Effect of sesame cake supplementation on feed intake, body weight gain, feed conversion efficiency and carcass parameters in the ration of sheep fed on wheat bran and teff (*Eragrostis teff*) straw.

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ABSTRACT

Twenty-five yearling growing intact sheep were arranged in randomized complete block design (RCBD) with five treatments and five replications. The experimental animals were supplied teff straw as basal ration. Different levels of sesame cake were supplemented in various treatment groups i.e. T_1 (150 gm wheat bran, 0 gm sesame seed cake DM/day) being control group, T_2 (150 gm wheat bran, 150 gm sesame seed cake DM/day), T_3 (150 gm wheat bran, 200 gm sesame seed cake DM/day), T_4 (150 gm wheat bran, 250 gm sesame seed cake DM/day) and T_5 (150 gm wheat bran, 300 gm sesame seed cake DM/day). The experiment was conducted for 90 day of feeding trial and 7 days of digestibility trial. There was significant ($p \leq 0.05$) increase in total dry matter intake (TDMI), total organic matter intake (Total OMI) and total crude protein intake (Total CPI) with increase in level of supplementation. There was significantly lower ($p \leq 0.05$) crude protein (CP) content in the feces of the control group as compared to the different of level sesame seed cake supplemented groups. There was significant difference in DM, OM and CP ($p \leq 0.05$) digestibility between supplemented and control groups. The control treatment had significantly higher ($p \leq 0.05$) feed conversion ratio than the supplemented treatments and lower ($p \leq 0.05$) feed conversion efficiency as compared to the highest level sesame seed cake supplemented group (T_5). Higher ($p \leq 0.05$) average daily body weight was gained in sheep supplemented with highest level (T_5) of sesame seed cake group than the other supplemented groups and the control treatment. There was increasing trend of body weight gain from control to higher level of supplementation i.e. T_1 (7.8), T_2 (60.0), T_3 (63.2), T_4 (72.8) and T_5 (77.8). There was increasing trend of slaughter weight (SW), empty body weight (EBW), hot carcass weight (HCW), dressing percentage on slaughter weight base and empty body weight base and rib-eye area with increase in supplementation of sesame seed cake being higher ($p\leq0.05$) value for T_5 followed by T_4, T_3, T_2 and T_1. The size of heart, liver with gallbladder, reticulo-rumen, small intestine, total fat, tail, kidney and total edible organic component (TEOC) were significantly ($p\leq0.05$) affected by supplementation. Sheep supplemented with sesame seed cake had significantly higher ($p\leq0.05$) visceral fat, and tail than the control treatments. There was a significant difference ($p\leq0.05$) due to supplementation on blood, spleen and pancreas, skin, testicle and penis, feet, head without tongue and total non-edible offal component (TNEOC%).The results of the present study showed that supplementation of 300gDM level of sesame seed cake (T_5) increased body weight gain and enhanced carcass parameters which is potentially more beneficial and economically feasible than the other levels of supplements and the control group. Strategic feeding with locally available feed resources will improve efficient use of nutrients by sheep.

Key words: *Average daily weight gain, Sesame seed cake, Sheep, teff straw, Wheat bran*

1. INTRODUCTION

Ruminants established a symbiotic relationship with rumen microorganisms. However, this symbiotic relationship has energy (loss as methane) and protein (loss as ammonia N) inefficiencies. Strategic feeding, using agro-industrial by-products, has proved to be useful strategy to improve efficiency of energy and protein utilization in ruminant livestock (Thi et al., 2012) Due to seasonal changes throughout the year, the shortage of feedstuffs has resulted in the fluctuation of animal production and therefore many farmers in Ethiopia feed their livestock with agricultural byproducts, mainly various straws. However, the use of such straw has limitations due to their low nutritive value indicated by their high cellulose, hemi-cellulose and lignin contents, and their low protein content and digestibility. Supplementation with other palatable materials, mainly agro-industrial by-products has been used in many developed countries for improving locally available nutrients of feed resources (Xianjun et al., 2012). It is well established that feed cost accounts for more than 70% of the total cost in any livestock production. Hence, it is paramount important to incorporate locally available byproducts and raw materials into the feed of ruminant animals. Agricultural and industrial by-products that are relatively cheaper are best sources for supplementation of animals on fibrous basal feeds. Sesame oil cake is one of the byproducts available in the region, *Humera,* as sesame seed oil processing plant exists in the area.

The chemical composition of sesame oil cake varies depending on the method of processing sesame seed , mechanical or solvent extraction, and the reported DM content ranges 83-96% while CP, ash, ether extract, NFE, and crud fiber are 23-46%, 7.5-17%, 1.4-27%, 25-32%, and 5-12%, respectively, (FAO, 1990).

In Northwestern Zone of Tigray, sesame seed cake is available at cheaper price throughout the year. Wheat bran is also produced in large quantities by a flourmill. Despite the availability of these agro-industrial by-products, they are not effectively utilized by smallholder farmers for feeding, mainly due to lack of information and lack of experience. Nevertheless, the use of these by-products is a potential alternative through which the productivity of animals can be improved. The objective of this study was, therefore, to determine effect of sesame cake on the performance of *Koraro* sheep fed on teff (*Eragrostis teff*) straw and supplemented with wheat bran.

2. MATERIAL AND METHODS

The experiment was conducted on twenty-five yearling growing intact indigenous sheep(*Koraro* sheep) weighed 19.1 $\pm$ 1.17 kg (mean $\pm$ Standard deviation). They were first drenched with a broad spectrum anthelmentic (abendazol) against internal parasites, sprayed with accaricide (sumicidin and butox) against external parasites and vaccinated against anthrax and pasteurelosis. The randomized complete block design (RCBD) was used with five treatments and five replications. The experimental animals were supplied teff straw, tapwater, and salt blocks comprising sodium chloride *ad libitum* daily in individual pens. The different levels of sesame cake for different group were T_1 (150 gm wheat bran, 0 gm sesame seed cake DM/day) being control group, T_2 (150 gm wheat bran, 150 gm sesame seed cake DM/day), T_3 (150 gm wheat bran, 200 gm sesame seed cake DM/day), T_4 (150 gm wheat bran, 250 gm sesame seed cake DM/day) and T_5 (150 gm wheat bran, 300 gm sesame seed cake DM/day). The experiment was conducted for 90 day of feeding trial and 7 days of digestibility trial. The five treatments were randomly assigned to each animal in a blocking giving five animal per treatment.

Feed intake was calculated by measuring daily offered and refusal of each treatment diet throughout the experiment. Daily feed intake was calculated as a difference of daily supplement and teff straw offers and refusals for each experimental sheep. Samples of feeds offered were collected on batches of feeds that of refusal were collected for each animal and pooled for each treatment. Daily body weight gain was calculated as the difference between final live weight and initial live weight divided by the number of days.

Representative samples of daily feed offers, refusals and feces were ground to pass through a 1 mm sieve screen size. The ground samples were analyzed for contents of dry matter (DM), ash, crude fiber (CF) and nitrogen using the procedure of AOAC (1990). Acid detergent fiber (ADF) and acid detergent lignin (ADL) were analyzed following the procedure of Van Soest (1994). The crude protein (CP) was computed as N x 6.25.

Feces were collected and weighed every morning for each animal before giving of feed or water. In addition, amount of feed offered and refusals were collected, weighed and recorded. The apparent digestibility coefficient (DC) of dry matter (DM), organic matter (OM) crude protein (CP), crude fiber (CF), acid detergent fiber (ADF) and acid detergent lignin (ADL) was calculated using the following equation: (McDonald et al., 2002)

$$\textbf{Nutrient digestibility coefficient (\%)} = \frac{\textbf{nutrient intake- nutrient excreted in feces}}{\textbf{Nutrient intake}} \times 100$$

Partial budget analysis was performed to evaluate the economic advantage of the different treatments by using the procedure of Upton (1979). The partial budget analysis was involved in the calculation of variable costs and benefits. The selling price difference of rams in each treatment before and after the experiment was considered as total return (*TR*) in the analysis. For the calculation of the variable costs, the expenditures incurred on various feedstuffs were taken into consideration. The cost of the feeds was computed by multiplying the actual feed intake for the whole feeding period with the prevailing prices. At the time of feed purchasing, the prevailing price of the feeds included the transportation cost incurred to move them to the experimental site. The labor cost was found to be constant for all the treatments.

Partial budget method measures profit or losses, which are the differences between gains and expenses for the proposed change and includes calculating net return (NR), i.e., the amount of money left when total variable costs (TVC) are subtracted from the total returns (TR):

NR = TR-TVC

Total variable costs include the costs of all inputs that change due to the change in production technology. The change in net return (ΔNR) were calculated by the difference between the change in total return (Δ TR) and the change in total variable cost (Δ TVC), and this was to be used as a reference criterion for decision on the adoption of a new technology.

ΔNR = ΔTR- ΔTVC

The marginal rate of return (MRR) measures the increase in net income (Δ NR) associated with each additional unit of expenditure (Δ TVC). This is expressed by percentage.

MRR% = (Δ NR / Δ TVC) X 100

The analyses of variance (ANOVA) on the experimental data were run using JMP5. The treatment means of the parameters were separated using Tukey HSD (Tukey Honestly Significant Difference) Test. The moderl used for the analysis of all parameters feed intake, weight gain, digestibility, and carcass parameters of the experiment was:

$$\mathbf{Yij = \mu + \alpha_i + \beta_j + \varepsilon_{ij}}$$

Where: $\mathbf{Y_{ij}}$ = response variable (feed intake, body weight gained and digestibility)

$\boldsymbol{\mu}$ = overall mean; $\boldsymbol{\alpha_i}$ = ith treatment effect (feeds);

$\boldsymbol{\beta_j}$ = block effect (five-blocks); $\boldsymbol{\varepsilon_{ij}}$ = ith random error (undefined factors)

3. RESULTS AND DISCUSSION

Based on the results, the DM, Ash, OM, CP, CF, ADF and ADL content of teff straw offered was 88.60%, 5.40%, 94.60%, 2.67%, 37.80%, 45.50%, and 37.90%, respectively. The DM and OM were almost similar to the content reported by Zemicheal (2007) with values 88.14and 94.75 %, respectively. The CP content of teff straw in this experiment was 2.67% which falls in the range of values of 2.5-7.5% CP content for teff straw reported by Seyoum and Zinash (1998). In contrast, Zemicheal (2007) reported CP content of 3.06%. The reasons for the difference might be due to season, soil fertility and post harvesting management.

In this study, the ADF and ADL contents of teff straw were 45.50% and 37.90%, respectively which was higher than the 44.5% and 5.32% reported by Seyoum and Zinash (1998). The CF part of the straw was 37.80% and this was similar to the result of reported by Beyene et al. (1977). The CP contents of the concentrate feed ingredients, namely, wheat bran and sesame seed cake were 16.87% and 39.92% , respectively. The CP content of wheat bran in this study was comparable to the values of 16.5% and 16.82% reported by Solomon et al. (2004) and Tesfay (2007) respectively, but lowers than the values 17.19%, and 19.99% reported by Getnet et al. (1999) and Alemu (1981), respectively. The variation might be due to the effect of processing in milling industries and the quality of the original grain used in the milling industries.

The CP content of the sesame seed cake was 39.92%, which was higher than the CP contents of 30.93% reported by Solomon (1992); 38% by Ensminger (2002) and 37.5% by Njie (1995). This may be due to the difference in efficiency on method of extraction within the screw pressing and similar suggestions were also reported in other studies (Solomon, 1992; Ensminger, 2002; Njie, 1995). The straw refusals contained lower CP and higher CF, ADF, and ADL than the teff straw offer in all treatments, indicating the selective behavior of sheep on portion of feeds with better nutritive value. The ADF content of sesame seed cake (10.40%) and wheat bran (13.98%) was almost similar to the result reported by Zemicheal (2007) being 10.38% and 13.08%. The ADF and ADL of wheat bran contents were higher than to other reports (Getnet, 1998; Simret, 2005 and Tesfaye et al., 2001). This may be due to the differences in milling efficiency of the factory and varietal difference of wheat grain. Generally, the contrasting nature of nutrients, namely high CP and low cell wall fiber contents in the supplements, and low CP and high cell wall fiber contents in the teff straw justifies the use of the supplements in teff straw based feeding of sheep.

No significant difference ($p>0.05$) was observed on the DM and OM intake of teff straw among treatment group. DM and OM intake of teff straw increased as the level of supplementation decreased. Bonsi et al. (1996) reported that supplementation improved the intakes of TDMI and TOMI. Sheep in the control consumed more dry matter and organic matter of teff straw as compared to the supplemented treatments. This might be due to the relatively low CP and high CF content of the feeds used in the control group and sheep were seeking to meet their nutrient requirement only through the intake of relatively more teff straw DM than the other treatments. This also indicated that there was a substitution effect of supplement at the expense of intake of teff straw. As the level of supplementation increased, there was decrease in teff straw dry matter and organic matter intake. The increased TDMI with increased levels of supplement in the diets also agrees with the findings of Akinsoyinu et al. (1975), and Crabtree and Williams (1971). Consistent with the present result, supplementation trial on Gwamble goat of Zambia at 0, 50, 100, and 150g peanut cake per animal per day showed that an increase in the level of peanut cake in concentrate mixture, increased total dry matter intake (Njwe and Olubajo, 1989). Besides, the DMI and growth rate in Alpine and Nubian goats increased linearly as the level of protein concentration in the diet increased. The TCP intake among the different treatment groups was significantly different ($p \leq 0.05$). There was an increasing trend of CP intake as the level of supplementation increases, the highest being in T_5 and the lowest in T_1. The TCP intake for the different treatments was 33.56, 79.22, 85.41, 87.89 and 92.44 gm/day for T_1, T_2, T_3, T_4 and T_5, respectively. The increased CP intake with the sesame seed cake supplementation level might be due to the increased total DMI and higher CP content of the sesame seed cake than the basal diet. The CP intake of the experiment was comparable with the value reported by Tesfay (2007) on Afar rams fed on teff straw basal diet supplemented with concentrate mixtures, but lower than the CP intake reported by Bonsi et al. (1996) on sheep with teff straw basal diet supplemented with cotton seed cake.

The total intake of CF (220.26, 224.66, 226.09, 235.40, 251.95) and ADF (188.14, 191.64, 187.44, 187.13, 196.02) were not significantly ($p>0.05$) affected due to supplementation. Similar results were reported by Asnakew (2005) and Tesfay (2007) for Hararghe highland goats supplemented with concentrate and fed hay basal diet, and Afar rams supplemented with concentrate mixture and fed teff straw basal diet, respectively.

There was a significantly lower ($p \leq 0.05$) crude protein content in the feces of the control group (12.16g/day) as compared to the different of level sesame seed cake supplemented groups. There was numerically increasing trend of crude protein content (13.26, 14.30, 14.81, 15.83 g/day for T_2, T_3, T_4 and $T_{5,}$ respectively)as the level of sesame seed cake increased, there was no significant difference ($p>0.05$) in the feces of these treatments. This could be due to high crude protein intake of the supplemented treatments and might be inappropriate utilization of dietary crude protein with increased level of supplementation. Among other parameters, feces of the experimental animals indicated no significant difference ($p>0.05$) on DM (141.30, 128.90, 124.80, 119.18, 113.36 g/day, respectively) OM (137.25, 117.77, 114.40, 110.12, 97.73 g/day, respectively), CF (86.13, 82.02, 77.46, 75.29, 74.93 g/day respectively), ADF (121.65, 116.74, 111.15, 103.20, 101.28 g/day respectively) and ADL (111.03, 101.60, 93.06, 91.50, 90.10, respectively) contents among all treatments. But, generally the control group had numerically higher contents of the above parameters (i.e. T_1>T_2> T_3> T_4> T_5). The reason might be due to more consumption of teff straw, which contained relatively high fiber (less digestible) and also due to deficiency in crude protein that leads to excretion of more nutrients in the form of feces.

Table 1. Apparent nutrient digestibility in sheep fed on teff straw based diet and supplemented with different levels of sesame seed cake in *Tahtay Koraro Woreda*.

Nutrients	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**SEM**
DM (%)	55.37^{b}	64.74^{ab}	64.99^{ab}	61.00^{ab}	70.32^{a}	3.183
OM (%)	53.05^{b}	67.00^{a}	66.79^{a}	67.23^{a}	73.24^{a}	3.145
CP (%)	$68.71b^{b}$	91.57^{a}	89.57^{a}	90.06^{a}	92.60^{a}	1.887
CF (%)	67.08	69.18	69.30	66.58	75.34	3.856
ADF (%)	44.54	37.42	48.67	42.72	50.57	4.868
ADL (%)	38.27	31.36	44.54	32.88	42.59	4.897

Breeds with different superscripts differ significantly at $p \leq 0.05$; SEM = standard error of mean; DM= dry matter; OM= organic matter; CP= crude protein; CF= crude fiber; ADF= acid detergent fiber; ADL= acid detergent lignin.

There was a significantly ($p \leq 0.05$) higher dry matter (DM), organic matter (OM) and crude protein (CP) digestibility between supplemented and control groups (Table1). Apparent digestibility of CP and OM of the supplemented groups were significantly increased ($p \leq 0.05$) due to supplementation. But, there, was no significant difference ($p>0.05$) in DM, OM, and CP digestibility among the supplemented treatments i.e. T_1, T_2, T_3, and T_4. There was increasing trend of digestibility of DM as the level of supplementation increased. This might be due to concentrate supplementation has improved the apparent digestibility of DM. In line with this result, Khanal and Olson (2004) reported that there was an increment in apparent DM digestibility for oil cake supplementations.

There was no significant difference ($p>0.05$) in the digestibility of CP among the supplemented treatments, but digestibility of CP was increased due to high total CP intake of the supplemented animals. Preston and Leng (1984), reported that any increase in protein intake may lead to an increase in the apparent digestibility of crude protein especially if, the intake is marginally sufficient in protein. In this study supplementation did not significantly ($p>0.05$) affect the CF, ADF and ADL apparent digestibility. This was also in agreement with MacRae and Armstrong (1969), who reported supplementation, had little or no effect on the digestibility of CF, ADF and ADF.

The lower DM, OM, and CP digestibility resulted for T_1 as compared to the supplemented treatments (T_2, T_3, T_4, and T_5) could be due to the relatively lower crude protein and higher crude fiber contents of the teff straw (basal diet). This can affect the microbial growth and fermentation in the rumen of sheep (Bonsi et al., 1996). As a result fiber degradation was lower in the control treatment group, while the opposite could have been true for the supplemented treatments (Ibrahim and Schiere, 1989). The lack of significant difference in DM digestibility among T_1, T_2, T_3 and T_4 and in CF, ADF and ADL digestibility among the control and the supplemented treatments might be due to a change in the microbial population in the rumen. At this supplementation level, the protein supplements may depress the rumen pH and therefore, the cellulolytic microbes favor the proteolytic and amylolytic populations.

The control treatment had significantly higher ($p \leq 0.05$) feed conversion ratio than the supplemented treatments and significantly lower ($p \leq 0.05$) feed conversion efficiency as compared to the highest level sesame seed cake supplemented group (T_5). There was no significant ($p>0.05$) difference in their FCE among the supplemented treatments except T_5. There was an increasing trend of FCE as the level of supplementation increased (i.e. $T_1< T_2< T_3<T_4$).

The improved feed conversion efficiency seems to be related to higher nutrient concentration of the supplement and the consequent increase in live weight gain although, there was no significant ($p>0.05$) difference in their feed conversion efficiency among the treatments except T_5. The highest level of sesame seed cake supplementation has resulted in significantly ($p \leq 0.05$) higher feed conversion efficiency as compared to the control treatment and other supplemented group. This indicates that rams in T_5 were efficient in the utilization of nutrients for their live weight gain. Similarly, Abule (1994) reported that there was a linear increment of feed utilization efficiency with the level of supplementation.

Heavier ($p \leq 0.05$) average daily body weight was gained in sheep supplemented with highest level (T_5) of sesame seed cake group than the other supplemented groups and the control treatment. Also T_2, T_3, and T_4 sesame seed cake supplemented group had significantly ($p \leq 0.05$) higher average daily weight gain than the control group. However, there was no significant ($p>0.05$) difference among the supplemented groups T_2, T_3 and T_4 and between T_4 and T_5. There was increasing trend in average daily weight gain from T_1 to T_5.

The control group had the lowest body weight change, which was attributed to the inclusion of wheat bran that supplied nutrients almost beyond the limit for their maintenance requirement. Similar reports are given by Trach (2004) for the increase in body weight gain of the control treatment. He reported that steers fed on teff straw with wheat bran had higher average daily weight gain than steers fed solely teff straw as a result of higher straw DMI, which in turn resulted from the increased digestibility of teff straw. .

From the present result, a positive weight gain of sheep was maintained on the control group showed us that wheat bran is very important in improving the nutritive values of poor quality roughages. However, the result was similar to the study of Hadjipanayiotou and Morand-Fehr (1991) who reported, feeding energy concentrates with barley straw cover the maintenance requirement of Awassi sheep. The final live weight gain was significantly ($p \leq 0.05$) higher for the highest level (T_5) sesame seed cake supplemented group as compared to the control treatment. But there was no significant ($p>0.05$) difference among the supplemented treatments T_1, T_2, T_3 and T_4, even though there was numerically an increasing trend as the level of sesame seed cake supplementation increased in both cases. This might be due to the inclusion of wheat bran had contributed to the experimental animals to maintain their growth for the control groups.

Carcass characteristics of animals under different feed treatments were assessed on the basis of parameters such as slaughter basis, empty body weight, hot carcass weight, dressing percentage, rib-eye area (*Longissimus dorsi muscle*), and internal fat deposits, edible, non edible and total usable offals. The characterization of edible and non-edible offal depends on the eating habit of the people (social taboos) and situation of the area where the experiment was conducted.

There was increasing trend of slaughter weight (SW) and empty body weight (EBW) with increase in supplementation of sesame seed cake. The T_5 group was significantly higher ($p \leq 0.05$)

in SW and EBW than the control group T_1, but no significant ($p \leq 0.05$) difference among T_1, T_2, T_3 and T_4 was observed (Table1). Significantly higher ($P \leq 0.05$) hot carcass weights (HCW) were observed in supplemented group. The highest value was observed in T_5 (11.33) followed by T_4 (10.00), T_3 (9.67), T_2 (8.90) and T_1 (7.17).

Dressing percentage (DP) on slaughter body weight, and empty body weight base were also significantly ($p \leq 0.05$) higher for highest supplemented (T_5) as compared to control group. There was no significant ($p \leq 0.05$) difference among the sesame supplemented treatments (T_2, T_3, and T_4) for these traits. Sendros (1993) reported that grazing yearling growing sheep supplemented with concentrate had significantly higher slaughter weight, hot carcass weight, and dressing percentage than the non-supplemented sheep. The highest hot carcass weight was recorded for animals on the highest level of supplementation.

Result obtained for dressing percentage on empty body weight in this study were in agreement with the findings of Asnakew (2005) who described that heavier empty body weight for the supplemented group than the control and significant difference between the supplemented groups were observed. Payne (1999) also reported that dressing percentage increases with increasing the proportions of concentrate in the ration. The dressing percentage on slaughter weight base and empty body weight base in this experiment was relatively small in all treatments than the results reported by Monaem et al. (1988) for Moghani rams; Galal and Kassahun (1981) for Ethiopian highland sheep and Horro sheep; and Macit et al. (2002) for Awasi, Morkaraman, and Tushin lambs. Dressing percentage describes the carcass merit condition as a proportion of carcass weight to body weight which helps to assess the meat proportion of the animal subjectively (Getahun, 2006 and Devendra and Burns, 1983) The dressing percentage of this study on the basis of slaughter body weight were 35.29%, 37.56%, 39.46%, 43.00% and 45.03 for T_1, T_2, T_3, T_4, and T_5, respectively. The dressing percentage on the basis of empty body weight were 44.20%, 47.28%, 51.03%, 52.64%, and 55.39 for T_1, T_2, T_3, T_4 and T_5, respectively. The values were almost comparable to the results reported by Zemicael (2007) for Arado sheep and Ewnetu (1990) for Menz and Horro sheep.

Dressing percentage values on the empty body weight basis were higher than on the slaughter weight basis, implying the influence of digesta (gut fill) on dressing percentage. Ingesta constitute a large portion of the body weight even when the animals are fasted for long hours. From Gibbs and Ivings (1993) point of view, it is more meaningful to express dressing percentage as the proportion of empty body weight than slaughter weight base. Similarly, El-khidir et al., (1998) reported that gut contents contribute 4 - 14% of fasted live weight in sheep and goats fasted for about 24 hours before slaughter. Dressing percentage of sheep are generally between 40 -50%, although affected by different factors (Gatenby, 1991). It increases with age, low in young sheep, where there is little muscle, and higher in older sheep.

According to Galal and Kassahun (1979) rib-eye area is an indirect estimate of body musculature or leanness of meat or the muscular development of the animal. The rib-eye muscle area in the present study was 5.34, 6.74, 7.93, 8.80 and 9.30 cm^2 for T_1, T_2, T_3, T_4 and T_5, respectively. The significantly higher ($P \leq 0.05$) rib-eye muscle areas were obtained in higher SSC supplementation i.e. T_3, T_4, and T_5 as compared to the control. This implies that the highly supplemented group's carcass leanness increased significantly from the control treatments. Comparable results to this study were reported by Asnakew (2005) for Hararghe goats, but lower than the values reported by Mulu (2005) for Wegera sheep. Sheep in the highest level of supplementation (T_5) exhibited higher (9.3cm^2) rib-eye area than the other treatment feeds. This was an implication of sheep supplemented with different levels of sesame seed cake were able to accommodate relatively better lean flesh than fed teff straw. This finding was in line with many other studies (Asnakew, 2005; Mulu, 2005; Simret, 2005; Zemicael, 2007).

Table 2. Body weight change, feed conversion ratio and efficiency of sheep fed on teff straw and supplemented with different levelssesame seed cake in *Tahtay Koraro Woreda*.

	T_1	T_2	T_3	T_4	T_5	***SEM***
Initial body weight (kg)	18.1	18.0	17.7	17.4	18.3	1.172
Final body weight (kg)	18.8^b	22.5^{ab}	23.4^{ab}	24.0^{ab}	25.3^a	1.131
Average daily live weight gain(g)	7.8^c	60.0^b	63.2^b	72.8^{ab}	77.8^a	9.658
FCR(g DMI/g LWG)	29.0^a	15.3^b	15.0^b	11.0^b	10.3^b	4.272
FCE (g LWG/g DMI)	2.47^b	6.84^b	8.96^b	9.54^b	14.40^a	2.361

Breeds with different superscripts differ significantly at $p \leq 0.05$; SEM = standard error of mean; FCR = feed conversion ratio; FCE = feed conversion efficiency.

In the current study, the size of heart, liver with gallbladder, reticulo-rumen, small intestine, total fat, tail, kidney and total edible organic component (TEOC) were significantly ($p \leq 0.05$) affected by supplementation (Table2). Kirton et al. (1972) reported that live weight and nutritional status of the animals can affect the production efficiency of carcass offals. Total edible organic components (TEOC) were significantly lower ($p \leq 0.05$) in the control treatment compared to the higher level of sesame seed cake supplemented treatment i.e. T_3, T_4 and T_5. However, there was no significant difference (p>0.05) on the combined weight of lung, trachea, and esophagus; empty gut, omaso-abomasum, large intestine, tongue and TEOC% due to supplementation.

Sheep supplemented with sesame seed cake had significant ($p \leq 0.05$) higher visceral fat, and tail than the control treatments. This fat deposit could be attributed to the fact that supplemented sheep tend to deposit more fat in their body as compared to the non-supplemented ones. In line with this result, Galal et al. (1979) indicated that there was heavier fat as indicated by visceral fat and tail weight for grazing Adal lambs supplemented with concentrate feeds. On the other hand, animals fed low quality feed use their fat body reserve in order to fulfill their nutrient requirement that leads to decreased fat storage in their body and as a result mobilization of body fat reserves will start. This is pronounced during dry season and prolonged underfeeding.

Table 3. Carcass characteristics of sheep fed on teff straw supplemented with different levels of sesame seed cake in *Tahtay koraro woreda*.

Variables	***Treatments***					***SEM***
	T_1	T_2	T_3	T_4	T_5	
Slaughter weight (Kg)	19.33^{b}	21.50^{ab}	22.10^{ab}	23.80^{ab}	25.17^{a}	0.888
Empty body weight (Kg)	16.22^{b}	17.80^{ab}	18.07^{ab}	18.85^{ab}	20.43^{a}	0.773
Hot carcass weight (Kg)	7.17^{c}	8.90^{b}	9.67^{b}	10.00^{ab}	11.33^{a}	0.288
Dressing percentage on						
Slaughter weight base	35.29^{b}	37.56^{ab}	39.43^{ab}	43.00^{ab}	45.03^{a}	1.886
Empty body weight base	44.20^{b}	47.28^{b}	51.03^{ab}	52.64^{ab}	55.39^{a}	2.380
Rib-eye area (cm^2)	5.34^{b}	6.74^{ab}	7.93^{a}	8.80^{a}	9.30^{a}	0.523

Breeds with different superscripts differ significantly at $p \leq 0.05$; SEM = standard error of mean.

There was significant difference ($p \leq 0.05$) due to supplementation on blood, spleen and pancreas, head without tongue, skin, testicle and penis, feet and TNEOC%, but there were no significant difference (p>0.05) on gut content and total non-edible organic component (TNEOC) from the non-edible offals. The total usable product were also significantly lower ($p \leq 0.05$) for the control (T_1) and the lower level concentrate mixture supplemented treatments as compared to the higher (T_4 and T_5) supplemented treatment, but there was no significant difference (p>0.05) between $T_1$and T_2; T_2 and T_3; & T_3, T_4 and T_5, even though the weight of the total usable product increased as the level of concentrate mixture supplementation increased (Table3). Thus, the significant difference observed in the total usable product was mainly due to the higher value of dressing percentage which was affected by level of nutrition among the other factors.

3.1. Partial Budget Analysis

Result showed that sheep fed on teff straw basal diet supplemented with different levels of sesame seed cake showed that the highest level of sesame seed cake supplementation (T_5) returned a higher profit than the other supplemented and un-supplemented treatments. The net return from the supplemented experimental treatments was 1.56, 13.54, 34.6, 57.24 and 82.00 ETB per head for T_1, T_2, T_3, T_4 and T_5 respectively. The costs of feed per kg total live weight change were 140.63, 30.83, 32.54, 31.26 and 32.45 ETB for T_1, T_2, T_3, T_4 and T_5 respectively. The difference in control and treatment was due to the difference in live weight change of the sheep in each treatment, which was a function of differences in feed quality and feed conversion efficiency. The higher net return and rate return in T_5 was due to the optimum protein and energy supplementation, which resulted in higher body weight gain (77.8 g/day) as compared to the other treatments that had relative body weight gain of 7.8 g/day/sheep, 60.0 g /day/ sheep, 63.0 g /day/ sheep and 72.8 g/day/sheep for T_1, T_2, T_3 and T_4 respectively. This indicates that sheep fed with better quality feed perform well and have higher body weight gain and sold at maximum price and earn better net return.

The result of this study suggested that supplementation of teff straw with 300gDM level of sesame seed cake was potentially more feasible and economically beneficial than the other level of supplements and the control group. Similar to this result, Tesfay (2007) studied on Afar rams fed on teff straw basal diet supplemented with concentrate mixtures (noug seed cake, sesame seed cake and wheat bran).

4. CONCLUSION

From the results of the present study, it can be concluded that supplementation of teff straw with 300g DM level of sesame seed cake (T_5) was potentially more feasible and economically beneficial to the livestock owning community to efficiently utilize nutrients in combination with locally available agro-industrial by- products, such as sesame seed cake for better sheep production performance.

5. REFERENCES

Abule, Ebro. 1994. Performance of crossbred calves fed on teff (*Eragrostis teff*) straw supplemented with graded levels of cowpea (*vigna unguculata*) and *Dolochos lablab* (*lablab perpureus*) hay. MSc Thesis presented to the school of Graduate Studies of Alemaya University of Agriculture, Alemaya, Ethiopia,41p.

Akinsoyinu, A.O., U.A. Mba & O.F, Olubajo. 1975. Studies on energy and protein utilization for pregnancy and lactation by the West African Dwarf goats in Nigeria. *East African Agric. J.* **41**: 167-176.

Alemu, Yami. 1981. Laboratory evaluation and estimation of nutritive value of some feedstuffs produced in the Alemaya Woreda. MSc Thesis presented to the school of graduate studies of Alemaya University,81p.

AOAC (Association of official Agricultural Chemists), 1990. Official methods of analysis. Association of official Agricultural Chemists, Washington, D.C.,1298p.

Asnakew, Aweke. 2005. Feedlot fattening performance and carcass characteristics of intact male Hararghe highland goats fed different levels of hay to concentrate ratios. MSc Thesis Presented to the School of Graduate Studies of Alemaya University of Agriculture, Ethiopia. 65p.

Beyene, Chichaibelu., Copper, C.E & McDowell, R.E. 1977. Laboratory evaluation and estimation of nutritive value of Ethiopia feedstuff and formula feeds. AAASAIV, **(2)**:9-24.

Bonsi, M.L.K., Tuah, A.K., Osuji, P.O., Nsahlai, V.I & Umunna, N.N. 1996. The effect of protein supplement sources or supply pattern on the intake, digestibility, rumen kinetics, nitrogen utilization and growth of Ethiopian Menze sheep fed teff straw. *Animal Feed Science and Technology*, **64**: 11-25.

Crabrtree, J.R & Williams, L.G. 1971. The voluntary intake and utilization of roughage concentrate supplement for hay and straw. *Anim. Prod*.,**13**:71-82.

DeGregorio, R.M., Tucker, R. E., Mitchell, G. E & Gill, W.W. 1982. Carbohydrate fermentation in the large intestine of lambs. *J. Anim. Sci.* **54(4)**: 855-62.

Devendra, C & Burns, M. 1983. Goat production in the tropics, 2nd Edition, Common Wealth Agricultural Bureax, UK, 56p.

E1-khidir, I. A., Babiker, A.S & Shafie, A.S. 1998. Comparative feed lot performance and carcass characteristics of Sudan's desert sheep and goats. *Small.Rumi.Res*., **30**: 147-151.

Ensminger, M.E. 2002. *Sheep and goat science*. 6th Edition, International Publishers, Inc., Danville, Illinois, pp.342-385.

Ewnetu, Ermias. 1990. Between and within breed variation in feed intake and fat deposition, and genetic association of these with some production traits in Menz and Horro sheep. MSc Thesis presented to the school of Graduate Studies of Alemaya University.

FAO, 1990. Guide to Food and Agriculture Organization (FAO) Documents (Website).

Galal, E.S.E & Kassahun, Awgichew. 1981. Ethiopian Adal sheep: genetic and environment factors affecting body weight and post-weaning gain. *Inter. Goat and Sheep Res*.,**1(4)**: 310-318.

Galal, E.S.E., Kassahun, Awgichew., Beyene, Kebede., Yohannes, Gojjam & Donovan, P.B.O. 1979. A study of fattening Ethiopian sheep: 1. performance of highland lambs under feed-lot conditions. *Eth. J. of Agric.Sci*., **1(2)**: 93-98.

Gatenby, R.M. 1991. Sheep. The Tropical Agriculturalist, CTA, Macmilan Educational Ltd. London.154p.

Getahun, Kebede. 2006. Effect of urea treatment and leucaena (Leucaenaleucocephala) Supplementation on the Utilization of Wheat Straw by Sheep**.** MSc Thesis Presented to the School of Graduate Studies of Alemaya University of Agriculture, Ethiopia.

Getnet, Berhanu. 1998. Performance of Somali goat supplemented with different proportion of groundnut cake and wheat bran. MSc Thesis presented to the Graduate Studies of Alemaya University of Agriculture, Ethiopia, 55p.

Getnet, Berhanu., Alemu, Yami & Mekonen, Hailemariam. 1999. Performance of lactating Somali does supplemented with different proportions of groundnut cake and wheat bran. Proceedings of the 7th Annual Conference of Ethiopian Society of Animal Production (ESAP), 26-27 May 1999, Addis Ababa, Ethiopia, pp.197-211.

Gibbs, M.J & Ivings, E.W. 1993. A note on the estimation of body fat, protein and energy content of lactating Holsteins Friesian cows by measurements of condition score and live weight. *J. Anim. Prod*. **56**: 18-83.

Hadjipanyiotou, M & Morand-Fehr, P. 1991. Intensive feeding of dairy goats. ***In***: P. Morand-Fehr ed., Goat nutrition, EAAP Publication No.46, Pudoc, Wageningen, the Netherlands, pp.197-208.

Ibrahim, M.N.M & Schiere, J.B. 1989. Feeding of urea-ammonia treated rice straw. A compilation of miscellaneous reports produced by the straw utilization project (Sir Lanka). Pudoc. Wageningen. pp.1-28.

ILRI (International Livestock Research Institute), 1995. Building a global research institute. ILRI. Addis Ababa, Ethiopia.

Khanal, R.C & Olson, K.C. 2004. Factors Affecting Conjugated Linoleic Acid (CLA) Content in Milk, Meat, and Egg: A Review. *Pakistan Journal of Nutrition*, **3(2)**: 82-98.

Kirton, A.H., Fourie, D.P & Jury, E.K. 1972. Growth and development of sheep. III. Growth of the carcass and non-carcass component of the South Down and Romney and their cross and some relationships with composition. *J. Agric. Res.*, **15**:214-227.

Macit, M., Esenbuga, N & Karaglu, M. 2002. Growth performance and carcass characteristics of Awassi, Markaraman and Tushin lamb grazed on pasture and supplemented with concentrate. *Small Ruminant Research*, **44**: 241- 246.

McDonald, P., Edwards, R.A., Greenhalgh J. F. D & Morgan, C.A. 2002. Animal nutrition. 6th Edition, Prentice Hall, London, pp.471-581..

MacRae & Amstrong. 1969. Studies on intestinal digestion of sheep. Digestion of some carbohydrate constituents in hay, cereal and hay-cereal rations. *Brit. J. Nutrition*, **23**:377 cited in DeGregorio R.M, Tucker R. E, Mitchell G. E., and Gill. W.W. 1982. *J. Anim. Sci*., **54 (4)**:855-862.

Monaem, M., Esmaili-Rad, E & Dokhanchi, S. 1988. Evaluations of the reproductive capacities of the Iranian sheep breed Moghani sheep. Research reports no.65. Animal husbandry research institute, Tehran, Iran.

Mulu Moges, 2005. Effect of feeding different levels of breweries dried grain on live weight gain and carcass characteristics of Wogera sheep fed on hay basal diet. MSc Thesis Presented to the school of Graduate Studies of Alemaya Univ., of Agriculture, Ethiopia, pp.139.

Njie, M. 1995. Economics assessment of feeding strategies for fattening ram lambs using sesame cake in the Gambia. Proceeding on agricultural science for biodiversity and sustainability in developing countries, held 3-7 April 1995, Tune Land boskole, Denmark, pp.192-198.

Njwe, R.M & Olubajo, F. O. 1989. Evaluation of cassava flower and groundnut cake as concentrate supplements for West African Dwarf goats. ***In***: A. N. Said and B.H. Dzowela (eds.), Overcoming constraints to the different utilization of agricultural by-products as animal feed. Proceeding of the 4th annual workshop held at the institute of Animal research, Mankon Station, Bamenda, Cameroon 20-27 October 1989, pp.306-323.

Payne, W.J.A. 1999. An introduction to animal husbandry in the tropics. Longman scientific and Technical United States, New York. **44**:233-240.

Preston, T.R & Leng, R.A. 1984. Supplementation of diets based on fibrous residues and by-products. pp. 373-413. **In**: F. Sundstol and E. Owens (eds.). Straw and other fibrous by-products as feeds. Elsevier publishing company.

Sendros, Demeke. 1993. Comaparative study on growth, carcass and wool traits on Menz sheep and their crosses with Awassi and Corriedal breeds under supplemented grazing. Msc. Thesis presented to the School of Graduate Studies of Alemaya University of Agriculture, Alemaya, Ethiopia. pp. 26-51.

Seyoum, Bediye & Zinash, Sileshei. 1998. Utilization o teff straw as livestock feed: review. Proceeding of the fifth annual conference of Ethiopia society of animal production. ESAP (Ethiopia society of animal production) held14-15 may 1998, Addis Ababa, Ethiopia, pp.173-185.

Simret, Betesha. 2005. Supplementation of graded levels of peanut cake and wheat bran mixture on nutrient utilization and carcass parameters of Somali goats. M.Sc. Thesis presented to the school of Graduate studies of Alemaya University of Agriculture, Alemaya, Ethiopia. 60p.

Solomon, Moges. 1992. The effect of processing method of oil seed cake in Ethiopia on the nutritive value of: In-vitro n-metabolism in growing sheep feed a basal diet maize Stover, PhD. Thesis, University of Bonn, Germany.

Solomon, Melaku., Peter, K.J & Azage, Tegegne. 2004. Effect of supplementation with foliage of selected multipurpose trees and their mixtures or wheat bran on feed intake, plasma enzyme activities, live weight and scrotal circumference gains in Menz sheep. *Livestock production sci*., **89**:253-264.

Tesfay, Hagos. 2007. Supplementation of Afar rams with graded levels of mixtures of protein and energy sources: effects on feed intake, digestibility, live weight and carcass parameters. MSc Thesis Presented to the School of Graduate Studies of Alemaya University of Agriculture, Ethiopia.

Tesfaye, Woldemichael., Osuji, P.O & Asfaw, Yimegnuhal. 2001. Effect of wheat bran supplementation at graded levels on changes in physical body composition in teff straw (*Eragrostis teff*) fed zebu (*Bos undicus*) oxen of Ethiopian highlands. Proceeding of 9th Annual Conference of the Ethiopian society of animal production (ESAP) held 30-31 August, 2001, Addis Ababa, Ethiopia, pp.99-109.

Thi, Trinh., Hong, Nquyen., Metha, Wanapat & Thao, The Nguyen. 2012. Feeding Strategies to increase Small ruminant production in dry environment. *Agricultural J.*, **7(2)**:95-100.

Trach, N.X. 2004. An evaluation of adaptability of alkali treatment of rice straw as feed for growing beef cattle under small holder' circumstances. *Livestock Res. Rural Dev*., **16(7)**.

Upton, M. 1979. Farm Management in Africa: The Principle of Production and Planning. Oxford University Press, Great Britain, pp.282-298.

Van Soest, P.J. 1994. *Nutritional ecology of the ruminant*. Cornell University Press, Ithaca and London, 476p.

Xianjun Yuan, Chengqun Yu, Shimojo, M & Tao Shao. 2012. Improvement of Fermentation and Nutritive Quality of Straw-grass Silage by Incubation of Wet Hulless-barley Distillers Grain in Tibet. Asian-Aust. *J. Anim. Sci.*, **25(4)**:479-485.

Zemicael, Gereslassie. 2007. Supplementation of sesame seed (*Sesame indicum*) cake, wheat bran and their mixtures on feed intake, digestibility, live weight changes and carcass characteristics of Arado sheep fed a basal diet of teff straw. MSc Thesis Presented to the School of Graduate Studies of Alemaya University of Agriculture, Ethiopia. 57p.