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Comparison of Supplementing Urea-Molasses Blockand Urea-Atela Blocks on Feed Intake and Digestibility of Male Blackhead Ogaden Sheep Fed Natural Pasture Hay

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Abstract
The experiment consisted of ninety days of feeding trial and seven days of digestibility trial at the end of the experiment with the objectives of the study were: (a) to evaluate the effect of supplementation with urea molasses block and urea-atela blocks on feed intake (b) digestibility of male black head ogaden sheep fed natural pasture hay (c) the physical and nutritional quality of the feed blocks and the economic feasibility of supplementing block made from molasses versus block made from atela were also compared. the treatments consisted feeding of urea-molasses block ad libitum (50% of molasses: 23% wheat bran: 9% urea: 12% cement: 6% salt, T1), urea-atela block adlibitum (30% atela: 43% wheat bran: 9% urea: 12% cement: 6% salt, T2), urea-atela block ad libitum (40% atela: 33% wheat bran: 9% urea: 12% cement: 6% salt, T3) urea-atela block ad libitum (50% atela:23% wheat bran:9% urea:12% cement :6% salt, T4). Two kg block per week per head was given to each experimental animal.Supplementation with urea-atela block, consisting higher amount of wheat bran (T2) had significantly ($P<0.001$) higher nutrient intakes ($CP=104.2 \pm 3.2$) than Urea-molasses block. Supplementation with T2 diet has also significantly ($P<0.001$) higher apparent digestibility of DM (69 ± 0.007), OM (63.2 ± 0.007) and CP (82.2 ± 0.01) than urea-molasses block.
Keywords: black head ogaden sheep, digestibility, feed intake, urea-atela block, urea-molasses block

Introduction

Ethiopia has huge populations of sheep, which are used as source of food, hair (wool), manure and the short generation interval; the ability to give multiple births and their smaller size make them adaptable to smallholder and mixed crop livestock production systems, whereby they contribute up to 22-63% of cash income (FAO, 2004).

However, productivity of sheep is very low and mortality rate is very high particularly in the remote area such as pastoralists and agro-pastoralists. One of the major causes of low productivity and death of animals is scarcity of feed. Livestock feeding in most part of Ethiopia is based almost entirely on fibrous feeds such as native pastures and crop residues, the quality and quantity of which is subject to great seasonal variation (ILCA, 1988).

Supplementation with urea-atela or urea- molasses blocks can increase digestibility of fibrous feeds, the nutrients the animal receives, and feed intake and provide opportunity to sustain body weight of animals during the dry period and under harsh environment when access to conventional sources of supplements are difficult. Blocks are a convenient way to make, store, transport and feed to animals. They can easily be made and used in villages. A person may make and sell blocks to farmers as a source of income. Since molasses is intensively used for production of ethanol, availability of molasses as animal feed and molasses based block preparation in the future is of great concern. Therefore, it is important to look for other alternatives, such as atela. Urea-atela block has also the potential of increasing viability of livestock production, increasing dry season body weight gain and enhancing household income, particularly during drought in pastoral and agro-pastoral areas as compared to other sources of supplements. Supplementation of atela to sheep fed a basal diet of hay with atela improved feed intake, body weight change, digestibility and carcass characteristics (Yoseph, 1999).

Urea-atela block technology is a cost effective approach to maximize the utilization of locally available feed resources for better animal productivity during the dry season and may perhaps constitute an innovative feeding strategy for other species of livestock as well, where concentrate feeding is not a common feature, particularly in remote area, such as pastoralists and agro-pastoralists. But urea-atela block is currently not effectively utilized by small holder farmers for feeding to animal, mainly due to lack of information and experience about their potential as supplement to small ruminant. Accordingly, the objectives of this study were: (a) to evaluate feed intake and digestibility of male blackhead ogaden sheep fed natural pasture hay supplemented with urea-molasses block and urea-atela block (b) to assess the economics of supplementing block made from molasses versus atela (c) to compare the physical and nutritional quality of blocks prepared from molasses and atela.

Materials and methods

Description of the study area

The experiment was conducted at Haramaya-University. The university is located 515 km east of Addis Ababa at 9^o N and 42^o E. The site is situated at 1950 m above sea level and has a mean annual rainfall of 790 mm and a mean annual temperature of 16 ^oC (Mishira *et al*., 2004).

Experimental animals and management

Twenty four yearling intact male Blackhead Ogaden sheep with initial live weight of 12.79 ± 1.4 (mean ±SD) were purchased from Babile. The age of the animal were determined by dentition. The animals were quarantined for 21 days and during this period all sheep were ear tagged for identification. The sheep were dewormed and sprayed against internal (flat and round worms) and external (tick and mange mite) parasites, and they were vaccinated against common diseases like pasturolosis, anthrax and blackleg based on the recommendation of the veterinarian at the end of the quarantine period. Then all sheep were placed in to individual pen and offered the basal diet and supplemented with urea-molasses block and urea-atela blocks according to the treatment for another 15 days to adapt the animal to the feed and experiment procedure prior to the beginning of the actual data collection.

Experimental design and treatments

The design of the experiment was randomized complete block design (RCBD). The experimental sheep were grouped in to six blocks with four male sheep in each block based on the initial body weight. The four treatment diets were randomly assigned to sheep in each block, which resulted in to six animals per treatment and the animal within a block had equal chance to receive one of the treatment diets.
The treatments were:
T1= Urea-molasses block *ad libitum* (50% of Molasses: 23% Wheat bran: 9% Urea: 12% Cement: 6% Salt).
T2= urea-atela block *ad libitum* (30% Atela: 43% Wheat bran: 9% Urea: 12% Cement: 6% Salt).
T3= urea-atela block *ad libitum* (40% Atela: 33% Wheat bran: 9% Urea: 12% Cement: 6% Salt).
T4= urea-atela block *ad libitum* (50% Atela: 23% Wheat bran: 9% Urea: 12% Cement: 6% Salt).
Urea-atela blocks were made by varying the proportion of atela to wheat bran, other ingredients being constant.

Experimental feed preparation, block physical quality and feeding

Procedure of block preparation

The procedure for preparing the blocks required the following steps.
1. Equipment was used. Simple blocket (mould) making equipment can be used for making blocks. In preparing the blocks used in the present experiment, we constructed the block maker from metal sheet, which was designed and made at Guarage.
2. Atela and urea were mixed in the same container (step-1).
3. Cement, salt and water (40ml per 2kg block) were mixed in a separate container (step2).
4. The mixture in step-1 was mixed with the solution in step-2 and stirred by hand until the ingredients are fully dissolved and mixed = (step 3)
5. Wheat bran was added to the solution in step-3 and thoroughly mixed (step 4).
6. Then the mixture was put in to rectangular mould by several pressing (step 5).
7. The pressed block was removed and put on plastic sheet spread on floor in the house and left to mature/harden for 2 days (step 6), after which it was fed to the animals. The block weighed about 2 kg.

Color and hardnes of the block

The color of the block was assessed by necked eye, and hardness of the block was estimated by pressing the block with finger or by inserting sharp object in to the block.

Feeding of hay and block

Hay purchased from Haramaya University dairy farm was used as basal diet throughout the experimental period. Wheat bran was purchased from Dire-Dawa food complex. Atela, urea, salt and cement were purchased from Harar. Atela was purchased from four tella houses in Harar throughout the experiment. According to the information obtained from producers the tella was made from mixtures of maize, sorghum, wheat and barley, the first two ingredients making the largest proportion in all tella houses. Fresh atela was transported every five days and immediately used for preparation of the block to prevent further fermentation. The block was stored for two days in door before it was given to animals to achieve sufficient strength, so as to prevent animals from breaking the block when they lick. Then the whole block was weighed and offered to individual animal in a separate trough for *ad libitum* consumption. The block was licked by the animal for 7 successive days, after that the block was removed and weighed, and a fresh block was given to the animal. Weight of the block was taken every morning throughout the experiment to calculate daily block consumption by the animal. Hay was offered to animal *ad libitum,* common salt lick and water were available all the time to the animal.

Blocks were introduced to animals slowly and fed after animals have consumed adequate forage. That is, the block was given one hour after hay. This prevents animals from consuming too much at any one time. During the first week of adaptation, animals get access to block for only one hour, and for two hours during the second week followed by free access throughout the feeding trial. Since some animals refused eating the blocks, they were forced urea-atela block to eat by limiting access to other feeds. By doing so, all animals get accustomed to eat the block.

Palatability of blocks

Palatability of block was assessed by observing the level of acceptability of the block by the animal. That means animals consume more if the block is palatable, but animals reject if the block is unpalatable.

Duration of block remained consumable

Duration of block remained consumable was identified by observing consumable of the block. That means animals refused licking after the block was dried and lick too match before it was dried.

Measurements and observations

Feed intake

Hay offer and refusal were collected and weighed daily to determine daily feed intake. Block offer was weighed daily to determine daily intake, and the amount of block remained was measured weekly at removal. The daily samples of feed offered per feed and refusal per animal were collected, bulked and sub samples were taken after mixed for determination of nutrient composition. Samples of ort for individual animal during digestion trial was separately collected, weighed and pooled by treatment for chemical analysis.

Digestibility

Digestibility experiment was carried out, after the completion of ninety days feeding trial. After adjustment period of three days to carrying of the fecal collection bag, feces was collected for seven days and each days collection of feces per animal was weighed and 20% was sub-sampled and stored frozen at -20 ^{0}C. At the end of the collection period, the composite samples were thawed to room temperature, mixed thoroughly, sub-sampled and dried at 55 ^{0}C to a constant weight. The dried samples of the feces was ground through 1 mm sieve and stored in airtight polyethylene bag until analyzed. The digestion coefficient (DC) was calculated as follows;

$$DC = \frac{\text{Total amount of nutrients in feed} - \text{Total amount of nutrients in feces}}{\text{Total amount of nutrients in feed}}$$

Chemical analysis

Chemical analysis of the offered and refused feeds in the experiment as well as feces were subjected to laboratory determination of DM, OM, N and ash following the procedure of AOAC (1990). The ADF, NDF and ADL component of each ingredient and feces was also determined according to the procedure described by Van Soest and Robertson (1985).

Statistical analysis

The data obtained for feed intake and digestibility were subjected to analysis of variance (ANOVA) using the general linear model procedure of SAS (2006). The correlation between feed intake and digestibility were also determined by the same software.

The model for the experiment was:

$Y_{ij} = \mu + \alpha_i + b_j + e_{ij}$

Where:

Y_{ij}= response variable
μ= over all mean
α_i = i^{th} treatment effect
b_j= j^{th} block effect
e_{ij}= random error

Results and discussions

Chemical composition of feeds

The chemical composition of individual ingredients of urea-molasses and urea-atela blocks (offered and refused) are given in table 1. In the current study, the DM content of the treatment feeds, except molasses were above 90%. Crude protein content of urea-atela blocks was by far higher than urea-molasses block; this is because atela has higher CP content than molasses. The NDF and ADF content of urea molasses block were lower than urea-atela blocks,. The dry matter content of atela (93.1%) and molasses (75.2%), but the CP content of atela was (10.2%). This is because atela in our experiment was made from low protein ingredients. The DM and CP content of wheat bran were (90.8%) and (16.8%), respectively. The CP of urea-molasses block used in the present experiment was 33.5%, but the CP content of urea-atela blocks was more than 58%, which is due to high CP content of atela than molasses.

The chemical composition of feed stuff (offered and refused) is given in table 1. In the current study, the DM content of the treatment feeds, except molasses and atela were above 90%. Crude protein content of atela blocks was by far higher than urea-molasses block. The NDF and ADF content of urea molasses block were lower than atela blocks.

Table 2. Chemical composition of the experimental feeds and refusals

Feed Offer	DM	Ash	OM	CP	NDF	ADF	ADL
Hay (%)	89.6	8.6	91.4	5.1	67.8	48.2	11.6
Atela (%)	93.1	3.9	96.1	10.2	32.7	16.4	5.9
Wheat bran (%)	90.8	6.2	93.9	16.8	54.2	14.6	4.1
Molasses (%)	75.2	3.1	96.9	4.1	13.6	5.4	2.3
T1 UMB (%)	95.3	31.5	68.5	33.5	15.56	7.2	2.85
T2 Atela block (%)*	96.6	32	68	62.5	37	16.4	5.2
T3 Atela block (%) *	95.6	33.7	66.3	61.5	37.1	19.4	5.2
T4 Atela block (%) *	95.7	34.5	65.5	58.5	33.7	21.6	5.6
Refusal							
Hay (%)	90.1	8.8	91.2	4.9	69.2	49.7	11.9
T1 UMB %)	95.5	32.1	67.9	32.6	13.8	7.6	2.3
T2 Atela block (%)(%)*	96.1	32	68	55	40	17.7	5.5
T3 Atela block (%)*	96.6	34.5	65.5	56.7	37.3	23.4	7.2
T4 Atela block (%)*	95.9	36.9	63.1	61.5	35.5	17.3	5.6

DM = dry mater; OM=organic matter; CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; ADL = acid detergent lignin. * = Percentage of atela block differ; UMB = urea-molasses block.

Properties of the block

The color of the blocks was dependent up on the amount of ingredients added to the block. As a result, the color of the block varies among treatments. The color of urea molasses block (T1) and T4, highest proportion of atela were dark, and more or less similar. The color of T2 and T3 urea-atela blocks were white. Blocks should be fed as a lick so that only the top surface is accessible to the animals. This requires that the block must have enough strength. This prevents animals from pushing the blocks around, breaking them up and consuming large chunks that could cause urea toxicity. When we compared urea molasses block with atela block, urea-molasses block was harder than urea-atela block. Although hardening is essential for block, quicker and extreme drying may be disadvantage as observed during the present experiment. One of the problem is it reduces intake and animals cannot consume the block after few days, but atela block was easily consumable to the animal for relatively longer period of time.

Feed intake

The mean daily DM intake is presented in Table 2. Hay and total DM intake of sheep consumed T2 diet (atela block consisting the highest level of wheat bran, 43%) was higher than the other treatments, but there were no significant difference between T1, T3 and T4. Block DM intake of T2 was higher than other treatments. There was no significant difference between T1 and T3, but T4 has the lowest block intake compared to the other treatments. T1 and T4 blocks consists equal proportion of wheat bran in the block, but the urea-molasses block (UMB) intake was high confirming the fact that high level of atela in block depresses dry mater intake. The OM intake of sheep in T2 is higher compared to T1, T3 and T4, but there were no significant difference between T1, T3 and T4. Crude protein intake of urea-molasses block was lower than urea-atela blocks, because molasses has low protein than atela.

Physical quality of the block such as hardness and palatability had direct effect on intake. The block made from atela was relatively more acceptable by the animal. This is because the amount of wheat bran added to urea-atela block was higher than the block made from molasses.

Table 3. Daily dry mater and nutrient intake of blackhead ogaden sheep fed hay supplemented with urea-molasses block and urea-atela blocks

Nutrient	T1	T2	T3	T4	SEM	SL
DMI						
Hay (g/d)	476.6[b]	494.6[a]	480.1[b]	488.2[b]	7.77	***
Block (g/d)	103.86[b]	105.85[a]	103.73[b]	95.25[c]	1.66	***
Total (g/d)	580.47[b]	600.45[a]	583.89[b]	583.45[b]	8.74	***
TCPI (g/d)	63.63[d]	104.2[a]	94.06[b]	86[c]	3.18	***
TOMI (g/d)	560.86[b]	584.23[a]	561.7[b]	563.2[b]	8.4	***
TNDFI (g/d)	377.62[c]	433.82[a]	403.47[b]	402.96[b]	6.91	***
TADFI (g/d)	264.2[c]	296.53[a]	279.35[b]	284.13[b]	4.59	**
DMI(%LW)	3.8	3.9	3.9	4.1	0.33	ns
g/Kg $w^{0.75}$	74.4[d]	78.2[a]	76.5[c]	77.5[b]	0.3	***

DMI = dry mater intake; OMI = organic matter intake; CPI= crude protein intake; NDFI= neutral detergent fiber intake; ADFI= acid detergent fiber intake; ADL= acid detergent lignin; mbw = metabolic body weight.

Feed intake in all treatments increased steadily throughout the experiment period, but remained high in T2 (Figure 1).

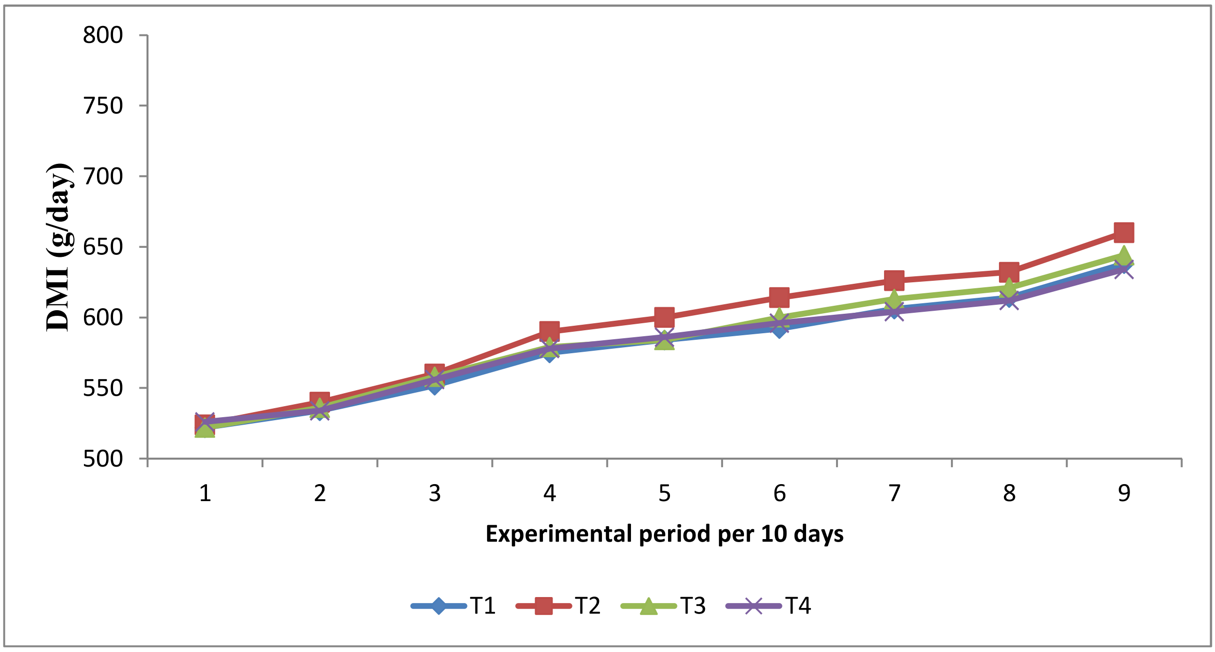

Figure 1. Trends in dry mater intake of blackhead ogaden sheep fed hay supplemented with urea-molasses block and urea-atela blocks during the experiment.

Dry matter and nutrient digestibility

The apparent nutrient digestibility is given in Table 3. The dry matter digestibility is significantly higher ($P<0.05$) for sheep fed T2 and T3 blocks than T1 and T4, which could be attributed to the high wheat bran in the blocks than UMB and T4 urea-atela block. There were no significant differences between T1 and T4 in DM digestibility. Organic matter digestibility in T2 was higher compared to T1 and T4, but similar with T3. The CP digestibility in T2 was higher compared to the other treatments and T1 has lower CP digestibility than T3 and T4. According to result obtained as the amount of atela increases digestibility of nutrient decreases. However, increasing the proportion of wheat bran in the block increased digestibility of nutrients.

Table 4. Apparent nutrient digestibility of blackhead ogaden sheep fed hay supplemented with urea molasses block and urea-atela blocks

Parameter	T1	T2	T3	T4	SEM	SL
DMD (%)	65.06^{b}	68.96^{a}	67.08^{a}	62.26^{b}	0.007	*
OMD (%)	58.9^{b}	63.2^{a}	59.7^{ab}	59.5^{ab}	0.0069	**
CPD (%)	71.4^{c}	82.2^{a}	77.8^{b}	75.5^{b}	0.01	***
NDFD (%)	51.5	54.4	53.8	52.3	0.0082	ns
ADFD (%)	52.5	53.8	54.3	52.2	0.0057	Ns

DMD = dry mater digestibility; OMD = organic matter digestibility; CPD = crud protein digestibility; NDFD = neutral detergent fiber digestibility; ADFD = acid detergent fiber digestibility.

The high apparent digestibility of CP in urea-atela blocks supplemented sheep groups could be related to the high content of nitrogen supplied by atela compared to molasses.

Correlation between nutrient intake and digestibility of experimental feeds

The correlation between nutrient intake and digestibility of feed was presented in table 4. Dry matter intake was positively and significantly correlated (P<0.001) with OMI, NDFI, ADFI intake, DOM and ADG. As the total DM intake increased the other nutrients intake were also increased. The positive associations among these parameters reflect the improved fermentation and passage rate, which leads to improved intake as a result of dietary treatment.

However, DNDF and DADF were negatively correlated with DDM. CP digestibility is also negatively correlated (P<0.05) with DNDF and DADF. This is because cell wall constituent reduce digestibility of CP as well as passage rate. CP intake was positively correlated (P<0.001) with intake of ADF and NDF, and digestibility of CP. But, CP digestibility was negatively correlated (P<0.05) with intake of ADF and NDF.

Table 5. Correlation between nutrient intake and digestibility

	TDMI	TOMI	TCPI	TNDFI	TADFI	DDM	DOM	DNDF	DADF	DCP
TOMI	.73***									
TCPI	.48*	.5*								
TNDFI	.95***	.7***	.68***							
TADFI	.94***	.67***	.61***	.98***						
DDM	.36ns	.36ns	.38ns	.31ns	.21ns					
DOM	.79***	.61**	.46*	.77***	.75***	.43*				
DNDF	.13ns	.061ns	-.5*	-.03ns	.01ns	-.22ns	.1ns			
DADF	.42*	.15ns	-.04 ns	.4ns	.48*	-.31ns	.34ns	.58**		
DCP	.34ns	.27ns	.73***	-.46*	-.37*	.54**	.47*	-.6*	-.17*	
ADG	.74***	.62**	.61**	.72***	.63***	.65***	.65***	-.07 ns	.06ns	.58**

ADF = ADF digestibility; ADFI = ADF intake; CPD = CP digestibility; CPI = CP intake; DMD = DM digestibility; DMI = DM intake; NDFD = NDF digestibility; NDFI = NDF intake; OMD = OM digestibility; OMI = OM intake; (**)=P<0.01; (*) =P<0.05 ;(***) = P<0.001.

Partial Budget Analysis

The partial budget analysis for the feeding trial is presented in Table 5. The result of the partial budget analysis indicated that the gross financial margin or total return obtained in this trial was 70, 90, 80 and 73 Birr/sheep for sheep fed T1, T2, T3 and T4 diets, respectively. As shown by partial budget analysis, sheep fed atela block with higher level of wheat bran (T2) returned higher net income (11.6 Birr/sheep) as compared to the other supplemented groups.

Table 5. Partial budget and marginal rate of return analysis for the experimental treatments

Variables	Treatments			
	T1	T2	T3	T4
Purchase price of sheep,birr/sheep	310	310	310	310
Hay consumed (kg/sheep)	47.86	51.66	48.2	49.04
Block consumed (kg/sheep)	9.81	10.79	9.77	8.96
Cost for hay (Birr/sheep)	53.20	57.40	55.58	54.40
Cost for block (Birr/sheep)	16.46	21	17	17
Total feed cost (Birr/sheep)	69.66	78.4	72.58	71.4
MRR %(Δ NI/ΔTVC)	-	129	242	72

Birr = Ethiopian currency; ΔNI = change in net income; ΔTVC = change of total variable cost; MRR = marginal rate of return; NR = net return; TR = total return.

The net return from the supplemented treatments was 0.34, 11.6, 7.42 and 1.6 Birr /head with marginal rate of return (MRR) of 129, 242, and 72% for T2, T3 and T4, respectively.

Conclusions

The result of the chemical analysis of feeds showed that CP contents of T1, T2, T3 and T4 blocks were 33.5, 62.5, 61.5, and 58.5%, respectively. This indicated that supplementation of urea-atela blocks to be good source of protein than urea-molasses block.

The apparent digestible of crude protein was significantly higher ($P<0.001$) for sheep supplemented with urea- atela block (82.2, 77.8 and 75.5 for T2, T3 and T4, respectively; SE=0.01) than urea molasses block, due to low protein content of molasses.The dry matter digestibility is also significantly higher ($P<0.05$) for sheep fed T2 (68.96 ± 0.007) and T3 (67.08 ± 0.007) blocks than T1 (65.06 ± 0.007) and T4 (62.26 ± 0.007), which could be attributed to the high wheat bran in the blocks than UMB and T4 urea- atela block. The OMD is also significantly higher ($P<0.01$) for sheep fed (T2) urea-atela block than urea-molasses block, T3 and T4 urea-atela blocks. However digestibility of NDF and ADF were similar between supplemented treatments.

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