Supplementation of Graded Levels of Wheat Bran to Intact and Castrated Afar Sheep Fed Urea Treated Tef Straw: Effects on Feed Intake, Digestibility, Body Weight and Carcass Characteristics

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Abstract: A feeding and digestibility trial was conducted to evaluate the effect of wheat bran (WB) supplementation on feed utilization and carcass characteristics in urea treated tef (*Eragrostis tef*) straw (UTTS) based feeding of Afar sheep. Sixteen intact and sixteen castrated Afar sheep with initial body weight (BW) of 15.75 ± 1.57 kg (mean ± SD) were used in a randomized complete block design with 2 sex (intact, T1-T4 and castrated, T5-T8) x 4 levels (0, control; 150 g, low; 250 g, medium; 350 g, high) of WB supplementation on a dry matter (DM) basis. Supplementation promoted higher total DM, crude protein (CP) ($P<0.001$), OM ($P<0.01$) intake, final BW, daily BW gain, feed conversion efficiency (FCE), rib-eye muscle area ($P<0.001$), and dressing percentage ($P<0.01$). Supplementation at medium and high levels compared to the low level resulted in higher ($P<0.05$) DM and CP intake. High and medium levels of supplementation resulted in higher ($P<0.05$) apparent digestibility of DM compared to feeding solely on UTTS. The results of the study showed that UTTS could promote a reasonable level of feed intake and animal performance. Moreover, it was found that the level of supplementation is more important regarding the performance of Afar sheep in feed intake, BW and carcass parameters than castration or maintaining them intact in small-scale fattening schemes. Failure to observe differences in BW, FCE and carcass characteristics between intact and castrated Afar sheep could be attributed to the age of the sheep used in the study.

Keywords: Afar Sheep; Carcass; Digestibility; Feed Intake; Urea Treated Tef Straw; wheat bran

1. Introduction

Sheep rearing in the mixed crop livestock production system in the highlands of Ethiopia is the most important form of investment and cash income, and provides food security during years of crop failure (Getachew, 1988). Moreover, it is a common traditional practice followed by Ethiopian farmers to castrate and fatten sheep intended for the lucrative religious holiday markets. The major reason for castration of sheep is to promote fat deposition in the carcass, although it is associated with low feed conversion efficiency (FCE) and daily body weight (BW) gain (MacDonald *et al.,* 2002). Nevertheless, the degree at which castration promotes fat deposition and compromises FCE and daily BW gain has not been studied in depth and documented for most indigenous sheep types subsisting on locally available feed resources such as crop residues in Ethiopia. McDonald *et al.* (2002) reported that crop residues such as straws and related by-products are extremely fibrous, most have a high content of lignin, low content of crude protein (CP) and, thus, are of low nutritive value. Their high fiber and low CP contents restrict the availability and use of nutrients contained in them by domestic animals such as sheep. Urea treatment of straws could improve the poor nutritive value of fibrous feeds by increasing their nitrogen content (ILRI, 1999) and by also making their cell wall fibers more amenable for microbial fermentation. On the other hand, supplementation with energy source agro-industrial by-products, such as wheat bran (WB), supply the energy required by rumen microorganisms to capture the ammonia released from urea treated straw and incorporate it into their cell proteins. Thus, this could be a group opportunity to use agro-industrial by-products such as WB as supplementary feeds, particularly in smallholder sheep fattening schemes which are being promoted by the livestock extension services in Ethiopia. Moreover, WB is currently being produced by a number of flour milling factories in different parts of Ethiopia, which makes it more accessible to farmers in most parts of the country. Policy shift also demands the intensification of livestock production in Ethiopia. Therefore, this study was conducted to evaluate the effect of the level of WB supplementation on feed intake, digestibility, BW change and carcass characteristics of castrated and intact Afar sheep offered a basal feed of urea treated tef (*Eragrostis tef*) straw (UTTS).

2. Materials and Methods

2.1. Experimental Site

The experiment was conducted at Wukro Saint-Mary ATVET College, located at 13° 47' N latitude and 39° 35' E longitude, and at an altitude of 1900 masl. It receives mean annual precipitation of 502 mm and has mean minimum and maximum temperatures of 17 °C and 23 °C, respectively (BoANR, 2004).

2.2. Experimental Design and Treatments

Thirty-two yearling Afar sheep with initial BW of 15.75 ± 1.57 kg (mean ± SD) were used in a study which lasted for 90 days of feeding and 10 days of digestibility trials. The Afar sheep are hardy and adapted to drought prone arid and semi-arid areas. They are fat, tailed, hairy sheep with an adult BW of 28.3 kg and 35 kg for females and males, respectively (DAGRIS, 2007). Sixteen of the thirty-two sheep were castrated 30 days before the beginning of the feeding trial. A randomised complete block design in a 2

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ISSN 1992-0407

(intact vs. castrated) x 4 (levels of supplementation) factorial arrangement was used in the study. The sheep were blocked based on initial BW within sex group. Each dietary treatment was randomly assigned to each sheep in a block resulting in four replications per treatment. The treatments included feeding of solely on UTTS (T1, control) and daily supplementation of 150 (T2, low), 250 (T3, medium) and 350 (T4, high) g WB on a dry matter (DM) basis to intact Afar sheep, and feeding solely on UTTS (T5, control) and daily supplementation of 150 (T6, low), 250 (T7, medium) and 350 (T8, high) g WB on a DM basis to the castrated Afar sheep. The experimental sheep were weighed every ten days after overnight fasting to determine weight change during the experimental period. The daily BW gain was calculated as the difference between the final and initial BW divided by the number of feeding days. The FCE was calculated as the daily BW gain divided by the daily feed intake.

2.3. Feed Preparation and Feeding Management

A solution of 4 kg of urea in 80 liters of water was prepared and applied to 100 kg of tef straw DM (Ibrahim and Schiere, 1989) in a trench with a dimension of 2 m x 2 polythene m x 2 m. The trench was covered with a polyethylene sheet on the floor and the four sides. The urea solution was sprayed thoroughly onto layers of tef straw, rubbed by hand to ensure proper penetration and trampled on by foot to ensure proper packing. After filling the trench with urea treated straw, it was covered with plastic sheeting, and loaded with soil to create a hermetic sealing and left to incubate for 21 days. The UTTS was fed to the experimental sheep *ad libitum* after overnight aeration. The experimental sheep had *ad libitum* access to water and common salt licks. With the exception of sheep in the control treatments, those in the other treatments were supplemented with the respective level of WB at 0800 and 1600 h in two equal portions. Daily feed offer and refusals were recorded for each sheep to calculate daily feed intake. Samples of feed offers were taken on batches of feed and refusals were sampled per animal and pooled for each treatment. Representative samples of UTTS offer and refusals were kept in a deep freezer to minimize loss of ammonia.

2.4. Feces Collection

Twenty four sheep were fitted with fecal collection bags for three adaptation days, which was followed by total collection of feces for seven consecutive days. Daily fecal excretions per animal were collected and weighed every morning. Twenty percent of the total collected feces were sampled daily and kept in air-tight plastic containers for each animal until the end of the collection period, during which time they were thoroughly mixed for each animal and sub- sampled for chemical analysis.

2.5. Carcass Characteristics

At the end of the experiment, 24 sheep were fasted overnight and slaughtered. Blood, skin, the gastrointestinal contents and all the internal organs were weighed separately. The rib-eye muscle area was determined by tracing its cross-section between the 11th and 12th rib on transparent paper and then measured using a planimeter. The empty BW, total edible offal components (TEOC) and total non-edible offal components (TNEOC) were determined by summation of the different carcass components. Dressing percent was calculated as the proportion of hot carcass weight to slaughter weight and empty BW.

2.6. Laboratory Analysis

Samples of feed offer, refusals and feces were ground to pass through a 1 mm sieve screen and analyzed for contents of DM, CP, ash (AOAC 1990), neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) (Van Soest and Robertson, 1985). The apparent DM and nutrient digestibility coefficients were determined as:

$$\text{Apparent digestibility} = \frac{\text{Nutrient intake} - \text{Fecal nutrient output}}{\text{Nutrient intake}}$$

2.7. Statistical Analysis

The experimental data were subjected to the analysis of variance using MSTAT-C computer software. Treatment means were separated using Duncan's multiple range test. The model used for analysis of data collected in the experiment was:

$Y_{ijk} = \mu + r_i + a_j + b_k + ab_{ik} + e_{ijk},$

Y_{ijk} = response variable; μ =overall mean; r_i =ith replication effect; a_j =jth effect of castration; b_k =kth effect of level of WB; ab_{ik} =ikth interaction effect of castration and supplement level; e_{ijk} =error component for interaction.

3. Results and Discussion

3.1. Chemical Composition of Experimental Feeds

The partial DM and the laboratory DM of the UTTS used in this study were 43.3% and 92.5%, respectively (Table 1) and are closely comparable with the values of 45% and 93% reported by Rehrahie and Ledin (2001) for UTTS used in their study. The CP content of UTTS used in this study was 8.4% and less than that reported by Rehrahie and Ledin (2001). Differences in CP content of urea treated straws have also been reported in other studies (Sundstøl and Coxworth, 1984; Chenost, 1995) and attributed to the evaporative loss of up to two-thirds of the ammonia generated into the environment in the course of straw treatment with urea and until fed to animals. It has also been stated that large increases in CP do not necessarily indicate better urea treatment, but may imply the existence of residual urea subjected to partial ureolysis which, in turn, results from the limited hydrolyzation of urea to ammonia gas. The CP content of the UTTS in the current study showed an increase by 158%, 55.4%, 121%, 86.4% and 174.2% compared with the CP content of untreated tef straw reported by Abule (1994), Bonsi *et al.* (1995), Rehrahie and Ledin (2001), Solomon *et al.* (2004), and Zemicael (2007), respectively. The major component of the DM of UTTS offer was NDF (76%), which was higher than 55%, the level above which NDF content has a limiting effect on voluntary feed intake (Van Soest, 1965). The UTTS refusals contained lower CP and higher ADL than the UTTS offer in all treatments, indicating the selective feeding behavior of sheep on portions of feeds with better nutritive value. The CP content (16.4%) of WB in this study was lower than 17% (Devendra and McLeroy, 1982), 17.19% (Tesfaye *et al.*, 2001) and 17.5% (Lonsdale, 1989). However, similar CP content (16.3%) as in this study was obtained by Getnet (1998) and Solomon *et al.*

(2004). Higher cell wall constituents (50%) and inorganic components (7%) of WB were also reported by Lonsdale (1989). The variation might be attributed to the effect of processing in flour milling industries and the quality of the original wheat grain used for milling.

Table 1. Chemical composition of the urea treated tef straws experimental feeds.

Nutrient	WB	UTTS offer	UTTS Refusal							
			Intact				Castrated			
			T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
DM (%)	87.4	92.5	92.2	92.2	92.2	91.9	92.3	92.0	92.0	92.3
Ash (%DM)	4.0	9.2	17.4	11.0	9.5	10.6	11.5	13.2	9.1	11.2
OM (%DM)	96.0	90.8	82.6	89.0	90.5	89.4	88.5	86.8	90.9	88.9
CP (%DM)	16.4	8.4	6.8	8.0	7.1	7.8	8.1	8.0	7.4	7.8
NDF (%DM)	35.2	76.0	65.0	71.0	72.8	71.2	71.3	69.5	75.3	71.9
ADF (%DM)	8.3	42.1	37.3	42.6	43.0	42.2	41.2	43.6	48.5	44.7
ADL (%DM)	2.2	3.8	5.0	4.5	4.2	4.4	4.1	5.0	5.5	5.3
Cellulose	26.9	33.9	27.7	28.4	29.8	29.0	30.1	25.9	26.8	27.2
Hemicellulose	6.1	38.3	32.3	38.1	38.6	37.8	37.1	38.6	43.0	39.4

ADF= acid detergent fiber; ADL= acid detergent lignin; CP= crude protein; DM= dry matter; NDF= neutral detergent *fiber; OM= organic matter; T1= intact sole UTTS; T2= intact UTTS + 150 g DM WB; T3= intact UTTS + 250 g DM WB; T4= intact UTTS + 350 g DM WB; T5= castrated sole UTTS; T6= castrated UTTS + 150 g DM WB; T7= castrated UTTS + 250 g DM WB; T8= castrated UTTS + 350 g DM WB; UTTS= urea treated tef straw;*
WB= wheat bran.

3.2. Feed Intake

Daily UTTS DM intake was higher (P<0.05) for the castrated compared to the intact sheep (Table 2). However, total DM intake was similar between both sexes. The daily total DM, organic matter (OM) and CP intake were higher (P<0.001) for sheep supplemented with WB than those fed only on UTTS. This could be attributed to the similar quantity of UTTS DMI consumed by sheep on the control treatment and those supplemented with the different levels of WB, where the latter contributed to the observed high total DM intake which increased with the level of supplementation. Sheep on the medium and high levels of WB supplementation had higher (P<0.001) total DM and CP intake compared to the low level of supplementation. This is contrary to the reports of Tesfaye *et al.* (2001) in which medium level compared to low and high levels of WB supplementation improved total DM intake in tef straw based feeding of zebu oxen. The similarity in daily total DM intake for UTTS out of all the supplemented treatments indicates absence of substitution of the basal diet with the supplement. The ADF intake was higher (P<0.05) for the non- supplemented sheep and those supplemented with the low level compared to the high level of WB. The higher ADF intake in the non-supplemented sheep and those supplemented with the low level of WB could be attributed to the high ADF containing UTTS contributing to a higher proportion of their daily DM intake. Moreover, urea treatment was also reported to increase the ADF content of straws (Zaman and Own, 1995).

Table 2. Daily feed intake of intact and castrated Afar sheep fed urea treated tef straw supplemented with graded levels of wheat bran.

Factor	UTTS DMI (g)	Total DMI (g)	OMI (g)	CPI (g)	NDFI (g)	ADFI (g)
A (Sex)						
Intact	735.3[a]	806.5	776.6	86.1	569.8	292.8
Castrated	799.2[b]	870.7	787.8	86.9	577.4	296.4
SL	*	ns	ns	ns	ns	ns
SEM	26.41	23.64	22.28	2.08	18.70	10.18
B (WB level)						
0 g	738.0	738.0[c]	674.1[b]	62.6[c]	566.7	312.4[a]
150 g	677.4	826.4[b]	804.8[a]	85.7[b]	608.7	317.0[a]
250 g	638.4	883.8[a]	815.5[a]	94.8[a]	571.6	286.1[ab]
350 g	623.9	963.7[a]	834.4[a]	102.9[a]	547.4	262.7[b]
SL	ns	***	**	***	ns	*
SEM	37.35	33.43	31.51	2.94	26.45	14.40
AxB (Interaction)						
SL	ns	ns	ns	ns	ns	ns

[abc] = Means within a column not bearing a common superscript differ significantly; *= P< 0.05; **= P< 0.01; ***= P< *0.001; ADFI= acid detergent fiber intake; CPI= crude protein intake; DMI= dry matter intake; NDFI= neutral detergent fiber intake; ns= non significant; OMI= organic matter intake; SEM= standard error of mean; SL= significance level; UTTS= urea treated tef straw; WB= wheat bran.*

3.3. Feed Digestibility

Supplementation with the medium and high levels of WB resulted in higher (P<0.05) apparent digestibility of DM compared to non- supplemented sheep, whereas only the high level of WB supplementation resulted in higher (P<0.05) apparent digestibility of OM compared to in the non- supplemented sheep (Table 3). The control treatment had lower (P<0.001) apparent CP digestibility compared to the low, medium and high levels of WB supplemented treatments. Moreover, the sheep on the low level of WB supplementation had lower (P<0.001) apparent digestibility of CP than those on the high level of supplementation. The result of this study agrees with a similar study (Ponnampalam *et al*., 2004) which reported a significant increase in hay DM digestibility in lambs supplemented with oat, and a further increase in DM digestibility with barley supplementation. Nuwanykpa and Butterworth (1987) also reported lower apparent digestibility of nitrogen in sheep fed solely on tef straw supplemented with molasses compared to those supplemented with urea or fed tef straw alone. Based on their results, the same authors argued that nitrogen deficiency may be a greater cause of poor performance than energy deficiency in sheep fed solely on cereal crop residues. The NDF digestibility was similar in all treatments, which agrees with the results of Nuwanykpa and Butterworth (1987) in Ethiopian Highland sheep fed on a basal diet of tef straw supplemented with noug seed cake.

Table 3. Apparent digestibility coefficient of feed nutrients in intact and castrated Afar sheep fed urea treated tef straw supplemented with graded levels of wheat bran.

	Apparent digestibility				
Factor	DM (%)	OM (%)	CP (%)	NDF (%)	ADF (%)
A (Sex)					
Intact	0.76	0.78	0.72	0.80	0.78
Castrated	0.78	0.80	0.75	0.81	0.80
SL	ns	ns	ns	ns	ns
SEM	1.08	0.91	1.31	1.17	1.16
B (WB level)					
0 g	0.73^{b}	0.76^{b}	0.62^{c}	0.82	0.82
150 g	0.77^{ab}	0.80^{ab}	0.74^{b}	0.81	0.80
250 g	0.78^{a}	0.80^{ab}	0.77^{ab}	0.79	0.77
350 g	0.81^{a}	0.82^{a}	0.80^{a}	0.81	0.79
SL	*	*	***	ns	ns
SEM	1.53	1.29	1.85	1.66	1.64
A x B (Interaction)					
SL	ns	ns	ns	ns	ns
SEM	2.16	1.82	2.61	2.34	2.32

*^{abc}= Means within a column not bearing a common superscript differ significantly; *= P< 0.05; **= P< 0.01; ***= P< 0.001; ADF= acid detergent fiber; DM= dry matter; CP= crude protein; ns= not significant; NDF= neutral detergent fiber; OM= organic matter; SEM= standard error of means; SL= significance level; WB= wheat bran.*

3.4. Body Weight Change

The daily BW gain was higher (P<0.001) in the order of high > medium > low > zero (control) level of supplementation (Table 4). Final BW and FCE were higher (P<0.001) in sheep supplemented with WB compared to those fed only UTTS. Out of all the supplemented sheep, those on the high level of WB supplementation had higher (P<0.001) final BW and FCE compared to those on the low level of WB supplementation (Table 4). In agreement with this study, supplementation of WB in rice straw based feeding of entire bulls (Chowdhury, 1996), and supplementation of WB in mixture with groundnut cake to pregnant does (Getnet *et al*., 1998) resulted in substantial BW gain. However, supplementation with mixtures of multi-purpose trees resulted in higher BW gain and final BW compared to supplementation with WB in tef straw based feeding of Menz sheep (Solomon *et al*., 2004). The absence of BW loss in Afar sheep fed sole UTTS is similar to the results of Trach (2004) which reported BW gain in steers fed on urea treated rice straw. This could be attributed to higher straw DM intake which, in turn, could have stemmed from the increased digestibility of the UTTS. Moreover, the CP content of the UTTS accounted for more than the minimum requirement of 7% and 8% to limit microbial fermentation in the rumen and feed intake in the host animal, respectively (Van Soest, 1994). Contrary to the results of this study, Sibanda *et al*. (1989) reported that FCE was not affected by the level of protein supplementation. However, in agreement with the current study, Merkel *et al*. (1999) reported lower FCE in control lambs compared to lambs fed tree leaves at 50% dietary CP intake. Abule (1994) also reported FCE increasing linearly with the level of supplementation. Higher nitrogen utilization efficiency at higher than lower levels of CP supplementation was also reported by Tegene *et al*. (2001).

Muhikambele *et al*. (1996) reported that castrated goats were less efficient in utilizing barley based concentrate and lucerne pellets than intact ones. Field (1971), Price and Yeats (1971) also indicated that entire males utilized feed better than castrated ones. However, the results of this study did not show differences between castrated and intact Afar sheep in FCE, daily BW gain and final BW achieved.

Table 4. Body weight change and feed conversion efficiency of Afar sheep fed urea treated tef straw supplemented with graded levels of wheat bran.

Factor	Initial BW (kg)	Daily BW gain (g/d)	Final BW (kg)	FCE
A ("Sex")				
Intact	15.7	65.6	21.6	0.07
Castrated	15.8	68.8	22.0	0.07
SL	ns	ns	ns	ns
SEM	0.11	4.00	0.33	0. 004
B (WB level)				
0 g	15.9	40.3^{d}	19.5^{c}	0.05^{c}
150 g	15.7	64.6^{c}	21.5^{b}	0.07^{b}
250 g	15.8	75.7^{b}	22.6^{ab}	0.09^{ab}
350 g	15.7	88.2^{a}	23.6^{a}	0.09^{a}
SL	ns	***	***	***
SEM	0.16	1.00	0.47	0.006
AxB (Interaction)				
SL	ns	ns	ns	ns
SEM	0.23	1.00	0.66	0.82

*^{abcd}=means within a column not bearing a common superscript differ significantly; *= P< 0.05; ** P< 0.01; *** P< 0.001; BW= body weight; FCE= feed conversion efficiency; ns= not significant; SEM= standard error of mean; SL= significance level; WB= wheat bran.*

3.5. Carcass Characteristics

Supplementation with the high level of WB resulted in heavier empty BW (P<0.01), hot carcass weight (P<0.01) and rib eye area (P<0.001) compared to the other treatments (Table 5). Moreover, the medium level of WB supplementation resulted in heavier (P<0.01) hot carcass weight compared to the non- supplemented sheep, and both the medium and low level of WB supplementation resulted in higher (P<0.001) rib eye muscle area compared to in the non- supplemented sheep. This agrees with the results of Asnakew (2005) which reported heavier empty BW for Hararghe Highland goats supplemented with concentrates. Rib-eye muscle area is mostly used as a tool to indicate the proportion of carcass lean or an expression of carcass desirability (Wolf *et al.*, 1980) and, in this regard, supplementation appeared to impart better carcass quality characteristics. The interaction between sex and level of WB supplementation was significant (P<0.01) for rib-eye muscle area, indicating that supplementation could disfavor carcass leanness in castrated Afar sheep, whereas the contrary is true for the non-castrated ones. Dressing percent on slaughter weight base was higher (P<0.01) for the WB supplemented sheep compared to those fed only UTTS. The dressing percent observed in this study agrees with the results of similar studies (Asnakew, 2005; Simret, 2005). According to Devendra and Burns (1983), dressing percent helps to assess the meat production capacity of animals. Therefore, it can be inferred that supplementation of UTTS with WB has contributed to increased meat production of Afar sheep. Castrated sheep had higher (P<0.05) omental fat than the intact sheep, (table 6) and this could be attributed to the fact that castrated animals tend to deposit more fat in their body compared to intact ones. Sheep supplemented with the high level of WB had heavier intestinal fat (P<0.05), omental fat, TEOC, skin and TUP (P<0.01) compared to sheep fed solely on UTTS. According to Kirton *et al.* (1972), nutritional dietary status of the animal and BW affect the production efficiency of offals. In agreement with the current study, Solomon *et al.* (1991) reported lower omental fat deposition for non- supplemented compared to maize, noug cake and alfalfa supplemented Afar goats.

The lack of differences in dressing percent and rib-eye muscle area between intact and castrated Afar sheep in this study agrees with other studies (Solomon *et al.*, 1991; Yibrah *et al.*,1991; Demissie *et al.*, 1989) in Afar goats and Horro sheep maintained at a high level of nutrition. Osman *et al.* (1970) also reported no effect of castration on hot carcass weight and dressing percent in 14 month-old Sudan Desert sheep. Unlike the findings of Mahgoub *et al.* (1997), this present study showed that yearling intact and castrated Afar sheep are equally suitable for meat production since they attained similar slaughter weight without reduced FCE and the risk of becoming excessively fat.

Table 5. Carcass characteristics of castrated and intact Afar sheep fed on urea treated tef straw and supplemented with graded levels of wheat bran.

Factor	SW (kg)	EBW (kg)	HCW (kg)	Rib-eye area (cm^2)	Dressing percentage	
					SW base	EBW base
A (Sex)						
Intact	20.8	16.2	8.5	5.4	42.0	52.4
Castrated	20.2	15.1	8.3	5.3	43.1	54.9
SL	ns	ns	ns	ns	ns	ns
SEM	0.55	0.48	0.25	0.15	0.93	1.32
B (WB level)						
0 g	19.4	13.8^{b}	7.2	4.3	38.3^{b}	51.8
150 g	19.8	15.3^{b}	8.2^{c}	5.1^{b}	42.3^{a}	53.1
250 g	20.6	15.6^{b}	8.6	5.2^{b}	44.1^{a}	54.1
350 g	22.2	17.9^{a}	9.7^{a}	6.6^{a}	45.6^{a}	55.5
SL	ns	**	**	***	**	ns
SEM	0.78	0.68	0.35	0.21	1.31	1.87
AxB						
1	18.8	13.3	6.7	3.71^{e}	37.0	50.1
2	19.8	15.9	8.3	4.96^{cd}	44.3	52.5
3	21.9	16.6	9.0	6.09^{ab}	43.2	52.7
4	22.8	19.1	10.0	6.67^{a}	43.7	55.6
5	19.2	14.3	7.7	4.19^{de}	39.5	51.0
6	19.9	15.3	8.8	4.81^{cd}	46.8	53.7
7	19.2	14.1	7.3	5.40^{bc}	41.5	54.3
8	21.6	16.7	9.3	6.61^{a}	44.5	58.6
SL	ns	ns	ns	**	ns	ns
SEM	1.37	0.96	0.50	0.29	1.86	2.60

*^{abc}= Means within a column not bearing a common superscript differ significantly; *=P<0.05; **= P<0.01; ***= P<0.001; EBW= empty body weight; HCW= hot carcass weight; ns= not significant; SEM= standard error of means; SL= significance level; SW= slaughter weight; T1= intact sole UTTS; T2= intact UTTS + 150 g DM WB; T3= intact UTTS + 250 g DM WB; T4= intact UTTS + 350 g DM WB; T5= castrated sole UTTS; T6= castrated UTTS + 150 g DM WB; T7= castrated UTTS + 250 g DM WB; T8= castrated UTTS + 350 g DM WB; UTTS = urea treated tef straw;WB = wheat bran.*

Table 6. Carcass offal characteristics of castrated and intact Afar sheep fed on urea treated tef straw and supplemented with graded levels of wheat bran.

Factor	Empty gut (kg)	Omental fat (g)	Intestinal fat (g)	Tail (g)	TEOC (kg)	Skin (kg)	Genital organ (g)	Gut fill (kg)	TNEOC (kg)	TUP (kg)
A (Sex)										
Intact	1.15	66.94^{b}	104.0	621.4^{b}	11.7	2.5	209.3^{a}	5.1^{a}	3.7^{a}	14.2^{a}
Castrated	1.22	87.03^{a}	122.0	848.8^{a}	11.2	2.2	95.4^{b}	5.2^{a}	2.6^{a}	13.4^{a}
SL	ns	*	ns	**	ns	ns	***	ns	ns	ns
SEM	0.04	6.68	7.84	60.00	0.38	0.01	11.67	0.02	0.50	0.47
B (WB level)										
0 g	1.1	50.8^{c}	88.4^{b}	565.9	9.9^{b}	1.9^{c}	94.5^{b}	4.4^{b}	2.7	11.9^{b}
150 g	1.2	65.0^{bc}	110.3^{ab}	686.7	11.4^{ab}	2.1^{bc}	152.7^{a}	5.0^{ab}	2.8	13.5^{b}
250 g	1.2	80.7^{b}	114.1^{ab}	797.5	11.5^{ab}	2.5^{ab}	165.4^{a}	5.3^{ab}	3.3	13.9^{ab}
350 g	1.3	111.5^{a}	139.2^{a}	890.2	12.9^{a}	2.9^{a}	196.8^{a}	6.1^{a}	3.7	15.8^{a}
SL	ns	**	*	ns	**	**	**	*	ns	**
SEM	0.06	9.44	11.10	113.1	0.53	0.01	16.50	0.03	0.70	0.67
AxB										
1	1.0	47.6	85.4^{a}	515.0^{b}	9.2^{c}	1.8	179.5^{bc}	3.9	2.7	10.9^{c}
2	1.1	49.1	100.0^{a}	560.0^{b}	11.0^{bc}	2.2	125.9^{cd}	5.3	2.9	13.2^{bc}
3	1.2	74.6	113.7^{a}	575.0^{b}	12.3^{ab}	2.7	239.9^{ab}	5.6	3.1	15.0^{ab}
4	1.4	96.4	117.0^{a}	1020.0^{ab}	14.3^{a}	3.2	309.3^{a}	5.8	4.0	17.5^{a}
5	1.1	54.0	91.5^{a}	480.4^{b}	10.6^{bc}	2.0	80.3^{d}	4.7	2.3	12.8^{bc}
6	1.2	80.9	103.6^{a}	616.7^{b}	10.7^{bc}	2.1	84.4^{d}	4.9	2.5	12.8^{bc}
7	1.3	86.7	164.8^{a}	813.3^{ab}	11.5^{bc}	2.2	90.8^{d}	5.1	2.6	13.9^{bc}
8	1.2	126.6	128.06^{a}	1300.0^{a}	11.9^{b}	2.5	108.7^{cd}	6.4	4.9	14.1^{bc}
SL	ns	ns	ns	*	*	ns	**	ns	ns	*
SEM	0.09	13.35	15.68	160.00	0.75	0.02	23.34	0.05	1.00	0.94

*^{abcd} means in the same row with different superscripts differ significantly; *** =(P<0.001); ** =(P<0.01); * =(P<0.05); ns =not significant; SEM =standard error of mean; SL =significance level; T1=intact sole UTTS; T2 =intact UTTS + 150 g DM WB; T3 =intact UTTS + 250 g DM WB; T4 =intact UTTS + 350 g DM WB; T5 =castrated sole UTTS; T6 =castrated UTTS + 150 g DM WB; T7 =castrated UTTS + 250 g DM WB; T8 =castrated UTTS + 350 g DM WB; TEOC =total edible offal component; TNEOC =total non edible offal components; TUP =total usable product; UTTS =urea treated tef straw; WB =wheat bran.*

4. Conclusions

The results of the study showed that UTTS could support a reasonable level of feed intake and animal performance. Moreover, it was found that level of supplementation is more significant regarding the performance of Afar sheep in feed intake, BW and carcass parameters than castration or maintaining them intact during small scale fattening schemes. Failure to observe differences in BW, FCE and carcass characteristics between intact and castrated Afar sheep could be attributed to the age of the sheep used in the study.

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