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Effect of urea treatment and concentrate mix supplementations on feed intake and digestibility of Horro sheep fed cured maize husk (*Zea Mays*) at Bako, Western Ethiopia

Girma Defar[1*], Mengistu Urgie[2] and Solomon Melaku[2]

[1]Department of Animal and Range Sciences, School of Agriculture, Madawalabu University, P. O. Box 247, Bale-Robe, Ethiopia.
[2]School of Animal and Range Sciences, Haramaya University, P. O. Box 138, Dire-Dawa, Ethiopia.

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Feed intake and digestibility experiment were conducted using twenty yearling male Horro sheep weighing 20.42 ± 0.35 kg (mean ± SD). The objectives of the study were to evaluate the response of Horro sheep to feed intake and apparent digestibility when supplemented with different level of noug seed meal and wheat bran mix (1:1) on DM basis. For this study, randomized complete block design was employed. Experimental sheep were blocked into four blocks of five animals based on their initial body weight (BW) and randomly assigned to the four treatment diets within a block. The treatments allocated were sole UTMH (T1, control), UMH + 200 g concentrate mix (CM) (T2), UMH + 300 g CM (T3) and UMH + 400 g CM (T4) on DM basis per head/day for 90 days. Total DM intake over the experimental period was higher (P<0.001) for the supplemented groups as compared to the control group. The DM intake of control group showed a decreasing trend during the first 50 days of the experiment which later showed an increasing trend that brought the sheep to maintain their body weight. Digestible nutrient intake and apparent digestibility of nutrients were higher (P<0.001) for supplemented sheep than control group. It was concluded that supplementation with nougseed meal and wheat bran mix promoted feed intake and apparent digestibility of DM and CP in Horro sheep fed cured maize husk.

Key words: Apparent digestibility, concentrate mix, feed intake, Horro sheep, maize husk.

INTRODUCTION

The presence of high livestock population with limited grazing lands associated with severe land degradation is a critical problem in many tropical countries like Ethiopia. Moreover, farmers have limited opportunity to improve the feed of animals through cultivation of forage crops due to small size of land holdings, which is mainly used for crop production (Getahun, 2013; CSA, 2004). High demand for cereals and other food plants for direct

*Corresponding author. E-mail: girmad16@yahoo.com or gdefaru@gmail.com.

human consumption in the future dictate animal industry and must adjusted to this scenario by making changes in feeding systems and management. To overcome the feed problem, matching livestock production with the available feed resources (crop residues) and increasing animal productivity through proper utilization of available feed resources is mandatory in mixed farming system (Solomon et al., 2008). In this regard, nonconventional feeds produced from cereals can be used as important feed resources for livestock.

Diriba and Lemma (2001) reported that maize is the major cereal crop in western Ethiopia. Maize husk is one of the widely known crop residues used as a feed for ruminants together with maize stalk after the harvest of the crop commonly during the dry season (Osafo et al., 1993). When observed under farmers' condition, it seems the husk has no palatability problem by ruminants.

But, it has not been fully exploited as feed for ruminants due to little or no knowledge of processing or level of incorporation of concentrate supplements (Melese et al., 2014). The stalk of maize residue is either left on the cultivated land for soil fertility conservation or it is used for construction of grain storage structure, fence and used as fuel wood (Adugna and Frik, 1999; FAO, 2001). Then, the husk is stripped, collected and fed to livestock.

However, studies were not conducted to verify the potential of untreated or treated maize husk as livestock feed under Ethiopian condition. Therefore, this study was initiated to investigate the effect of feeding urea treated maize husk (UTMH) and different levels of concentrate mix (CM) supplements on Horro sheep fed cured maize husk.

MATERIALS AND METHODS

Study area

The study was conducted at Bako Agricultural Research Station, Western Ethiopia which lies approximately at 09° 06' 56" N latitude and 37° 03' 30" E longitude at about 239 km from Addis Ababa capital of Ethiopia. Average elevation of the area is 1650 m above sea level. The area receives an average of 1242 mm rainfall annually and the mean annual minimum and maximum temperatures ranges from 13.3 to 27.9°C during the period of 1961-2010 (Meteorological Station; Bako Agricultural Research Center).

Experimental design and feeding management

Twenty yearling male Horro sheep with 20.42 ± 0.35 kg body weight were used in a feeding and digestibility trial. Experimental design employed was randomized as complete block design consisting of four treatments, namely, chopped UTMH (T1, control), untreated maize husk (UMH) supplemented with a mix of noug seed meal (NSM) and wheat bran (WB) (1:1) at 200 g (T2), 300 g (T3) and 400 g (T4) DM per day. The experimental sheep were housed in individual pens. They were vaccinated against infectious diseases, sprayed and dewormed against external and internal parasites, respectively. Maize husk (BH-660) was collected from production site after the harvest of the kernel (grain) and chopped to appropriate size using tractor mounted chopper. The husk was offered *ad libitum* allowing 30% refusal. Supplement feeds were offered in two equal proportions at 8:00 and 16:00 h each day after thorough mixing. Mineral salt and water were available. Daily feed offers and refusals were weighed and recorded for each animal to calculate daily feed intake.

Feces collection and samples preparation

Total feces collection was done for seven consecutive days by adapting the experimental sheep to carry feces collection bags during the digestibility trial. Feces were collected daily and mixed thoroughly and 20% was sub-sampled and pooled for seven days per animal. Feces samples were stored at -10°C pending chemical analysis. The composite fecal samples per animal were thawed at room temperature and dried at 60°C to a constant weight. Dried samples of feeds offered, refused and feces were ground to pass through a 1 mm sieve and preserved in airtight plastic containers pending chemical analysis. Apparent digestibility coefficients of nutrients were calculated as the proportion of nutrients consumed and not recovered in feces.

Laboratory analysis

Determination of DM, ash and organic matter (OM) contents were performed according to AOAC (1990). Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADF) were determined by the method of Van Soest and Robertson (1985).

Statistical analysis

Data collected during the experiment were subjected to the analysis of variance using the general linear model procedure of SAS (2004) version 9. Differences between treatment means were tested using least significant difference (LSD) test. The model used for the analysis of data on feed intake, digestible nutrient and coefficient of digestibility was:

$$Y_{ij} = \mu + T_i + B_i + E_{ij}$$

Where:
Y_{ij} = the response variable, μ = overall mean, T_i= treatment effect, B_j = block and effect, E_{ij}= random error.

RESULTS AND DISCUSSION

Treatment feeds chemical composition

The result of the chemical analysis of treatment feeds is presented in Table 1. The supplement feed mixture contained high DM, OM and CP ingredients as compared to UMH and UTMH, where the former contained higher content of cell wall fibers.

Feed intake

The intake of untreated maize husk DM was high for low level supplemented sheep and significantly different (P<0.001) (Table 2). Total DM intake was higher (P<0.001) for the supplemented sheep than the control

Table 1. Chemical composition of the treatment feeds.

Feed types	DM (%)	Ash	OM	CP	NDF	ADF	ADL
				(%DM)			
Untreated maize husk (UMH)	92.24	6.44	93.56	5.76	75.8	43.13	13.04
Urea treated maize husk (UTMH)	87.57	5.95	94.05	10.42	71.5	38.84	12.67
Wheat bran (WB)	88.7	6.6	93.4	16.9	46.8	36.2	6.1
Nougseed meal (NSM)	94.2	8.2	91.8	31.4	37.9	33.6	6.1
WB and NSM mixture (1:1)	93.27	5.39	94.61	24.13	41.1	34.3	5.06

DM = dry matter, OM = organic matter, CP = crude protein, NDF = neutral detergent fiber. ADF = acid detergent fiber, ADL = acid detergent lignin.

Table 2. Daily nutrient intakes of Horro sheep fed sole urea treated maize husk and untreated maize husk supplemented with different levels of wheat bran and nougseed meal mix.

Parameter	T1	T2	T3	T4	SEM	SL
MHDMI (g/d)	514.5^{a}	471.1^{b}	429.5^{c}	446.5^{c}	8.16	***
CMDMI (g/d)	_	200.0^{c}	300.0^{b}	400.0^{a}	0.00	***
TDMI (g/d)	514.5^{d}	671.1^{c}	729.3^{b}	846.5^{a}	9.29	***
Ash intake (g/d)	34.5^{d}	40.1^{c}	44.1^{b}	49.6^{a}	0.74	***
OMI (g/d)	483.7^{d}	631.0^{c}	785.2^{b}	796.9^{a}	8.61	***
CPI (g/d)	60.5^{d}	70.2^{c}	91.6^{b}	114.6^{a}	0.57	***
NDFI (g/d)	344.1^{d}	472.7^{c}	499.1^{b}	571.8^{a}	6.84	***
ADFI (g/d)	194.7^{d}	278.8^{c}	296.8^{b}	351.5^{a}	4.06	***
ADLI (g/d)	57.5^{b}	68.4^{c}	68.2^{c}	81.5^{a}	1.13	***
EME (MJ/d)	5.9^{d}	7.6^{c}	8.2^{b}	9.4^{a}	0.13	***
DMI (%BW)	2.6^{c}	3.0^{b}	3.1^{b}	3.3^{a}	1.48	***
DMI (g/kgW$^{.75}$)	56.5^{d}	65.2^{c}	67.7^{b}	74.2^{a}	0.84	***
SR	-	-0.37^{b}	-0.04^{a}	-0.08^{a}	0.04	***

^{a,b,c,d} = Means with the same letter in the same row are not significantly different, ***= (P<0.001), ADF= acid detergent fiber; ADL= acid detergent lignin; Ash; CMDMI= concentrate mix dry matter intake, CP= crude protein; DMI (%BW)= DMI percent body weight; DMI (g/kgW$^{.75}$)= DMI g/kg metabolic body weight; MHDMI= maize husk dry matter intake, NDF=neutral detergent fiber; OM= organic matter; SEM= standard error mean, SL= significance level, SR= substitution rate, TDM= total dry matter.

group. Among the supplemented sheep, total DM increased with the level of supplementation, indicating it promotes the intake of the basal diet**.** Also, the trends in DMI of Horro sheep over the experimental period are given in Figure 1. The mean daily total DMI was higher in T4 and lower in T1 and different (P<0.001) in the order T4>T3>T2>T1, respectively. The reason for high mean daily DMI of UTMH (T1) might be attributed to relatively low fiber content of UTMH as compared to UMH of supplemented groups. This is in agreement with Melese et al. (2014) who fed urea treated straw to lambs of control group and found that intake increased as compared to supplemented one.

The mean daily DMI of UMH was higher (P<0.001) for supplemented sheep and lower for control group sheep, which resulted in negative substitution rate for the experimental period. In agreement with the present study, Ewnetu, (1999) reported that concentrate supplemented sheep had higher DMI as compared to those fed poor quality roughage alone. Total DM, OM, CP, NDF and ADF were also higher (P<0.001) in the order of T4>T3>T2>T1 (Table 2). The DMI as BW% in the current study was 2.7 to 3.3%, which is within the range of 2 to 4% of BW suggested by Susan (2003).

Variation in the amount of DMI recorded in the present experiment when compared with other similar studies might be due to differences in quality and coarse texture of the basal feed material, animal factors (breed, age and physiological status), rate of degradation of treatment feeds and the prevailing temperature and humidity (Van Soest, 1982; Nsahalai et al., 1991). Comparisons between UTMH and UMH showed an increase (P<0.001) in intake of maize husk and total DM, OM, CP and NDF for sheep fed UTMH alone and UMH supplemented with concentrate mix (Table 2). This indicated a useful effect of urea treatment and supplementation to enhance nutrient utilization.

In this study, negative substitution rates indicated

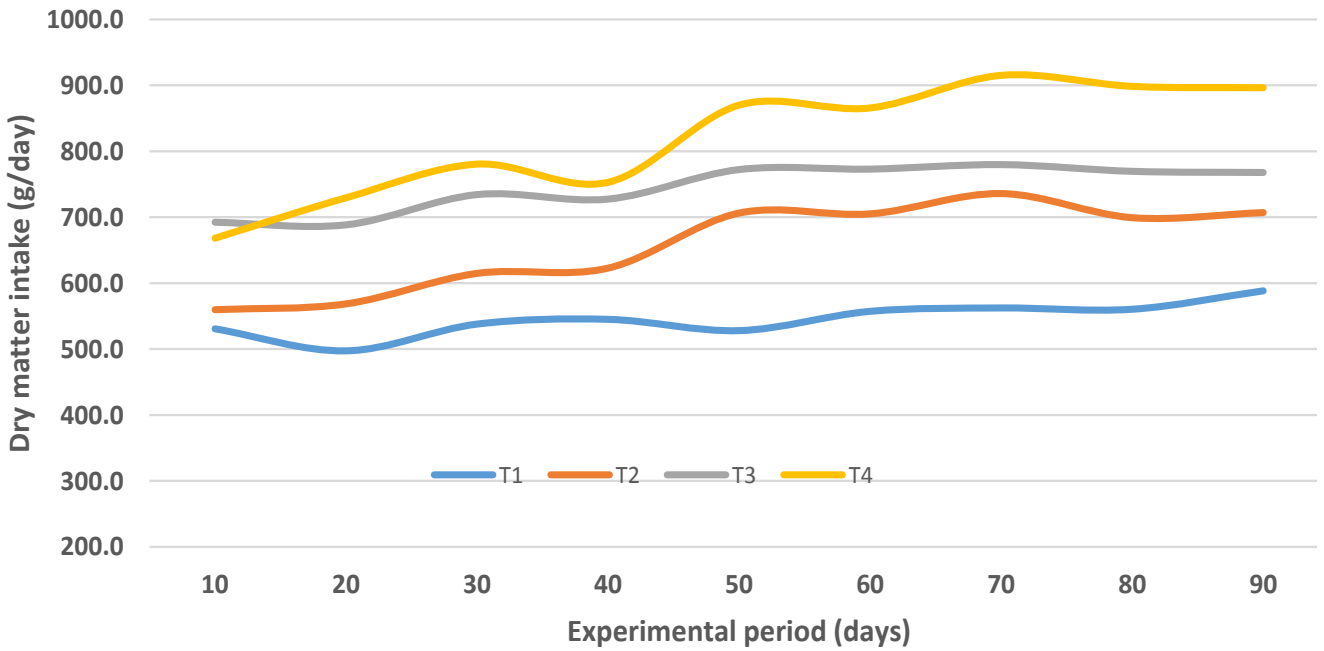

Figure 1. Trends in DMI of Horro sheep fed on sole urea treated maize husk and untreated maize husk supplemented with different levels of wheat bran and noug seed meal mix. T1 = UTMH, T2 = UMH + 200 g (WB + NSM), T3 = UMH + 300 g (WB + NSM), T4 = UMH + 400 g (WB + NSM).

supplementation promoted more basal diet intake as compared to the control group. Thus, it is possible to say supplemented group consumed concentrate in addition to UMH without replacing it. Dawit and Solomon (2009) reported supplementation with graded levels of vetch and alfalfa hay improved total DMI of Arsi-Bale sheep fed urea treated barley straw by 71%. Additionally, feed intake of experimental animals fed on a basal diet of urea treated sorghum residue was lower than the animals supplemented with concentrate mix (Ahmed et al., 2001). Figure 1 shows the change in daily DMI with time over the experiment period.

Moreover, the result of an experiment undertaken by Koralagama et al. (2008) to compare the effect of supplementing maize residue with cowpea (*Vigna unguiculata*) haulms or commercial concentrate on feed intake and nutrient digestibility of male Ethiopian Highland sheep showed that relative to the control group, cowpea increased maize residue intake. Estimated metabolisable energy (EME) indicated that the energy intake for all treatments were above the minimum maintenance requirement range (3.7 to 4.1 MJ/day) estimated for a 20 kg lamb (ARC, 1980). The calculated value was higher ($P<0.001$) in both UTMH and supplemented groups (5.9-9.4 MJ/day) (Table 2).

In the current experiment, differences ($P<0.001$) were observed among all treatments in daily DMI g/kg $W^{0.75}$ and as % BW. The difference observed might be due to variations in BW gain and efficiency of feed utilization of the experimental sheep. The values of DM intake (56.5 to 74.2 g/kg $W^{0.75}$) in the present study are relatively lower than that of Awet and Solomon (2009) that reported 90 to 108 g/kg $W^{0.75}$ in Afar rams fed urea treated tef straw supplemented with wheat bran.

Digestible nutrient intake

The positive effect of supplementation on feed intake might be a reflection of increase in the intake of essential nutrients such as energy, vitamin and minerals and particularly nitrogen. Similar to those previous results obtained from roughage basal diet supplementation by different authors (Melese et al., 2014; Michael and Yayneshet, 2014), treating maize husk with urea or supplementing it with protein and energy source feeds improved DM, CP and OM intake by sheep. Like that of DMI, digestible nutrient intake (g/kg DMI) were different ($P<0.001$) among the treatments in the order of T4>T3>T2>T1 since it is strongly correlated with total DMI (Tables 2 and 3).

In the present study, low nutrient intake because of high ambient temperature coupled with less nutrient content and digestibility made the control group to maintain their initial weight during the experimental period. Contrary to the present work, Gemeda et al. (2003) reported that all animals fed basal diet died before the termination of the study in an experiment that evaluated the growth performance of weaned Horro lambs fed a basal diet of barley straw and supplemented

Table 3. Daily digestible nutrient intakes of Horro sheep fed sole urea treated maize husk and untreated maize husk supplemented with different levels of wheat bran and noug seed meal mix.

Parameter	Digestible nutrient intake (g/kg DMI)/day					
	T1	T2	T3	T4	SEM	SL
DM	391.1[d]	517.2[c]	567.4[b]	652.2[a]	9.386	***
OM	375.6[d]	493.8[c]	543.0[b]	623.5[a]	8.575	***
CP	55.8[c]	58.1[c]	75.8[b]	95.8[a]	1.612	***
NDF	274.4[d]	363.6[c]	382.0[b]	436.1[a]	6.585	***
ADF	133.5[d]	212.3[c]	228.4[b]	272.3[a]	4.341	***

[a,b,c,d] = Means with the same letter in the same row are not significantly different, ***= (P<0.001), DDM= digestible dry matter; DOM= digestible organic matter; DCP= digestible crude protein; DNDF= digestible neutral detergent fiber; DADF= digestible acid detergent fiber.

Table 4. Digestion coefficients of nutrients by Horro sheep fed sole urea treated maize husk and untreated maize husk supplemented with different levels of wheat bran and nougseed meal mix

Parameters	T1	T2	T3	T4	SEM	SL
DM	0.71[b]	0.75[a]	0.75[a]	0.74[a]	0.017	***
OM	0.72[b]	0.77[a]	0.76[a]	0.76[ab]	0.017	***
CP	0.87	0.82	0.82	0.83	0.025	ns
NDF	0.71[b]	0.75[a]	0.74[a]	0.74[ab]	0.017	***
ADF	0.65[b]	0.76[a]	0.76[a]	0.77[a]	0.019	***

with different level of concentrate. The observation in the current study underlines the importance of supplementation with protein source feed when animals are fed on fibrous low quality diet.

Apparent digestibility of nutrient

The digestibility of DM, OM, CP, NDF and ADF in Horro sheep fed sole UTMH and UMH supplemented with WB and NSM mix are presented in Table 4. The apparent digestibility of DM, OM, NDF and ADF were lower (P<0.001) for control and higher (P<0.001) for the supplemented sheep. CP digestibility was similar between groups fed UTMH and those supplemented. Mulugeta and Gebrehiwot (2013) and Chenost (1995) suggested that urea treatment and concentrate supplementation tends to increase the digestibility of low quality roughages through its effect on plant cell walls. Additionally, FAO (2002) reported that as much as 20% improvement in digestibility would be expected upon ammoniating the poor quality roughages.

The similar digestibility in DM, OM, NDF and ADF among the supplemented sheep in the current study might be due to rapid digestibility of supplementary feed that might activate the micro-organisms in rumen for fiber digestion. The current result is supported by Solomon et al. (2003) in that feeding of protein diet to goat and sheep, respectively improved digestibility as compared to low protein diet. In agreement with the current result, Ferrill et al. (1999) and Getahun (2013) documented a significant improvement of DM, OM and CP digestibility in protein and energy supplemented feed as compared to sole roughage diet, which was attributed to the high digestibility of the supplements. Digestibility is much reduced when a ration contains too little protein in proportion to the amount of readily digestible carbohydrate (McDonald et al., 2002).

Various research reports support the fact that DM and nutrient digestibility of fibrous feeds could be improved due to supplementation of protein and energy source feeds (Getahun, 2013; Kaitho et al. 1998) and that the digestibility of DM, OM and nitrogen (CP) were increased with level of supplementation. In agreement with this, Getahun (2006) reported that urea treatment of straw and supplementation significantly increased apparent straw DM, OM and CP digestibility. However, contrary to the above reports and the present result, Fentie and Solomon (2009) reported that there was no significant difference in apparent digestibility of DM and OM between supplemented and non-supplemented treatments in Farta sheep fed a basal diet of grass hay supplemented with NSM, WB and their mixes which might be effect of variety of feed material and breed difference.

Conclusion

The chemical analysis result of the experimental feeds

indicated that urea treatment improved the CP content of maize husk. Intake and digestibility of DM, OM, CP, NDF and ADF improved due to urea treatment and supplementation. Intake of DM was positively correlated with intake of OM, CP, NDF, ADF and digestibility of OM, CP, NDF and ADF. Similar CP digestion for T1 (control) and the supplemented group is as a result of urea treatment that enhances digestibility of roughage feed which is comparable to the supplemented ones that indicates effectiveness of the treatment.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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