyrotechnica*, *Calotropis procera*, and *Acacia raddiana*. The sandy low rainfall Savanna dominant grasses herbs, shrubs and tree are *Qeuiera senegalensis*, *Boscia senegalensis*, *Leptadenia pyrotechnic*, *Acacia Senegal*, *Ziziphus spinachristi*, *Fedherbia albida*, *Adansonia digiata*, *Tamarindus indicus*, *Sclerocarya birrea*, *Combretum cordofanum*, *Balanites aegyptiaca*, *Cenchrus biflorus*, and *Eragrostis tremula*. The last two are grasses that are continuously grazed on the sandy soils. Moderately grazed or protected areas have the following grass species: *Andropogon gayanus*, *Chloris gayana*, *Dactyloctenuim aegyptuim*, and *Baracharia spp* [10, 11]. The main activities in the area are livestock raising and cultivation where each village represents an agro-pastoral community. Groundnuts, sesame, Roselle, watermelon, sorghum and pearl millet are grown as food and cash crops. Sheep, goats, camels and cattle are the main animal species raised. Local merchants and exporters and their agents gather on fixed days in the designated market places where animals are brought for sale. Sheep are the main animals offered for sale [2].

2.1.1. Questionnaire and Data Collection

A questionnaire was designed to cover certain issues concerning producers characteristics, source of animals owned, herd size, source of animal feed, migration routes, persons responsible for herding animals, methods of diagnosis of the suspected animals, treatment and prevention methods, number of infected animals, mortality due to the incidence and ways adopted for getting rid of the animals carrying balls. 202 sheep producers responded from the six selected villages. Percent respondents for each village, occupation and activities are shown in Table 1.

Table 1. *Percent respondents from the six villages selected, educational level, marital status and occupation in the area of study (n=202).*

Site	**%**
Gheibaish.	30.2
Ennuhud	25.2
AbuZabad	14.9
Alkhuwei	9.9
Saata	9.9
Alkhamas	9.9
Educational level	
Illiterate	32.2
Primary.	27.2
Intermediate	27.2
Secondary	11.4
Above secondary	1.5
Marital Status of the respondents	
Married	94.6
Single	3.5
Divorced	0.5
Widowed	0.5
Did not specify	1.5
Occupation	
Farmers	23.8
Shepherds	18.8
Shepherds/herders	16.3
Herders	11.9
Employees	9.9
Craftsmen	7.9
Looking after herd	%
Hired labors	70.3
The owner himself	18.8
A relative	9.4
Left to scavenge all the day	1
Tethered	0.5

2.1.2. Rang Inventory

Range inventory was carried out at six villages within the study area on rangelands where *M. emarginata* grows naturally. Range inventory included determination of frequency (defined as occurrence and non-occurrence of plants species observed on the rangeland covered by the inventory), density (defined as number of plants of each species observed per unit area (plant species per hectare, square kilometer, square mile) and composition (as the percentage of each plant species relative to other plants). Other parameters studied were dominance (percent of cover of *M. emarginata* to percent total vegetation cover), abundance and scarcity of species, (counting the number of individual plant of *M. emarginata*) observed. The collected samples were classified on the basis of general plant morphology and flower forms and color as well as seed size shape and color according to [5].

2.1.3. Chemical Composition and in Vitro Digestibility of the Plant Species (*M. emarginata* 2) Causing Ball Formation

Chemical composition of *M. emarginata* at four physiological stages (before flowering, at flowering, with immature pods and at full maturity) were determined as outlined by the Association of Official Agricultural Chemists [3] whereas the neutral detergent fiber and acid detergent lignin were determined according to [9]. The in vitro dry matter and organic matter digestibilities were determined according to the method described by [19].

2.1.4. Balls' Physical and Chemical Characteristics

Randomly selected animals from each village were used for the determination of the degree of incidence of sheep with balls in the study area. Diagnosis was done by rectal palpation for a total of 662 sheep. Then ten sheep from each village were slaughtered and the balls recovered were studied for their physical characteristics: number of balls per animal, size, weight, density and site of formation within the digestive tract. The chemical characteristics of the balls were done according to the AOAC (1998). Degradability of balls was tested by soaking in distilled water for 24 hours in autoclaved containers kept in an oven at 37 ℃. Then from the partially disintegrated material, fibers type and length were determined.

2.1.5. Feeding Trials

In a completely randomized design, 55 desert ecotype (Hamari) rams were used in two feeding trials. They aged between 1 to 2 years with average weights ranging from 30 to 40 kg at the beginning of the trial. Animals were weighed, ear-tagged, vaccinated, drenched with iverimectin, broad spectrum anthelmintic against endo and ecto- parasites.

(i). Feeding Trial I

This trial was carried out with the purpose of investigating the dry matter intake and live body weight change in the rams given *Merrimia emarginata* at four physiological stages, (before flowering, at flowering, with immature pods and at full maturity). The animals were divided into 5 equal groups of 6, each of the four group randomly given one of the physiological *Merrimia emarginata* stages while the fifth was considered as a control and was give a diet free of *Merrimia emarginata*. The experiment lasted for 70 days preceded by 10 days adaptation period.

(ii). Feeding Trial II

Trial II was carried out to examine the effect of ingestion of fully mature *M. emarginata*, included in a ration at four percentages (0, 15, 30 and 45%). 30 rams divided into equal groups of 5 were randomly allocated to a concentrate diet containing the different percentages of *M. emarginata*, at maturity stages as mentioned above, the experimental procedures were same as above.

2.2. Statistical Analysis

Data collected from the questionnaire were analyzed using the computer program of SPSS (The Statistical Package for Social Sciences, Microsoft computer software, 1976). Analysis of variance of means was performed according to [16]. Means were compared for significant differences according to [6] multiple range test. Simple correlation coefficients between incidence of sheep infected with balls and frequency or density of *M. emarginata* in the range were computed. χ^2 was used to compare between number of hired shepherd or number of occupation sheep owners and frequency of density of *M. emarginata* [17].

3. Results

3.1. Respondents' Characteristics

The total number of respondents was 202 from the six selected villages. Their percentage contribution varied as shown in Table 2. Most were illiterate, received primary and intermediate education. Most were married and involved in farming activities followed by those involved in animal herding or as shepherds. Table 3 shows the sources of animals and feeds offered in the area of study. Inheritance or purchased animals constituted the main source of sheep owned by the respondents, while the natural grazing or natural grazing supplemented by crop residues constituted the main source of feed for the animals in the area of study. Different animal husbandry systems were adopted, most (70.3%) of the animals owners hired laborers to look after their animals, while others would look after their animals by themselves (18.8%) or resorted to their relatives (9.4%) (Table 4). Feeding systems adopted showed that most animals were allowed to graze naturally and either supplemented with rations

(38.6%) or crop residues (38.1%). Natural grazing alone represented 16.8% while supplementation with groundnut haulms represented 5%. Giving rations or rations with crop residues represented smaller percentages (0.5%). These rations are usually a mixture of two or three of the above mentioned ingredients but their percentages are never fixed. Diagnosis of sheep suspected to carry the balls was done either by the owner (83.2%), with help of experienced persons (2%) or with the assistance from a responsible veterinarian (14.4%). Diagnosis was done mostly by palpation (62.4%), general appearance, veterinarian or experienced persons. The majority (71.8%) believed that the ball could not be treated easily and could not rely on any of the known methods, others would resort to surgery for removal of the ball, and still others would use laxative materials such as natron salt and oil. Prevention of incidence was over-viewed by most (82.5%) respondents by restraining sheep from grazing *M. emarginata* but would not specify which stage of the plant growth. Others held some other plant species and water melon responsible for the cause of the disorder. A small percentage had no idea about the methods of avoidance (Table 5). Incidence of the disorder in sheep brought to a central market from different rural areas during 2004 – 2005 or that belonged to respondents (Table 6) showed various intensities of occurrence. It could be seen that the highest incidence were observed in Enhud village in sheep brought to the market and that belonged to respondents coming from the same area. Percent incidence of balls in sheep that belonged to the respondents at west Kordofan State showed the highest percent diagnosed was from Alrowyana (56.67%) (Table 7).

Table 2. *Sources of animals and feeds offered to sheep in West Kordofan State.*

Sources of animals	**%**
Inherited + purchased	44.1
Purchased	43.7
Inherited	11.9
From hired labor	7.9
Inheritance+ purchase + hired labor	1.5
Sources of feed:	
Natural grazing + rations	38.6
natural grazing +Crop residues	38.1
Natural grazing	16.8
Natural grazing + Groundnut Haulms	5.0
Crop residues	1.0
Rations	0.5
Groundnut Haulms alone	0.0
Sources of animals	**%**
Supplements	%
Salt+ seedcake+ sorghum+ Roselle seeds	28.7
Roselle seeds	24.8
Salt	21.8
Seedcake +Sorghum+ Roselle seeds	9.9
Salt+ Roselle seeds	5.0
Sorghum	1.0
Salt+ Sorghum	2.5
Seedcake+ Roselle seeds	2.0
Seedcake+ Sorghum	2.0
Salt+ Seedcake	1.5
Sorghum+ Roselle seeds	1.0
Seedcake alone	0.0

Table 3. *Persons who were reported by the respondents to diagnose sheep with incidence of ball-shaped bodies, methods of treatment and avoidance in West Kordofan state.*

Persons responsible for diagnose	**%**
The owner	83.2
Veterinary officer	14.4
Assistance from experienced (Basseer)	2.0
Didn't Know	0.5
Method of diagnosis	%
Palpation and from appearance	62.4
By the help of veterinary officials	19.3
From general appearance of the animal	14.4
With assistance from a local experienced person	2.0
By palpation	1.5
Did not know	0.5
Treatment method	%
did not know treatment method	71.8
Surgery	12.4
Didn't Know the incidence	10.4
Atron (Bicarbonates)	3.0
Common salt	1.5
Methods of avoidance	%
Avoidance of grazing *Merrimia emarginata*	82.5
Ignorant	4.5

Persons responsible for diagnose	%
Avoidance of grazing *Calotropis procera*	3.5
Had no experience	3.0
Avoidance of grazing both *M. emarginata*, *C. procera* and watermelon	3.0
Avoidance of feeding watermelon and *M. emarginata*	2.5
Avoidance of plastic bags ingestion	1.0

Table 4. *Percent incidence of balls in sheep brought from different areas of West Kordofan to a central market.*

			% incidence	
Sites	**No diagnosed**	**No of animal with balls**	**Per diagnosed**	**Per herd**
Ennuhud	96	43	58.76	40.80
Alkhuwei	189	56	30.11	90.84
Abuzabad	79	23	29.11	50.4
Gheibaish	179	57	28.93	60.31
Alkhamas	45	12	26.67	20.84
Saatat	56	9	16.07	1.71
	total = 644	average = 20	average =30.21	average =50.3

Table 5. *Percent incidence of balls in sheep that belonged to the respondents at west Kordofan State.*

Site	Animals diagnosed	Incidence %
Alrowyana	300	56.67
Gheibaish	500	16.66
Alkhamas	550	14.55
Alkhuwei	110	9.1
Ennuhud	490	6.25
Abuzabad	450	2.5
AlMujlad	200	0
Babanusa	150	0
Alfula	100	0

3.2. Correlations Between Balls Incidence, Predominance *Merrimia emarginata* in the 14 Rangeland and Some Respondents' Characteristics

Correlations between balls incidence, predominance *Merrimia emarginata* in the rangeland and some respondents' characteristics are shown in Table 6. The correlation was highly significant ($P < 0.01$) between the incidence of sheep with balls and frequency and density of *Merrimia emarginata* on the sites surveyed. There was also a high ($P < 0.01$) correlation between incidence of sheep carrying the balls and hired shepherds ($P < 0.01$) as well as with the type of occupation of the owner ($P < 0.05$).

Table 6. *Correlation between Incidence of Sheep with balls on rangelands of West* Kordofan *state and some Parameters studied.*

Parameters	Correlation Coefficients (r)	R^2
Frequency of Merrimia emarginata	0.773**	0.59
Density of *Merrrimia emarginata*	0.831**	0.69

Parameters	Correlation Coefficients (r)	R^2
		χ^2
Hired shepherds (n = 142)	Frequency of *M. emarginata* (22.6%)	0.77**
	Density of *M. emarginata* (n = 60846)	0.42**
Occupation of sheep owner (n = 60)	Frequency of *M. emarginata* (22.6%)	3.5*
	Density of *M. emarginata* (n = 60846)	7.09*

*Significant (P<0.05), ** Highly significant (P <0.01).

3.3. Chemical Analysis and Digestibility of *Merrimia emarginata*

The chemical analysis of *M. emarginata* at different physiological stages as well as in vitro dry matter and organic matter digestibility are shown in Table 7. Generally, except for the NFE, nutrient contents of the plant species increased significantly (P <0.01) with the advancement of maturity, although no significant difference was detected for organic matter (OM) between flowering and full maturity. Ash content was the highest (P <0.01) in the plant carrying immature pods and the lowest (P <0.01) before flowering. In vitro digestibility was generally decreased (P <0.01) with the advancement of maturity, although organic matter digestibility was the highest (P <0.01) at flowering. The addition of different percentages of the plant at full maturity to a concentrate diet, did not affect the nutrient contents of the final ration (Table 8, Figure 1).

Table 7. *Chemical composition (% dry matter basis) and digestibility of Merrimia emarginata at four stages of maturity used in feeding trial I.*

Stage of maturity	DM (%)	OM (%)	CP (%)	CF (%)	NFE (%)	EE (%)	ASH (%)
Before flowering	91.25	79.43	6.11	18.12	52.51	2.92	11.62
At flowering	93.21	84.42	6.42	21.31	48.63	2.84	7.94
With immature pods	93.21	77.23	7.11	22.62	49.39	3.52	15.63
At full maturity	95.81	84.32	8.51	24.61	49.24	3.91	11.65

Digestibility		
Stage of maturity	**In vitro dry matter digestibility (IVDMD)**	**In vitro organic matter digestibility (IVOMD)**
Before flowering	66.7	76.8
At flowering	69.5	77.2
With immature pods	45.5	64.1
At late maturity	43.5	44.6
±SE	4.32**	6.53**

NS: not significant
** Highly significant at P< 0.01

Table 8. Chemical composition (% dry matter basis) of the rations used in feeding trial II.

Percent of *M. emarginata* (late maturity) added to concentrate diet*	Dry matter	Organic matter	Crude protein	Crude fiber	Nitrogen Free extract	Ether extract	ASH
0	87.29	77.30	17.05	14.68	45.26	3.48	9.99
15	88.67	81.06	15.77	16.17	45.85	3.54	7.61
30	89.84	79.84	14.49	17.72	49.11	3.17	10.47
45	91.12	80.41	14.27	19.14	47.04	3.67	10.71

Ingredients: 30% sorghum grain, 20% groundnut cake, 45% groundnut haulms, 2% oyster, 3% common salt

Figure 1. Merrimia emaraginata with flowers and immature pods, stage of growth proved cable of initiating balls in sheep.

3.4. Chemical and Physical Analyses of the Balls Removed from Different Sites of the Digestive Tract

Chemical composition of the balls removed from different sites of the digestive tract, showed that the rumen, except for CP and NFE, had the highest (P <0.01) nutrient content, followed by the reticulum and omasum. However, significant differences could not be detected for both DM and OM between the rumen and reticulum. NFE decreased significantly (P <0.01) and progressively from the omasum to reticulum and rumen. The physical characteristics of the balls showed that weight and volume decreased significantly (P <0.01) and progressively from the rumen to reticulum and omasum. However, balls' density was the lowest (P <0.01) in those removed from the reticulum. Fiber length of the balls did not vary with their site in the digestive tract (Table 9). Also balls soaked in distilled water showed little solubility (Figure 2).

Table 9. Chemical composition (% dry matter basis) and Physical properties of the balls removed at different sites of the digestive tract.

Chemical properties									
Site	**DM (%)**	**OM (%)**	**CP (%)**	**CF (%)**	**EE (%)**	**NFE (%)**	**ASH (%)**	**NDF (%)**	**ADF (%)**
Rumen	89.32	78.56	5.23	30.55	1.03	34	11	67	34
Reticulum	87.21	78.13	7.12	25.53	1.12	37	9	54	31
Omasum	81.39	75.23	7.56	21.45	1.01	46	6	55	32

Physical properties				
Fiber length (mm)	**Density**	**Volume (cm)**	**Weight (g)**	
1.56	0.44	192.4	76.8	Rumen
1.25	0.3	42.2	16.33	Reticulum
1.25	0.43	24.3	10.4	Omasum

Physical properties				
Fiber length (mm)	**Density**	**Volume (cm)**	**Weight (g)**	
NS	0.03	0.32	0.12**	±SE

NS: not significant
** highly significant at P< 0.01
DM=dry matter; OM=organic matter;CP=crude protein
CF=crude fiber; NFE=nitrogen free extract;EE =ether extract

Figure 2. *Balls removed from the rumen soaked in water, showing little solubility.*

3.5. Feeding Trials

In feeding trial I, where the rams were fed *M. emarginata* at different physiological stages, DMI decreased significantly (P <0.01) and progressively with the advancement of the plant age. A similar trend was observed for the final body weight and live weight change, although significant differences could be detected when the rams were fed the plant carrying immature pods or the fully mature stage. On the other hand, the number of balls removed from rams in full stage were higher (P <0.01) than those on plants carrying the immature pods (Table 10). Inclusion of the fully mature stage at different percentages in a concentrate diet (feeding trial II), showed that DMI and final body weight decreased significantly (P <0.01) at both 30 and 45% inclusions. The decrease in live weight was higher (P <0.01) in rams on 30% than 45% inclusion of the plant at late maturity. As in trial I balls were also removed from rams at the 30 and 45% but no significant differences could be detected (Table 11).

Table 10. *The effects of feeding sheep Merrimia emarginata at different physiological stages (trial I).*

Feeding trial I						
Physiological stages of *M. emarginata* (feeding trial I)						
	Control*	**Before flowering**	**flowering**	**With immature pods**	**Late maturity**	**±SE**
No of animals	6	6	6	6	6	
Experiment period (days)	61	61	61	61	61	
Initial weight (kg)	31.94	32.09	31.48	31.3	31.38	1.44 NS
final Weight (kg)	35.41	35.75	43.11	25.87	25.79	0.56**
dry matter intake g/day	828	834	802	676	532	0.72**
Live weight change g/day	56.86	51.5	41.11	93.934^{C}	91.639^{C}	0.0015**
Feed conversion ratio	14.562	16.194	19.508	_	_	1.72NS
No of balls/ sheep	0	0	0	3	5	0.60**

Table 11. *Inclusion of same plant at different percentages in a concentrate diet (trial II) on dry matter intake, live weight change and feed conversion ratio.*

Feeding trial II					
	Percent inclusion of *M. emarginata* in a concentrate diet				
	0%	**15%**	**30%**	**45%**	**±SE**
No of animals	5	5	5	5	
Experiment period (days)	70	70	70	70	
Dry matter intake (g/day)	955	975	650	676	0.053**
Initial weight (kg)	34.5	33.75	34.25	34.3	0.755NS
final Weight (kg)	40.467	40.155	29.613	30.783	0.020**
Live weight change (g/day)	85.25	91.5	-66.25	-50.25	0.0010**
Feed conversion ration	8.925	9.384	_	_	
No. of balls/sheep			4	3	

NS: not significant
** highly significant (P< 0.01)
*Fed *Eragrostis tremula* at dough stage

4. Discussion

The majority of the respondents were aware of the plant species that would cause the formation of the balls and diagnosis was mostly done by the owners, but they were mostly ignorant of the methods of treatment. As most of the sheep were either inherited or purchased, control of ball formation was very difficult. This condition was further exacerbated by leaving the animals to shepherds who were poorly paid and so less keen to retrain animals from grazing plant species at certain stage of maturity responsible for the disorder. Strong correlations were obtained between sheep disorders and number of hired shepherds. Also there were strong correlations between frequency and density of *Merrimia emarginata* carrying immature pods or at late maturity. A similar correlation was obtained between ball formation and change in plant composition due to long term climatic changes and human factors such as overgrazing, illicit cutting of trees, over exploitation of underground water and bush fire [1]. Phytobezores (balls formed from plant origin) formation due to ingestion of certain materials was also observed by several workers; [14] observed phytobezores in a series of in vitro studies of sheep eating mature flowers or seeds of Karoo bushes. Also in vivo trials with sheep eating papus hair or seeds of certain plant species developed phytobezores [4]. Other plants material that were observed to cause the incidence were pasque flowers covered with fibrous hairs [18], and fruits that contained water soluble tannin [13]. It was shown in this study that the balls had very little solubility in water causing obstruction of the digesta through the alimentary tract leading to death. Similar observations were obtained in horses where the balls caused ulcers and rupture of the stomach [13] as well as obstruction of the esophagus in cattle [15]. In this study, feed intake and digestibility were greatly reduced in sheep ingesting the mature stages of the plant this had led to significant decreases in body weights.

Chemical composition of *Merrimia emarginata* at different phonological stages, showed that most of the nutrient contents increased with the increase with advancement of the plant maturity. Although there was an increase in crude protein content, in vitro of both dry matter and organic matter decreased which could be related to the increase of crude fiber content of the plant at early and mature pod formation.

Chemical composition of the balls could be to some extent related to site of their formation in alimentary tract plant, where the crude protein contents of the balls formed in the rumen were higher than those formed elsewhere, while the crude fiber contents decreased. The physical properties of the ball could be correlated with its site of formation, larger ball with heavier weight, volume and density were removed from the rumen compared with those removed from the reticulum, with the omasum showing the smallest sizes. However, fiber length was not affected by the physical characteristics of the balls. Incidence of ball formation could be correlated with high density and abundance of the plant at late stages of maturity during the dry season when range forages deteriorate. To assist in early diagnosis of incidence of ball formation veterinary services should be delivered to area where veterinary officers can help in treatment of infected animals without

resolving to surgery which is costly. Range management policies should be established especially during the dry season where more fodder plant are made available to livestock grazers. Shepherds should be well paid to keep animals away from grazing *Merrimia emarginata* at late stage of maturity.

It could be concluded that enormous economical losses due to ball formation is now facing sheep producers. Serious steps from the government should be taken to minimize such losses as sheep contribute largely to the domestic gross product.

Abbreviations

GDP	Gross Domestic Product
DM	Dry Matter
OM	Organic Matter
CP	Crude Protein
CF	Crude Fiber
EE	Ether Extract
NFE	Nitrogen Free Extract

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Alhindi F A (2004). Phytobezoars in Sheep on Syrian pastures. In: Caprine and Bovine Journal of the Middle East 10th year No. 47. October-December 2004. Middle East Publishers.

[2] Ali M (2002). Body measurements, performance and meat characteristics of the desert sheep. Ph D. Thesis. Faculty of Agricultural Sciences, University Of Gezira, Sudan.

[3] AOAC (1998) Official Method of Analysis. 15th Edition, Association of Official Analytical Chemists, Washington DC.

[4] Bath GF, Botha P, Vorster HJ, Cross RH (1982). Physical structure and chemical composition of abomasal phytobezoars of goats and sheep. Department of Theriogenology, Faculty of Veterinary Science, University of Pretoria, Onderstepoort, Rep. South Afr.

[5] Braun M, Burgstaller H, Hamdoun AM, Walter H (1991). Common Weeds of central Sudan. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), GmbH, 1991, Eschborn, Fed. Rep. of Germany.

[6] Duncan B D (1955). Multiple range and multiple F tests. Biometerics 11: 1-42.

[7] Federal Ministry of Finance and National Economy (2002). The Annual report, Khartoum, Sudan.

[8] FAO, Food and Agriculture Organization (1999). Production Year book. Statistical series. vol. 53, No. 156, Rome, Italy.

[9] Goering HK and Van Soest, PJ (1970). Forage fiber analysis (apparatus, procedures and some applications). USD ARS hand Book No. 379. USDA.

[10] Harrison N M and Jackson J K (1958). The Ecological Classification of the vegetation of the Sudan. Bull. Forestry Department N. S. NO. 2, 15.

[11] Jadalla JB (1995). The effects of supplementation of the dry season grazing with groundnut haulms on nutrients utilization and sheep performance. M.sc. thesis. Faculty of Animal Production U. of K.

[12] Mahmoud T (2000). Constrains to Gum Arabic Production and Marketing in Sudan. Ph.D. thesis. Dresden, Germany.

[13] Morgan SE and Bellamy J (1994). Persimmon colic in a mare. Equine Practice, 16: 8-10.

[14] Njau BC, Kasali OB, Scholtens, RG (1988). Abomasal impaction associated with anorexia and mortality in lambs. Vet. Res. Commun. 12(6): 491-5. International Livestock Centre for Africa, Addis Ababa, Ethiopia.

[15] Raosstits OM, Gay CC, Blood DC, Hinchcliff KW (2000). Esophageal Obstruction In: veterinary medicine. 9th Ed. W. B. Saunders. Pp. 193-197.

[16] Senecedor GW and Cochran WG (1982). Statistical Methods. Iowa State University Pres Ames USA.

[17] Steel RGD and Torrie JH 1980. Principles and Procedures of Statistics. A Biometrical approach. McGraw-Hall Co., New York, USA. 633pp.

[18] Tabosa IM, Souza IC, Graca DL (2000). Neuronal vacudation of the trigeminalnuclei in goats caused by ingestion of *Prosopis juliflora* pods (mesquite beans). Vet Hum Toxicol, 2000; 42: 155-158.

[19] Telly JMA and Terry RAA (1963). Two- Stage Technique for the in vitro Digestion of Forage crops. J. of the Brt. Grassland Society 18-104. abomasotomy to remove an unusual number of trichobezoars in a goat. *Indian Vet. J.* 77(4): 332-333.