Effects of Supplementing Cassava Leaf Meal, Brewers' Dried Grain and their Mixture on Body Weight Change and Carcass Traits of Local Goats Fed Urea Treated Tef Straw

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Abstract

There is shortage of animal feed in Ethiopia, especially during the dry season. So, there is a need to look for an alternative supplementary feed to small ruminants. Twenty-four yearling intact local goats with a mean live weight of 14.57 ± 2.2 kg (mean ± SD) were used to evaluate the effect of supplementing cassava leaf meal (CLM), brewers' dried grain (BDG) and their mixture on body weight change, feed conversion efficiency and carcass characteristics of goats fed urea treated tef straw (UTTS). The experiment consisted of 90 days of feeding trial and evaluation of carcass parameters at the end. The four treatments included *ad libitum* feeding of urea treated tef straw and supplementation with 0g (T_1), 300g cassava leaf meal (T_2), 150g CLM +150g brewers' dried grain (T_3) and 300g BDG (T_4).The goats weights were recorded at the beginning of the experiment and thereafter every ten days interval. The experimental goats were grouped in to six blocks of four animals based on initial live weight and randomly assigned to the four treatments. The crude protein (CP) content of UTTS, CLM and BDG were 8.3, 21.9 and 24.4 %, respectively. Feed conversion efficiency differed significantly ($p< 0.05$) among treatments, which was higher for T_3 than T_1. Supplementation had no effect ($p>0.05$) on final body weight and average daily gain. Positive average daily gain (1.1g/d) was observed in the control treatment, whereas 14.5, 21.15, 29.8 g/d was recorded for T_4, T_2 and T_3, respectively. Hot carcass weight and dressing percentage on slaughter weight basis was greater ($p<0.05$) for T_2 (5.9 ± 1.2 and 35.8 ± 2.8, respectively) than T_1 (4.3 ± 0.66 and 30.6 ± 1.5, respectively), while values for T_1 and T_4 (5.2 ± 0.76 and 34.2 ± 1.1, respectively) were similar with other treatments. Therefore, based on most performance parameters, T_2 and T_3 can be recommended as a better treatment in this study. This study also highlights the positive potential of CLM as a supplement to ruminants on a basal diet of fibrous feed.

Key words: cassava leaf, tef straw, brewer's grain, Carcass, Body Weight, Goats,

Introduction

In Ethiopia there is a gap between animal requirements and the available feeds, especially during the dry season. So, there is a need to look for cheap and available animal feed to feel the nutritional gap. Most of the goats in Ethiopia that are owned by smallholder farmers and pastoralists rely entirely on natural grassland and bushes as the sole source of feed (Workneh and Peacock, 1991). However, most (68%) of the feedstuffs available to goats have crude protein (CP) levels below 8% and neutral detergent fiber (NDF) of above 55% (Seyoum and Zinash, 1995). McDonald et al. (2002) showed that all the straws and related by-products are extremely fibrous, most have a high content of lignin and all are of low nutritive value.

Ethiopia's domestic demand for goat meat is high (Gryseels and Anderson, 1983) with goat meat realizing higher prices than mutton or beef in eastern part of the country (Farm Africa, 1996). Ethiopia is also competing in the world market by exporting goat meat to a number of Middle Eastern countries (Ethiopian Export Promotion Agency, 2003). In addition, small ruminants are considered as investment and insurance due to their short generation interval, high fertility, adaptation to harsh environment and their ability to produce on limited feed resource (Asfaw, 1997). However, productivity of ruminant livestock in Ethiopia has been quite low. One of the major limiting factors to animal production in Ethiopia is nutrition (Tsige-Yohannes, 1998).

Establishing simple techniques, which allow improvement of the feeding value of crop residues, is important. Urea treatment has been noted to be important for improving the nutritive value of cereal straws (Djajanegra and Doyle, 1989) and stovers (O'Donovan et al., 1997), and has long been used in developing countries of the tropics. Other means of improving the feeding value of crop residue is by supplementation with agro-industrial by-products. In this regard, brewers' dried grain and cassava leaf meal can be potential supplements to crop residues to improve animal performance and/or fill the nutritional gap during times of feed shortage.

Brewers' dried grain is considered as good sources of CP especially of un-degradable dietary protein that by-passes the rumen (around 53%) and is digested in the hindgut (Ensminger et al., 1990). Cassava is one of the most drought tolerant crops and can be successfully grown on marginal soils, giving reasonable yields where many other crops can't do well. Cassava leaves have been found to have high nutritional value which can effectively boost the nutrition of small ruminants when preserved as hay, thereby assisting in formulating and processing of simple, adoptable and low cost feed resource strategy for small ruminants during the dry season when there is scarcity of forage (Wanapat et al., 2000). Therefore, this study was designed with the objective of evaluating the effect of supplementing cassava leaf meal, brewers' dried grain and their mixture on body weight change, feed conversion efficiency and carcass characteristics of intact local goats fed urea treated tef straw as a basal diet.

Materials and Methods

This study was conducted at Kombolcha agricultural college's sheep and goat farm, belongs to animal science department.

Experimental animals

Twenty- four growing (yearling) male intact local goats with 14.57 ± 2.2 kg (mean ± SD) body weight were used and penned individually in this experiment. Dentition was used to determine the age of the animals. The experimental animals were quarantined for three weeks and de-wormed with albendazol and sprayed with diazinol against internal and external parasites, respectively. The animals were vaccinated against pasteurollosis and anthrax. During 14 days adaptation period, the animals were offered *ad libtium* urea treated tef straw at 20% refusal and supplemented with the mixture of brewers' dried grain and cassava leaf meal to acclimatize them to the experimental feeds before the beginning of the experiment.

Experimental Feed Preparation and Feeding

Urea treated tef straw (UTTS), brewers' dried grain and cassava leaf meal were the feeds that were used in the experiment. According to Ibrahim and Schiere (1989) a solution of 4 kg of urea in 80 liters of water was prepared to treat 100 kg of tef straw in pit. The urea solution was applied to the tef straw in a trench dug into the ground with a dimension of 2mx2mx2m (length, width, and height) and was covered with polyethylene sheet on the floor and all the four sides. The solution was sprayed thoroughly to layers of tef straw, rubbed with hand to ensure proper penetration and trampled with foot to ensure proper packing. After filling the trench, it was covered with plastic sheeting and soil, the material was left for 21 days to ensile. After three weeks the treated straw was removed and aerated overnight to avoid excess ammonia by spreading on polyethylene sheet and experimental animals were fed *ad libitum* at 20% of feed refusal.

The cassava leaf meal was prepared from cassava leaves. The leaves were separated from the stem by hand before distributing the stem to the farmers for vegetative propagation. Then, the cassava leaves were sun-dried under shade. The sun drying consisted of spreading the leaves on the ground and turning them over while exposed to the sun. The dried leaves was directly used for feeding or stored for latter feeding. The wet brewers' grain was bought from Kombolcha beer factory (BGI Ethiopia) and was spread on polyethylene sheet to dry it.

Treatments and Experimental Design

Four treatments with six replications were employed in a randomized complete block design. After the end of the quarantine period, the animals were blocked into six blocks of four animals each based on initial body weight and animals in a block were randomly assigned to one of the four treatments. The treatments consisted supplementation of cassava leaf meal, BDG and their mixture (1:1) to experimental goats fed urea treated tef straw *ad libitum*. The amount of supplement for each animal was 300 g/d/head on dry matter basis. The daily supplements were offered in two equal halves at 0800 and 01600 hour. All animals had free access to water and salt block.

Body weight change measurements

Initial weight of animals was determined by taking mean of two consecutive weights after overnight fasting. The goats were weighed at 10 days intervals, in the morning before feeding throughout the experiment. Average daily gain was calculated by regression of the 10 days weight measurements. Feed efficiency was computed as a ratio of daily weight gain and daily feed intake.

Carcass Parameters measurements

After feeding trial, all animals were slaughtered for measurements of carcass parameters. The blood was collected in a container and weighed. Weight of offal like head, skin and feed, heart, lungs and trachea, liver with gall bladder, spleen, fat (omental, intestinal and kidney), testis, penis, kidneys, reticulo-rumen, omasum, abomasums, small and large intestine were recorded.

Empty body weights were determined by subtracting the gut content from the slaughter weight. Total edible offal components were taken as the sum total weight of blood, heart, liver with bile, empty gut, testis, tongue and fat (omental, intestinal and kidney). The sum total weight of hot carcass, total edible offal components and skin were taken as total usable product. Total non-edible offal components were considered as the sum of the weight of lung with trachea, skin, penis, spleen, feet, gall bladder without bile and gut content. Hot carcass weight was computed by excluding thoracic, abdominal and pelvic cavities, head, skin with feet and tail from the slaughtered animal. Dressing percentage was calculated as proportion of hot carcass weight to slaughter or empty body weights, using the following formula:

$$\text{Dressing percentage} = \frac{\text{Hot carcass weight}}{\text{Slaughter weight}} \times 100 \text{ or } = \frac{\text{Hot carcass weight}}{\text{Empty body weight}} \times 100$$

The carcass was partitioned into hind and four quarters between 12 and 13 ribs of the carcass. The rib-eye muscle area of each animal was determined by tracing the cross sectional area of the 12th and 13th ribs after cutting perpendicular to the back bone. The left and right rib-eye muscle area was traced on a transparent water proof paper and the area was measured using planimeter. The mean of the right and left cross sectional area was taken as a rib-eye muscle area.

Chemical Analysis

Samples of urea treated tef straw, brewers' dried grain, cassava leaf meal offered, refusals and feces were dried at 55^oC for 72 hours in a forced draft oven and ground to pass 1 mm mesh screen size and were analyzed for DM, CP, and ash according to AOAC (1990). The NDF, ADF and ADL (acid detergent lignin) concentration were determined according to the procedure of Van Soest et al. (1985). All the chemical analysis was done at Debre-Zeit Agricultural Research Center Nutrition Laboratory.

Statistical Analysis

The data was subjected to analysis of variance using the general linear model (GLM) procedure of statistical analysis system (SAS, 2002). After analysis of variance, significant treatment mean differences were revealed, then Tukey's test in SAS was used to test means that are different and significance level was declared at $P < 0.05$. The ANOVA model used for data analysis was

$$Y_{ij} = \mu + \alpha_i + \beta_j + e_{ij},$$

Where;

Y_{ij} = Response variable
μ = Overall mean
α_i = Treatment effect
β_j = Block effect
e_{ij} = Random error term

Results and Discussion

Chemical composition of experimental feeds

The Chemical composition of cassava leaf meal (CLM), brewers' dried grain (BDG) and urea treated tef straw (UTTS) (offered and refused) are presented in Table 1. The crude protein content of the BDG in the present study was 244g/kg DM which was comparable with that reported by Diriba (1991) and higher than that reported by Mulu (2005). This variation may be because of the difference in the type of initial raw material and type of processing in the beer manufacturing industry. Chemical composition of brewers' grain depends mainly on quality of the barley and malt used in the process, but it is also affected by processing method used and by the filtration techniques (Boza and Fernando, 1989). A number of chemical analyses have shown that BDG contain high but variable CP ranging from 23 to 28% and thus they are classified as protein supplement feeds (Parra and Escobar, 1985). The NDF and ADF content of BDG in this study were within the range of values of 499 to 753 g/kg DM and 216 to 315 g/kg DM, respectively reported by MAFF (1990). The ADF values of BDG in this study was in agreement with 28.4 % DM reported by Mulu (2005).

Table 1. The chemical composition of experimental feeds and refusal

				UTTS refusal			
Nutrients	BDG	CLM	UTTS	T1	T2	T3	T4
DM (%)	92.9	92.8	92.4	92.1	92.1	92.5	92.0
Ash (%DM)	4.2	12.3	8.3	10.1	11	11.0	9.8
OM (%DM)	95.8	87.7	91.7	89.9	89	89.0	90.2
CP (%DM)	24.4	21.9	8.3	8.2	8.0	7.9	7.3
NDF (%DM)	70.0	36.6	72.0	68.8	68.8	68.4	69.6
ADF (%DM)	28.0	21.0	47.7	48.8	48.4	48.4	46.6
ADL (%DM)	7.2	7.0	5.8	7.2	7.6	5.5	8.0

DM= Dry matter; OM= Organic matter; CP = Crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; ADL= Acid detergent lignin; UTTS= Urea treated teff straw; BDG= Brewers' dried grain; CLM = Cassava leaf meal; T_1 = UTTS *ad libitum*; T_2 = UTTS *ad libitum* + 300g DM CLM; T_3 = UTTS *ad libitum* + 150g DM BDG + 150g DM CLM; T_4 = UTTS *ad libitum* + 300g DM BDG.

The crude protein content of the CLM in the present study was within the range of values reported by Wanapat (2001, 1999), and Wanapat et al. (2000), who reported values ranging from 200g/kg DM to 300g/kg DM. A similar value was reported by Duong (2004), with a crude protein content of 226g/kg DM. Other authors had reported CP content of cassava leaf meal of 188g/kg DM (Man and Wiktorsson, 2001) and 211g/kg DM (Man and Wiktorsson, 2002). The NDF content in this study was higher whereas the ADF content was lower than that reported by Wanapat (1999, 2001), and Wanapat et al. (2000), which were 296g/kg for NDF and 241g/kg for ADF.

The CP content of UTTS in the current study was 8.3% DM. This result was comparable with that reported by Awet (2007) which was 8.39% and slightly less than that reported by Rehrahie and Ledin (2001) which was 8.90%. The CP content of the UTTS in the present study showed an increase by 38.3%, 53.70%, 62.75% as compared with the CP content of untreated tef straw results reported by Seyoum et al. (1998); Bonsi et al. (1995) and Rehrahie and Ledin (2001), respectively. The increase in CP content due to urea treatment in tef straw in the current study was 118.4%, which was slightly lower than Rehrahie and Ledin (2001) (134%) and Awet (2007) (121%). The lower CP content of UTTS in the current study could be due to volatile N loss during drying for analysis and during overnight ventilation of the silo before feeding. It is noted that up to two-third of the ammonia generated is usually evaporated in the course of urea straw treatment and until feeding to the animals (Sundstøl et al., 1978; Sundstøl and Coxworth, 1984; Chenost, 1995).

The NDF content of the treated tef straw was 72% which was less than that reported by Rehrahie and Ledin (2001) and Awet (2007) which was 76.1%. This figure was much larger than the level (55%) above which voluntary feed intake is limited (Van Soest, 1965). The ADF content of UTTS in this study was higher than 43% reported by Awet (2007). The removal of the soluble components of the NDF, such as nitrogen free extract (NFE), ether extract (EE) and soluble carbohydrates results in the increase of ADF, ADL, and ADF-ash (Musimba, 1981). The NDF components are expected to be lower in urea treated straw compared to untreated straw due to the ability of ammonium hydroxide to dissolve the hemicelluloses content during the treatment process resulting in the fragmentation of the cell wall constituents. This brings about the advantage of the increased fermentation of cell wall components in the rumen which in turn enhance the amount of rumen fermentable sugars (Givens et al., 1988).

Body weight change

Means of initial and final live weight, body weight change, average daily gain (ADG) and feed conversion efficiency (FCE) of the experimental goats are presented in Table 2. Feed conversion efficiency was significantly ($p < 0.05$) higher for CLM + BDG supplemented goats as compared to the control and there was no significant difference ($p > 0.05$) between the control and BDG supplemented goats. Values for FCE were similar ($p > 0.05$) among supplemented treatments. Better feed conversion efficiency with CLM + BDG supplementation is consistent with previous studies (Leng, 1990). The reason for lack of significant difference ($p > 0.05$) between the control and T_4, was because brewers' dried grain is a bulky feed, low in energy and therefore seldom used for intensive beef fattening (Morgan et al., 1991). Previous studies also showed that low energy intake and high fiber content of the supplemental diet might lead to a depressed use of the net efficiency of metabolisable energy (Ngi et al., 2006) for goats fed rice straw and supplemented with maize offal and cassava leaf meal.

Table 2. Initial and final body weight, average daily gain and feed conversion efficiency of local intact goats fed urea treated tef straw and supplemented with brewers' dried grain, cassava leaf meal and their mixture

Parameters	T_1	T_2	T_3	T_4	SEM
Initial BW (kg)	14.0	14.9	14.4	14.1	0.42
Final BW (kg)	14.1	16.8	16.9	15.3	0.74
ADG (g/d)	1.1	21.15	29.8	14.5	7.14
FCE (g ADG/ g TDMI)	0.001^{b}	0.02^{a}	0.026^{a}	0.015^{ab}	0.006

$^{a, b}$ Means in the same row with different superscript differ significantly at $p<0.05$; SEM= Standard error of mean; ADG=Average daily gain; FCE=Feed conversion efficiency; T_1 = UTTS *ad libitum*; T_2 = UTTS *ad libitum*

+ 300g DM CLM; T_3 = UTTS *ad libitum* + 150g DM BDG + 150g DM CLM; T_4 = UTTS *ad libitum* + 300g DM BDG; BW= Body weight.

Average daily gain and final body weight were not affected (p> 0.05) by supplementation in this study. Even though, there was no significant difference between supplemented and non-supplemented goats, ADG was very much close to significant difference (p= 0.0537). Lack of significance difference could be explained by the fact that the major part of the dietary protein was probably degraded in the rumen resulting in the production of ammonia and this might have led to 28 % losses of nitrogen in the stomach (Ash and Norton, 1987b). Consistent to this study, Ngi et al. (2006) showed that there were no statistical differences (p>0.05) in average daily gains in goats on diet 50% CLM +50% maize offal, 30% CLM + 70% maize offal and 70% CLM +30% maize offal.

The goats in the control treatment had positive ADG in this study. UTTS can fulfill a little beyond maintenance requirement because 7% CP content in DM is the threshold level for normal rumen function and ideal to maintain weight for sheep and goats (Kay and McDonald, 1973). The reason for positive ADG in the control treatment might be increased intake of UTTS DM and the added nitrogen which intern resulted from the increased digestibility of urea treated straw (Tarch, 2004). Other studies with un-treated tef straw showed that due to low nitrogen, high cell wall and slow digestion, animals kept on a sole diet of tef straw or hay may not be able to maintain their nitrogen balance and growing animals could lose body weight (Skerman and Riveros, 1990; Kaitho, 1997).

Average daily gain of the experimental goats had a positive and a significant (p<0.01) correlation with total crude protein intake. This can be concluded that increasing level of crude protein can bring increased average daily gain in goats. Supportive idea was observed by Abbasi *et al*. (2011) in Iranian Angora kid goats. Several studies have shown increased intake (Egan and Moir, 1965; Kempton et al, 1979) and positive response in live weight gain.

Carcass characteristics

The mean values of slaughter weight, empty body weight, hot carcass weight, dressing percentage and rib-eye area of local intact goat fed basal diet of UTTS and supplemented with CLM, BDG and their mixture are presented in Table 3. Supplementation had no significant (p>0.05) effect on slaughter weight (SW) and dressing percentage on the basis of empty body weight (DP-EBW). Similar result was reported by Awet (2007) and Shajalal et al. (2000) for sheep fed basal diet of UTTS and supplemented with graded level of wheat bran, and for goats fed high and low protein diet, respectively.

Table 3. Carcass parameters of local intact goats fed urea treated tef straw and supplemented with brewers' dried grain, cassava leaf meal and their mixture

Parameters	T_1	T_2	T_3	T_4	SEM
Slaughter weight (kg)	14.0	16.8	16.9	15.3	0.74
Empty body weight (kg)	9.9^b	12.5^a	11.7^{ab}	11^{ab}	0.46
Hot carcass weight (kg)	4.3^b	5.9^a	5.5^{ab}	5.2^{ab}	0.33
Dressing percentage					
Slaughter body weight basis	30.6^b	35.8^a	34.2^{ab}	34.2^{ab}	1.1
Empty body weight basis	43.4	46.9	46.8	47	1.4
Rib-eye area (cm^2)	4.3^b	8.3^a	8^a	5.6^b	0.46

[a, b,] Means in the same row with different superscript differ significantly at P< 0.05; SEM= Standard error of mean; T_1 = UTTS *ad libitum*; T_2 = UTTS *ad libitum* + 300g DM CLM; T_3 = UTTS *ad libitum* + 150g DM BDG + 150g DM CLM; T_4 = UTTS *ad libitum* + 300g DM BDG.

Cassava leaf meal supplemented goats had significantly (p<0.05) higher empty body weight, hot carcass weight and dressing percentage on the basis of slaughter body weight than the control treatment. Cassava leaf has high protein content (Yousuf et al., 2007) with almost 85% of the crude protein found as true protein (Ravindran, 1991). The presence of tannin in cassava leaf might form tannin- protein complex that by pass the rumen (Wanapat et al., 1997), and the complex dissociates in the low pH of the abomasum. These may result to the supply of better profile of amino acids in the lower gut and the animal, which might have resulted to improvement in animal performance. Generally supplementation induces greater dressing percentage (Okello et al., 1994), although this was not the case in all supplemented treatments in this study. Generally un-supplemented animals tend to have greater gut fill that may reduce their dressing percentage.

Difference in empty body weight, hot carcass weight and dressing percentage on slaughter body weight basis between CLM supplemented and other supplemented treatments were not significant (p>0.05). Similarly there was no significant difference in the mentioned parameters among the control, T_3 and T_4. The dressing percentage on slaughter body weight values observed in the current study was lower than the dressing percentage reported by Ensminger (2002) and Matiwos (2007). 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). Supplementation of CLM alone or in mixture with BDG had higher (p<0.05) rib-eye area than BDG supplemented and the control treatments. Increased rib eye area (P <0.01) has been reported in supplemented Barbari kids (Ameha and Mathur, 2000) and Sidama goats (Matiwos, 2007) than non-supplemented controls.

Edible offal component

Mean values of edible offal components of the experimental goats are presented in Table 4. Most of the edible offals were not significantly affected (p > 0.05) by treatments. The weight of the head was the lowest (p<0.05) for T_4 and values for other treatments were similar (p > 0.05). The weight of testis was significantly heavier (p<0.05) for CLM supplemented goats as compared to T_3, T4 and the control treatment. The CLM supplemented goats had significantly (p<0.05) higher weight of abdominal fat and total edible offal components (TEOC) than non-supplemented goats. However, there was no significant (p>0.05) difference among T_1, T_3 and T_4 in the weight of abdominal fat and TEOC. Similar to the current study, Matiwos (2007) reported that, generally supplemented goats had significantly higher weight of total edible offal than non-supplemented goats. On the contrary, Ameha and Mathur (2000) reported that the percentage of edible offal components on slaughter weight basis was not significantly influenced by supplementation.

Regarding the total usable product (TUP), CLM and CLM + BDG supplemented goats had significantly (p<0.05) higher weight of TUP than the control treatment. There was no significant difference (p>0.05) among the supplemented treatments and also between T_1 and T_4. There was no significant difference (p>0.05) between supplemented and non-supplemented goats in the weight of liver, kidney, kidney fat, heart, reticulo-rumen, omaso-abomasum, large and small intestine, tail, blood and tongue. This indicates that supplementation had no effect on the above mentioned part of total edible offal components. Similar to the current study, Okello et al. (1994) and Simret (2005) reported that, goats supplemented with different diet had no significant effect on empty gut. Likewise, Ameha and Mathur (2000) also reported that dietary variation did not affect the percentage of liver, kidneys, heart and spleen of Barbari kids.

Table 4. Weight of edible offal of local intact goats fed urea treated tef straw and supplemented with brewers' dried grain, cassava leaf meal and their mixture

Weight (gm)	T_1	T_2	T_3	T_4	SEM
Liver	314.2	427	408.7	384.7	27.4
Kidney	101.6	94.4	90.5	90	4
Kidney fat	40.9	55.1	57.7	67.9	7.2
Heart	101.2	117	112.7	108.3	5.1
Head	839.2^{a}	972.6^{a}	928.5^{a}	691^{b}	56
Reticulo-Rumen	515.6	583	578.3	555.7	25.7
Omaso-Abomasum	222.3	263.7	267.5	257.2	20.3
Small & Large intestine	501	543.4	551.7	543.3	25.4
Tail	46.8	55.4	57.7	54	3
Testis	111.2^{b}	239.2^{a}	147^{b}	160^{b}	21.8
Abdominal fat	33.6^{b}	75.6^{a}	61.8^{ab}	57^{ab}	7.7

Blood	666.4	705	700.8	753.5	38
Tongue	111.7	132.3	106.5	130.6	10
TEOC (kg)	3.6^{b}	4.3^{a}	4.1^{ab}	3.9^{ab}	0.14
TUP (kg)	7.9^{b}	10.3^{a}	9.6^{a}	9.2^{ab}	0.4

[a, b,] = Means in the same row with different superscript differ significantly at P <0.05; SEM= Standard error of mean; TEOC=Total edible offal component; TUP=Total usable product; T_1 = UTTS *ad libitum*; T_2 = UTTS *ad libitum* + 300g DM CLM; T_3 = UTTS *ad libitum* + 150g DM BDG + 150g DM CLM; T_4 = UTTS *ad libitum* + 300g DM BDG.

Non-edible offal component

Mean values of non-edible offal components of the experimental goats are presented in Table 5. Cassava leaf meal supplemented goats had significantly ($p<0.05$) higher weight of skin than the control and BDG supplemented goats. This didn't agree with the result reported by Ameha and Mathur (2000). The difference might be CLM supplementation had brought increased subcutaneous layer of fat deposition on the skin. Values for skin were similar ($p> 0.05$) among T_3, T_4 and non-supplemented goats. There was no significant difference ($p>0.05$) between supplemented and non-supplemented goats in the weight of feet, penis, lung with trachea, spleen, total gut fills and total non-edible offal components. Similar to the current study, Hag and Shargi (1996) and Saikia et al. (1996) reported that different feed supplement had no effect on edible and non-edible offal. Contrary to the current study; Matiwos (2007) reported that, generally supplemented goats had significantly higher weight of total non-edible offal than non-supplemented goats.

Table 5. Weight of non- edible offal of local intact goats fed urea treated tef straw and supplemented with brewers' dried grain, cassava leaf meal and their mixture

Parameters (gm)	T_1	T_2	T_3	T_4	SEM
Skin	934^{b}	1132^{a}	1041^{ab}	854.8^{b}	51.4
Feet	529.6	415.2	444.2	468.5	29
Penis	28.8	46.2	37.2	40.7	4.2
Lung with trachea	334.4	386.4	348.2	317.7	29
Spleen	23	38.4	40.3	37.6	5.3
Total gut fills (kg)	4.1	3.9	4.3	4	0.24
TNEOC (kg)	6	5.9	6.2	5.8	0.3

[a, b,] = Means in the same row with different superscript differ significantly at P <0.05; SEM= Standard error of mean; TNEOC=Total non-edible offal component; T_1 = UTTS *ad libitum*; T_2 = UTTS *ad libitum* + 300g DM CLM; T_3 = UTTS *ad libitum* + 150g DM BDG + 150g DM CLM; T_4 = UTTS *ad libitum* + 300g DM BDG.

Summary and conclusions

The CP content of UTTS, CLM, BDG and CLM + BDG was 8.3, 21.9, 24.4 %, and 24.2%, respectively. The NDF contents were 72.0, 36.6 and 70.0 % for UTTS, CLM and BDG, respectively.
Increased feed conversion efficiency was observed for T_3 followed by T_2. There was no significant difference (p> 0.05) in FCE among supplemented treatments and between T_1 and T_4. Supplementation had no effect (gain (P>0.05) on average daily weight and final body weight. The goats in the control treatment showed a positive but lower weight gain as compared to supplemented goats.
Hot carcass weight (4.3, 5.9, 5.5 and 5.2 (SEM = 0.33) for T_1, T_2, T_3 and T_4, respectively), empty body weight and dressing percentage on slaughter weight basis of animals supplemented with CLM were significantly higher (P<0.05) than the non-supplemented goats, whereas values for T_3 and T_4 were similar with the other two treatments. Rib-eye muscle area of T_2 and T_3 were significantly higher (P<0.05) than the non-supplemented and BDG supplemented goats.
Most of the edible and non-edible offal were not affected (p> 0.05) by treatment. The weight of head was lower for T_4 and that of testis was higher for T_2 than other treatments. Abdominal fat and total edible offal were greater for T_2 than T_1, while values for T_3 and T_4 were similar with other treatments and to each other. Among the non-edible offal, only the weight of the skin was affected by treatment (p< 0.05) being higher for T_2 than T_1 and T_4, whereas values for T_3 being similar with other treatments.
The result of this study showed that CLM supplementation as sole or in combination with BDG appeared to improve carcass parameters. This study also highlights the positive potential value of CLM as a supplement to ruminants fed fibrous basal diets.

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