Effect of Graded Levels of Concentrate Supplementation on Carcass Yield and Characteristics of Local Sheep Fed Urea Treated Maize Cob as a Basal Diet

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Abstract

The experiment was conducted with the objective of investigating the effect of graded levels of wheat bran (WB) and noug seed cake (NSC) mixtures on carcass yield and characteristics of local Arsi-Bale sheep fed urea treated maize cob (UTMC). The experiment consisted of digestibility and ninety days of feeding trials followed by evaluation of carcass components at the end of these trials. Twenty yearling male sheep were used as experimental animals in this research. The experimental design was randomized complete block design. The treatments were *ad libitum* feeding of UTMC (T1) and supplementation with mixtures of WB and NSC at a ratio of 2WB:1NSC offered at 150 g (T2), 250 g (T3) and 350 g DM/head /day (T4). Water and salt were offered free choice and UTMC was given *ad libitum* throughout the experimental period. The result indicated that dressing percentage on slaughter weight (SWT) and hot carcass weight (HCW) basis was higher (P<0.001) for supplemented sheep than the control. Similarly, rib eye muscle area was higher (P<0.001) in supplemented sheep than the control group. Generally, T4 improved carcass yield as well as characteristics and could be used as an alternative feed supplement in UTMC based feeding of Arsi-Bale sheep.

Keywords: dressing percentage, edible offal, local sheep, maize cob, urea treatment

1. Introduction

Varying agro-ecologies and subsequent variations in vegetation and crop types enabled Ethiopia to keep a huge livestock population in Africa [1]. Despite the large sheep population in Ethiopia, the productivity per animal is relatively low and meat production is estimated at about 3.5 kg per sheep per year in the population and 10 kg per sheep slaughtered. Both values are very low when compared with those in neighboring countries that have small ruminant population of 50–75% less than Ethiopia [2].

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The main cause for low productivity of sheep in Ethiopia is shortage of feeds both in quantity and quality particularly during the dry season. Lester [3] and ILRI [4] reports had asserted that demand for meat and milk will be increased and more than double over the next two decades in developing countries.

The major factors driving the demand for livestock source foods are population growth, increased urbanization and higher incomes in developing countries [4, 5].

Ethiopians remained slightly below the meat intake of all low-income countries consuming only 9kg per capita annually [6]. Pertaining to market availability for export, there is high demand for live animals as well as meat from small ruminants by consumers in the Middle East, North and West African countries [7].

High population growth rate in developing countries, like Ethiopia, is expected to continue to limit grazing land that can be devoted to livestock production [8]. The problem of feeds can be aggravated because of shrinkage of the pasture land which emanates from the expansion of cropping land. Above all, shortage and increase in feed costs due to competition between man and animals for cereal grains has consequently stimulated interest in ways of making use of agricultural by products in the diets of monogastrics and ruminants [9, 10].

Since the costs of sheep feeds prepared from concentrates will be very prohibitive, attempts are being made by some researchers to formulate sheep rations based mainly on agricultural and agro-industrial by-products such as maize crop by products. Among maize crop by products, maize cob is the common and widely known but underutilized crop residue in Ethiopia [11]. The major limitation of maize cob to be used in animal feeding is its low digestibility due to lignifications of its cell walls which form bulk of the materials. It is also low in crude protein, water and most likely some essential minerals [12]. Maize cob can be used as sheep feed provided that it is properly treated and supplemented with other agro-industrial by products. It can be treated using urea. Urea is cheap and safe form of chemical that decomposes into ammonia, and facilitates the breakdown of cell wall fibers in maize cobs [13].

One of the carcass parameters in evaluating meat is dressing percentage. Dressing percentage of meat animals depends on the level of nutrition, species, breed, sex, season, age, gut fill, castration, live weight, methodology and pre-slaughter management [14]. However, almost no research work has been done to study the effect of maize cob on animal feeding and meat yield under Ethiopian condition. Moreover, no attempts were made to study the use of sole UTMC as a basal diet in sheep. Therefore, this study was designed to find the effects of feeding graded levels of concentrate mixture on carcass yield and its characteristics in Arsi-Bale sheep fed on a basal diet of UTMC.

2. Materials and methods

Experimental Animals and Feeds

Twenty yearling male Arsi-Bale sheep were used to conduct the experiment. The initial body weight of the sheep was 20.56±0.45 (mean±SD) kg. Maize cob of variety BH660 was collected and chopped to approximate size of 1-3 cm, and treated with urea solution in the ratio of 4 kg of urea to 100 kg of maize cob on air DM basis. Firstly, a 4 kg of urea was thoroughly dissolved in 50 liters of water and then uniformly sprayed onto 100 kg of chopped maize cob batch by batch. The treated maize cob was ensiled for 3 weeks as recommended [15]. Concentrate mix was prepared by mixing 33% of NSC with 67% of WB based on their DM content in order to maintain at least 22% CP from the two ingredients based on the averaging out of research results of the previous works in order to attain the recommendation made [16] who suggested that for moderate and rapid growing lambs that weigh 10 to 20 kg body weight, the CP required per day would range from 16.3 to 26.4%.

Experimental Design and Treatments

The experimental design that was used was a randomized complete block design. Animals were categorized into five blocks each containing four animals based on initial body weight of the sheep. The four experimental treatments (Table 1) were randomly allocated to each animal in a block. The sheep were disinfected to control external parasites, dewormed to prevent internal parasites and vaccinated against common infectious diseases of sheep and injected multi vitamins after arrival to minimize stress during transportation. They were quarantined for 5 days and acclimatized to treatment feeds for another 15 days.

Table 1. Experimental treatments

Treatments	UTMC (basal feed)	Supplements
		WB+NSC (g) on DM base
T1	*ad libitum*	0
T2	*ad libitum*	150 (low)
T3	*ad libitum*	250 (medium)
T4	*ad libitum*	350 (high)

DM=dry matter, NSC=noug seed cake, T1=UTMC alone, T2=UTMC+150 g supplement, T3=UTMC+250 g supplement, T4=UTMC+350 g supplement and WB=wheat bran

Feeding Management

The experimental sheep were offered the basal diet, UTMC allowing 35-45% refusal of previous 5 days' intake. The supplements were offered in two equal portions at 0800 and 1600 h, respectively. Experimental sheep had free access to water and common salt. The same feeding management was maintained for the digestibility trial of 7 days and the feeding trial of 90 days.

Chemical analysis of feeds

Samples of feeds used in treatments and feces collected were sent to National Veterinary Institute and subjected to laboratory analysis for DM, OM, CP and ash following the procedure [17] and the neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) components of each ingredient and feces were determined according to Van Soest et al. [18] procedures.

Caracas yield and characteristics

At the end of the feeding trial, experimental sheep were slaughtered after overnight fasting to determine the effects of treatment feeds on carcass parameters. Edible and non-edible offal were weighed and recorded. Empty body weight was calculated as slaughter weight less gut contents. Hot carcass weight was estimated after removing weight of head, skin, thoracic, abdominal and pelvic cavity contents as well as legs below the hock and knee joints. The carcass was partitioned into hind and fore quarter between 12 and 13 ribs of the carcass. Rib eye area was then traced on 12 ribs [19]. The dressing percentage was calculated as hot carcass weight percent on slaughter weight and empty body weight base.

Statistical Analysis

The data collected on feed intake, body weight and carcass parameters were subjected to statistical analysis of variances (ANOVA) using the General Linear Model Procedure of Statistical Analysis System [20] version 8. Treatment means were separated using least significant difference (LSD). The model used for the analysis of data on feed intake, body weight and carcass parameters was:

$$Yij = \mu + \alpha_i + \beta_j + e_{ij}$$

3. Results and discussion

Experimental feeds and their chemical composition

The chemical compositions of experimental feeds used in the present experiment are shown in Table 2. Urea treated maize cob produced a pleasant smell which is an indication of the occurrence of good fermentation process and the formation of organic acids. DM and OM contents of feeds used were above 90% except NSC that possessed 88.5% of OM. Charray et al. [13] revealed that untreated maize cob contained 93.3 and 3.2% DM and CP contents, respectively. Besides, Urio and Kategile [21] described the chemical composition of untreated maize cob to be 88.1% DM, 2.2% CP, 3.9% ash and 17.3 gross energy in MJ/kg DM. Girma Abebe [22] also mentioned that 89.6, 84.6, 53.7, 2.8 and 7.3% DM, NDF, ADF, CP and lignin content for lime treated maize cob, respectively. The same author mentioned that dietary energy of water treated and ensiled maize cob based diet is low and the energy concentration of the diet is below that of the maintenance requirement. The chemical analysis in the present study showed that UTMC contained higher CP and lower NDF percentage as compared to untreated maize cob. Dry matter, OM, EE and NDF were reduced by 4.2, 0.3, 7.4 and 9.8%, respectively. This might be due to hydrolysis of fibrous fraction during ensiling. On the other hand, ADF and ADL increased by 0.4 and 0.3% and this might happen because of production of artifact lignin or Maillard reaction during the process of long ensiling period.

Table 2. Chemical composition of treatment feeds

Feed items	DM	OM	CP	EE	NDF	ADF	ADL	Ash
	% DM							
Untreated maize cob	95.1	98.2	4.4	15.0	84.6	40.6	5.9	1.8
Urea treated maize cob	90.9	97.9	9.3	7.6	74.8	41.0	6.2	2.1
Wheat bran	93.4	94.7	14.9	3.5	41.0	12.0	1.8	5.3
Noug seed cake	95.1	88.5	29.4	8.9	38.2	32.8	7.6	11.4
Mix of WB+NSC(2:1)	93.4	93.1	22.6	5.5	40.0	15.6	4.2	6.9

ADF: acid detergent fiber, ADL: acid detergent lignin, CP: crude protein, DM: dry matter, EE: ether extract, Mix: mixture, NDF: neutral detergent fiber, NSC: noug seed cake, OM: organic matter, WB: wheat bran

In line with this, Van Soest and Robertson [23] explained that heat damaged protein is recoverable in the fiber, specifically in the lignin fraction. It is also possible to presume that loss of hemicelluloses would proportionately increase the lignin content. The observed CP value difference could be because of urea treatment that could add nitrogen source to the maize cob during treatment.

UTMC showed 111% increment in CP content and this result is nearer to the value reported by [24] who reported increased CP content of urea treated tef straw by 121%. Tuah and Orskov [25] reported increment of N from 0.5 to 1.29% when maize cob was treated with 3.5% ammonia. In another study, chopped maize straw treated with 4% urea and ensiled for 1 week had resulted in CP content of 8.4% compared with 4.8% of untreated straw [26].

Based on its CP content, the basal diet used in this study can be considered as medium quality roughage and used as a good source of roughage feed that can provide sufficient CP required for proper function of rumen microbes as Van Soest [27] indicated that roughage containing 7% CP can be considered as medium quality roughage. However, its high NDF and ADF content might have contributed to low nutritional quality, and thus might render it to be categorized as a low quality feed. Cognizant of this, Cheeke [28] mentioned that roughage with NDF content greater than 65% is classified as low quality feed. This suggests that the current basal diet can be considered enough poor quality feed. Bishaw and Melaku [29] reported that the mixture of WB and NSC at similar ratio (2WB:1NSC) had DM, OM, NDF, ADF, ADL, CP and ash content of 94.05, 93.1, 37.65, 20.54, 7.49, 23.79, and 7.89, respectively. The assumed and observed CP contents of concentrate mixture in this study were 22 and 22.6%, respectively. The reduction in observed CP content of mix in this study was possibly due to the reduction in CP content of the two ingredients (WB and NSC) that could be affected by various factors.

Wheat nutrients composition varies depending on the original form and the extraction rate [30]. Accordingly, fine wheat contains CP that ranges from 16 to 21% and coarse wheat or bran contains less CP content. In support of this, AFCO [31] reported 13.5 to 15% CP for wheat bran, and the CP content of wheat bran (14.9%) used in this study was within the range indicated. The chemical composition of NSC used in this study was closer to that reported by Bishaw and Melaku [29] which were 38.79, 30.43, 12.21 and 28.99% for NDF, ADF, ADL and CP, respectively. The slight variation observed may be due to the difference in efficiency of extraction while extracting oil and other internal and external factors.

Body weight gain and feed conversion efficiency

Body weight parameters of the experimental sheep are presented in Table3. The final body weight and daily body weight gain were higher (P<0.001) for the supplemented compared to the control treatment. Among the supplemented treatments, sheep in T4 had better (P<0.001) performance in final body weight and daily body weight gain. The daily body weight gain for sheep with the high level of supplementation in the current study is similar with report of Wambui [32]. The lower body weight gain for sheep in the control treatment could be attributed to the high cell wall fiber content of UTMC resulting in poor supply of nutrients.[16] revealed that low energy intake that results from either feed restriction or low ration component digestibility prevents sheep from meeting their requirements and from attaining their genetic potential. In support of this, the negative control group lost weight over the experimental period when experimental sheep were offered maize stover basal diet with cowpea (*Vignaunguiculata*) haulms or commercial concentrate [33]. Abebe Tafa [34] also reported that Arsi-Bale sheep fed hay containing 6.75% CP diet lost body weight by 1.52 g/day.

Table 3. Body weight parameters and feed conversion efficiency of Arsi Bale sheep fed urea treated maize cob and supplemented with graded levels of noug seed cake and and wheat bran mixture

Parameters	T1	T2	T3	T4	Mean	SD	SEM	SL
IBWT (kg)	20.2	20.1	20.5	21.3	20.5	0.54	0.45	ns
FBWT (kg)	18.3^{c}	23.1^{b}	24.8^{b}	28.6^{a}	23.7	4.27	0.95	***
DWTG (g)	-9.2^{c}	33.3^{b}	48.0^{b}	80.8^{a}	38.2	37.33	7.74	***
TDMI (g)	505.1^{d}	688.4^{c}	844.1^{b}	966.9^{a}	751.1	177.12	7.07	***
FCE (%)	-1.8^{d}	5.1^{c}	5.8^{b}	8.6^{a}	4.43	4.42	0.04	***

$^{a, b, c, d}$ Means with same letter in the same row are not significantly different, ***=(P<0.001), DWTG: daily weight gain, FBWT: final body weight, FCE; feed conversion efficiency, IBWT: initial body weight, ns: non-significant, SEM: standard error mean, SL: significant level, T1=control (UTMC alone), T2=UTMC+150g(67%WB+33%NSC), T3=UTMC+250 g (67% WB: 33% NSC), T4=UTMC+350 g (67%WB:33% NSC)

Feed conversion efficiency (FCE) varied (P<0.001) in the order T4>T3>T2>T1.Better performance in body weight and FCEof highest supplement group in the current study might be related to better nutrient utilization of sheep. In agreement with this, sheep fed on high protein (HP, 208 g) showed high live weight gain (36.6 g/day) as compared to those fed on low protein (106 g/kg DM) which was 10.7g/day) [35]. Megahed and Etman [36] reported increment in body weight gain from 47.65 to 59.44 kg in Saidi rams fed on 1% UTMC supplemented with 500 g/head/day concentrate feed mixtures. Additionally, higher daily weight gain was also observed in sheep fed rations containing UTMC ensiled with enzose than in those fed UTMC ensiled without enzose [37].

The low FCE of sheep in the control treatment in the current study was probably the result of low protein and energy intake and high fiber content of the diet that might have caused the net efficiency of use of metabolizable energy to be depressed slightly. In general, FCE was improved as a result of supplementation of concentrate mix to UTMC as in line with many other reports [34, 38].

Carcass Characteristics

Different carcass characteristics of experimental sheep are given in Table 4. Except for dressing percentage on empty body weight basis, all the other carcass parameters were lower (P>0.05) for the control compared to the supplemented sheep. Among the supplemented sheep, hot carcass weight was higher (P<0.001) in the order of T4>T3>T2. Slaughter body weight, empty body weight and rib eye muscle area were higher (P<0.001) for T4 compared to T3 and T2.

Table 4. Carcass characteristics of Arsi Bale sheep fed urea treated maize cob and supplemented with different levels of noug seed cake and wheat bran mixture

Parameters	T1	T2	T3	T4	SEM	SL
SBWT(kg)	18.3^{c}	23.1^{b}	24.8^{b}	28.6^{a}	0.95	***
EBWT(kg)	14.3^{c}	18.2^{b}	20.1^{b}	23.5^{a}	0.73	***
HCWT(kg)	6.9^{d}	9.2^{c}	10.4^{b}	12.1^{a}	0.40	***
Dressing % on:						
SBWT	37.8^{b}	39.8^{ab}	42.0^{a}	42.5^{a}	0.92	*
EBWT	48.3	50.2	52.1	51.7	1.06	Ns
REMA(cm^2)	4.4^{c}	6.2^{b}	6.7^{b}	8.1^{a}	0.29	***

$^{a, b, .c, d}$ Means with different superscripts in row are significantly different *=(p<0.05),***=(P<0.001), EBWT: empty body weight, HCWT: hot carcass weight, ns: non-significant, REMA: rib-eye muscle area, SBWT: slaughter body weight, SEM: standard mean error, SL: significant level.

Dressing percentage is the proportion of body weight considered to be edible and it is an important trait in carcass merit consideration. The dressing percentage of sheep can vary between 35 and 45, and largely depends on slaughter weight of the animals [39]. It is affected by breed, age, sex, and plane of nutrition [40]. In general, level of nutrition is known to influence body condition or carcass composition significantly [41]. Pralomokarn et al. [42] indicated that dressing percentage increased as feed intake increased. Additionally, Adu and Brinckman [43] revealed that dressing percentage tends to increase with increasing the level of concentrate supplementation. Moreover, report of Michael and Yayneshet [44] revealed that higher carcass yield was observed for higher level of concentrate supplementation in Tigray highland breed. Higher dressing percentage (41.2 and 47.7%) was reported by Galal et al. [45] in the feedlot performance of Ethiopian highland sheep and Horro lambs, respectively when fed on ration containing 50% native grass hay. Additionally, Sendros Demeke [46] reported that grazing lambs supplemented with concentrate had higher slaughter weight (31.3 kg), hot carcass (13.7 kg) and dressing percentage (43.3 kg) than the non-supplemented lambs that had slaughter weight, hot carcass and dressing percentage of 21.7, 8.8 and 40.5 kg, respectively. Similar effects were reported by Abebe Tafa [34] on local sheep breed subjected to supplementation with linseed cake and wheat bran and their mixture. Gebremeskel and Kefelegn [48] reported that diet (NSC and WB) had a significant effect on empty body weight (17.2, 19.7, 21.0 and 18.3, 19.5, 20.7 kg) and hot carcass weight (7.5, 8.3, 9.0 and 7.7, 8.2, 8.6 kg) for Horro and Washera sheep, respectively. However, dressing percentage on slaughter and empty body weights basis as well as rib eye muscle area was not significant. As reported by Hirut et al. [49], Tigray high land sheep have shown hot carcass weight of (7.11, 7.19, 8.17 and 8.57 kg) and dressing percentage on empty body weight base (46.2, 46.3, 50.1 and 53.4%) that were significantly different with level of concentrate supplementation (control, 150, 200 and 250 g), respectively.

The present dressing percentage is within the range mentioned by Gelgelo et al. [50] and Payne [51] who reported dressing percentage that ranged from 38.8-57.3 and 32.6-54.5%, respectively. Animals should be adequately fed if high dressing is to be achieved [52]. In agreement with this, O'Rourke et al. [53] described that the dressing percentage of different breeds differ and can be improved by some extent through improved feeding and management. Moreover, other reports by Gelgelo et al. [50] indicated that differences in most carcass traits are consistent with the differences observed for final weight and FCE which in turn are mainly the results of environment particularly feeding regime. Breed affected the dressing percentage that ranged from 42.5 to 44.6% and 54.3 to 55.8% on SBW and EBW basis, respectively [2].

Rib eye area indicates the muscular development of the animal that will be increased through the live weight gain. In the current study, the lack of significant difference between T2 and T3 in dressing percentage and rib eye muscle area can be due to similarity in their daily body weight gain and final body weight indicating that there was no difference in improvement of carcass yield through the feeding of 150 g supplement (T2) and 250g supplement (T3). Sheep that consumed high CP demonstrated better rib eye muscle area and this can indicate that comparatively those groups had efficiently used nitrogen for body growth. The rib eye muscle area is used by the industry as a predictor of meat yield as it is correlated with the overall retail cut yield of a carcass [54] with a higher meat to bone ratio and more beneficial to farmer or its higher prices.

Carcass composition is an important aspect of meat quality and is normally assessed by amount of physical dissected tissues (muscle, fat and bones) or chemical analysis of constituents i.e. protein, fat, water and ash [55]. According to the report of Getahun Legesse [56], greater eye muscle area is associated with a higher production of lean in the carcass and higher lean to bone ratio. Therefore, in the current study, sheep fed higher level of supplement showed relatively higher rib eye muscle area which is a reflection of increase in lean meat and this in turn would prove the quality of meat.

Various studies showed that supplementation had significant and positive effect on rib-eye muscle area. Lawrence and Fowler [57] reported significantly higher ($P<0.05$) rib-eye muscle area (13-19.5 cm^2) on sheep supplemented with brewer's dried grain than is observed in the current study and Sendros Demeke [46] also reported 6.9-9.2 cm^2 rib eye muscle area. Smaller rib eye muscle area (3.15- 6.95 cm^2) as compared to the present study was reported by Assefu Gizachew [47] and a comparable rib eye muscle area (3.7-8.4 cm^2) with the current study was also reported by Banerjee [52].

Edible carcass offals

Carcass offal components are categorized into edible and non-edible based on tradition, beliefs, culture, and differences in preference of the people from one locality to the other and is so more or less subjective [58]. Edible carcass offals of sheep under study are shown in Table 5. Blood, heart, testis, omental and mesenteric fat, kidney fat, kidney and liver were significantly (P<0.001) higher in the supplemented treatments as compared to the control treatments. The increase in liver weight with supplementation might be related to the storage of reserve substances like glycogen [52]. Similarly, Assefu Gizachew [47] reported significantly higher values in the supplemented sheep for aforementioned parameters.

In agreement with the present study, Targhee sheep fed on concentrate had gained heavier weight of visceral fat than alfalfa fed sheep. In the current study, higher (P<0.001) heart weight was observed in T3 and T4 as compared to T2 and the control treatment.

Table 5. Effect of supplementation of graded levels of noug seed cake and wheat bran mixture on edible carcass offals of Arsi Bale sheep fed urea treated maize cob based diet

Parameters	T1	T 2	T3	T4	SEM	SL
Blood (g)	809.6[c]	1090[b]	1174[b]	1318[a]	18.51	***
Tongue (g)	73.8	75.7	77.3	79.8	4.67	ns
Testis (g)	84.92[c]	218.4[b]	200.1 [b]	267.6[a]	8.17	***
Omental and mesenteric fat (g)	72.4[b]	97.2[b]	127.9[a]	133.7[a]	9.95	**
Empty gut (g)	1278[c]	1650[b]	1850[ab]	2060[a]	96.45	***
Heart (g)	75.6[b]	82.8[b]	103[a]	108.0[a]	3.81	***
Liver (g)	297.7[b]	350.2[b]	355.6[ab]	384.1[a]	20.77	**
Kidney (g)	52.7[c]	65.2[b]	67.4[b]	78.2[a]	2.18	***
Tail (g)	806[c]	1150[b]	1260[ab]	1390[a]	53.19	***
Kidney fat (g)	54.3[c]	62.3[b]	67.9[a]	63.2[b]	1.32	***
TEO (g)	3609[c]	4846.8[b]	5289.2[b]	5891.8[a]	103.67	***

[a,b,c,] Means with different superscripts in row are significantly different,**=(p<0.01) ***=(P<0.001), ns: non-significant, SEM: standard error mean, SL: significant level, TEO: total edible offals.

Higher (P<0.001) value was also seen in total edible offal (TEO) components in supplemented sheep as compared to the control sheep. In agreement with work of Tuah and Orskov [25] and [51], the supplemented group showed higher weight of TEO when compared to control group. This indicates that supplementation improved TEO of sheep that fed UTMC based diet. In general, supplementation has positively affected the production of visceral fat and other edible offal components. This might be due to the high energy content of supplement feed which promoted higher internal fat deposition, whereas sheep fed non supplemented UTMC did not obtain adequate energy even to satisfy their maintenance requirement. The same phenomenon has been mentioned by Tuah and Orskov [25]. It is revealed that production efficiency of offals can be affected by nutritional dietary status of the animals and their live weight [59].

Non edible carcass offals

Non edible carcass offals of the experimental sheep used in the experiment are presented in Table 6. Head without tongue, skin, feet, penis, gall bladder, spleen and urinary bladder were significantly (P<0.001) higher in supplemented treatments as compared to the control sheep. This suggests that supplementation has improved the growth of these organs. Impacted by the supplementation, especially the improvement seen in skin would contribute to the economic value of the product while better growth observed in testis would demonstrate reproductive potential of the sheep. It can be said that in the current study, the variations observed might be due to both the breed and dietary differences used in the experiment. However, there was no significant (P>0.05) difference among T1, T2, T3, and T4 for respiratory tract (lung, trachea and esophagus together). Comparable to the present trial, Assefu Gizachew [47] and Payne [51] reported non-significant difference in these specified parameters. Total non-edible offals (TNEO) were significantly higher (P<0.001) in supplemented sheep than the control ones. Moreover, T3 and T4 had higher (P<0.001) TNEO compared to T2. In contrast to this, other studies conducted by Tuah and Orskov [25] and Payne [51] reported non-significant difference in TNEO weight between controls and supplemented treatments. However, Banerjee [52] and Abebe Tafa [34] reported heavier TNEO for supplemented Wogera and Arsi-Bale sheep, respectively than the non-supplemented sheep fed basal diet of grass hay. Breed had a significant effect on most of the carcass parameters while dietary effects were statistically similar for most traits, except for dressing percent and some non-carcass components [2].

Table 6. Non edible offals of Arsi Bale sheep fed urea treated maize cob and supplemented with graded levels of noug seed cake and wheat bran mixture

Parameters	T1	T2	T3	T4	SEM	SL
Head without tongue (g)	1234.2[d]	1614.3[c]	1802.7[b]	2079[a]	41.76	***
Skin (g)	1302[b]	1910[a]	2020[a]	2240[a]	106.28	***
Feet (g)	506[b]	504.6[b]	539.0[b]	620.8[a]	13.40	***
Penis (g)	41.4[b]	55.4[a]	55.6[a]	64.4[a]	2.91	***
Lung, trachea end esophagus (g)	408.6	423.2	425	451.8	33.76	ns
Gall bladder (g)	3.0[c]	12.7[b]	16.8[a]	18.9[a]	2.50	***
Spleen (g)	30.7[b]	45.3[ab]	40.9[ab]	51.6[a]	4.43	*
Urinary bladder (g)	5.3[b]	9.4[a]	10.1[a]	10.6[a]	0.59	***
TNEO (g)	3535.3[c]	4579.9[b]	4916.7[a]	5556.8[a]	118.08	***

[a,b,c,d] Means with different superscripts in row are significantly different,*=(P<0.05), **=(P<0.01), ***=P<0.001), ns: non- significant, SEM: standard error mean, SL: significant level, TNEO: total non edibleoffals, T1=control (UTMC alone), T2=UTMC+150g (73%WB+33%NSC), T3=UTMC+250 g (67% WB:33% NSC), T4=UTMC+350 g (67%WB:33% NSC)

4. Conclusions

Except for dressing percent on empty body weight basis, all the other carcass parameters were lower for the control compared to the supplemented sheep. The results of this study showed that feeding UTMC to Arsi-Bale sheep and supplementing with 350 g concentrate mixture can be potentially selected as important alternative feed to attain high carcass yield and quality. This level of concentrate mixture supplement can also be used in other low quality agricultural by products to increase sheep carcass yield and quality.

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