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Research Article

Effects of replacement of cafeteria leftover by concentrate mixture on biological performance and economic return of Washera lambs fed desho grass hay as basal diet

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Abstract: *The study was conducted to evaluate the inclusion of cafeteria leftover (CL) on biological performance and economic return of Washera lambs fed desho grass and supplemented with concentrate mix (CM) in Ethiopia. Microbiological analyzes were performed in order to assess the feed safety of CL using standard microbiological guidelines. Twenty-five male Washera lambs with a mean body weight of 21.9±1.01 kg (mean ± SD) were used in randomized complete block design consisted of five replications. The dietary treatments included: 0% CL+100% CM (T1), 25% CL+75% CM (T2), 50% CL+50% CM (T3), 75% CL+25% CM (T4) and 100% CL+0% CM (T5). The data collected includes, chemical composition of diets, nutrient intake, nutrient digestibility, carcass yield and quality. The microbiological quality assessment of the CL indicated that it conformed to satisfactory limits of feed safety and therefore it fit for animal feeding. Sheep under T2 had higher (p<0.001) total dry matter intake (DMI) and organic matter intake (OMI) whereas as compared to other treatment groups, sheep under T1 and T5 had lower (p<.001) total DMI and OMI, respectively. The DM digestibility coefficient was higher (p<0.01) for sheep fed with mixed supplement diet (T2 to T4). The protein digestibility coefficient was higher (p<0.01) for the mixed supplement and lower for solely dried students' cafeteria leftover (CL). Average daily gain showed higher (p<0.01) for T1 but similar values for treatments (T2 to T4) compared to (T1 and T5). The average empty body weight (EBW) and hot carcass weight (HCW) showed higher (p<0.01) for the dietary treatments (T2 to T4). According to the partial budget analysis, T4 was the most profitable diet, followed by T3, T2, T1, and T5. Based on this, it is possible to conclude that CL could be included in Washera lambs CM rations at a level of 75% without any adverse effect on the performance and carcass characteristics of sheep. Drying and processing of the entire student cafeteria leftover imposed due to sun drying of laxative food leftover such as pasta. As food leftover contains more moisture and is easily spoiled, guidelines for collecting, transporting, drying, and storing raw materials should be developed to ensure the safety of food leftover for animal feed. Thus, further research is required to investigate technological options for properly drying laxative food leftovers such as pasta so that such food leftovers can be used for ruminant animal feed.*

Keywords: Body weight, Carcass yield, Digestibility, Food waste, Growth rate, Microbiological quality

1. Introduction

In Ethiopia, despite the importance of sheep, both at household and national levels of the economy, production and productivity of the sheep sub-sector have been quite low. Sheep production is one of the most important subsectors of livestock production in Ethiopia supporting national and household economy (Solomon *et al*., 2010). However, sheep productivity, like that of other livestock species, is relatively low, as evidenced by low sheep performance in terms of average daily gain, final body weight gain, and carcass yield. This low productivity is primarily due to insufficient nutrient intake, which is linked to diets with low nutrient availability, such as natural pasture hay, crop residues, and stubble grazing (CSA, 2021). As a result, it is critical to seek alternative feed sources that can replenish nutrients in sheep's main diets and improve sheep performance. The candidate supplement consists of cafeteria leftovers, which are typically wasted as an invaluable resource. People frequently discard food leftovers as garbage, particularly in urban institutes such as higher learning institutions and food production companies. Westendorf (2000) defines food waste as edible waste from food production, transportation, distribution, and consumption.

It has been discovered that feeding food waste to animals in a safer manner has two significant advantages, including the ability to provide alternative feed sources to animals, which reduces environmental pollution (Westendorf, 2000). Such judicious use of food waste for livestock feed can also reduce feed costs during the manufacturing process. Amene *et al*. (2016) demonstrated the contribution of CL as livestock feed, reporting that CL can replace the conventional concentrate mix up to 67 percent without affecting pig performance under Ethiopian conditions. Furthermore, Truong *et al*. (2019) demonstrated that food waste in general could play an important role in broiler rationing and concluded that food waste could serve as a partial substitute for corn and soy in broiler diets. Rodrguez *et al*. (2007) demonstrated that CL could be used to improve the overall performance of fattening lambs.

Not only do the livestock benefit from the nutrients in recycled food, but society benefits from the environmental benefits as well (Salemdeeb *et al*., 2017). There are many higher learning institutions in the area where this study was conducted that host many students who rely on cafeterias, and urbanization is also on the rise, which could be a source of food waste. The hypothesis of this study was that cafeteria leftover (CL) would have the same effect on the biological performance of lambs as the concentrate mixture (CM). Therefore, the current study was designed to assess the effect of dried student cafeteria leftovers, including mixed concentrate, on the biological performance and economic return of feeding Washera lambs.

2. Materials and Methods

2.1. Description of the study areas

The experiment was conducted at the Zenzelima Campus of Bahir Dar University (Figure 1) located at 11° 37′ N and 37° 28′ E with an altitude of 1900 m.a.s.l. Annual average temperature is 20.1 °C and annual rainfall ranges from 1430 to 1520 mm. The main rainy season is from June to September. The soils are dominantly fine soils developed on basaltic bedrocks. Crop-livestock farming is the most important source of livelihood in rural areas. The most popular livestock species kept by urban producers are dairy cattle, beef cattle, sheep, and chicken.

2.2. Feed preparation

The feed ingredients used for supplementing the experimental animals were the dried students' cafeteria leftover (CL) obtained from student's cafeteria and concentrate mix (CM) was prepared from locally available ingredients such as maize grain (48.5%), wheat bran (20%), soybean meal (30%) and limestone (1.5%). The main constituents of student's cafeteria leftover were *Enjera* (major food in Ethiopia) mainly made of teff (*Eragrostis tef*), bread mainly made of wheat (*Triticum aestivum*) and sauce (*wot* in Amharic) mainly made from onion, *berbere* (pepper and spices mixture), vegetable oils, lentil (*Lens culinaris*) and pea (*Pisum sativum*) cooking. It is known that feed for ruminant animals should not contain meat or bone meal derived from ruminants (FDA, 2008). Due to this reason, meat was excluded from the cafeteria leftover. Potential food items that would lead to fungal development such as Pasta and Macaroni were excluded by preliminary

observation because it will take too much time to dry. The student's cafeteria leftover was collected and sun-dried by sparsely spreading on canvas. It took 30 days to dry the whole student's cafeteria leftover which used for the entire experimental periods. After drying the required amount for the entire experiment, the CL was grounded in mill house for the animal to be easily consumed and then stored in sacks until required for formulation of the experimental rations. The desho grass hay used in the current experiment was grown at Bahir Dar University campus and harvested at four months of age after planting. The grass was air dried under shed and stored at dry place before feeding. The basal diets were manually chopped in to sizes 5-10 cm to increase feed intake.

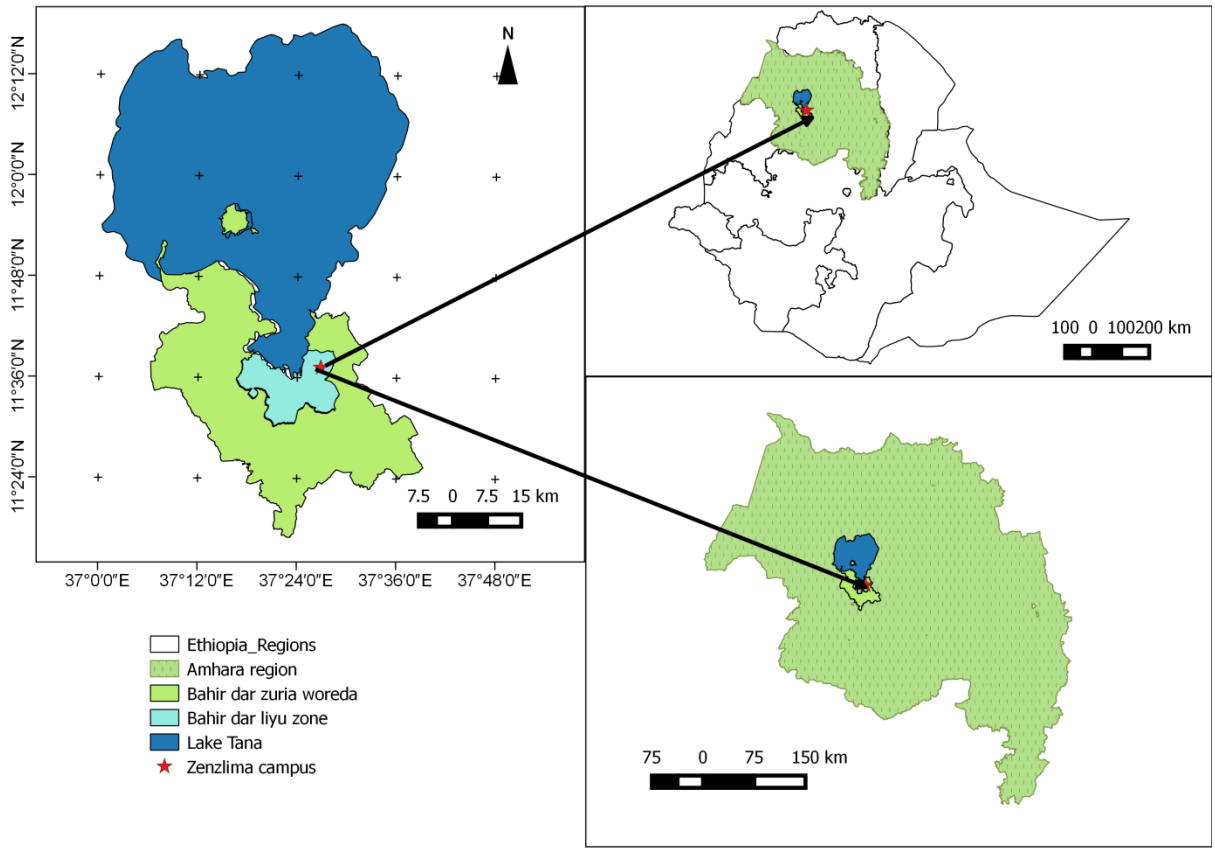

Figure 1: Location of Zenzelima campus, Bahir Dar University
Source: Prepared by authors using Geographic Information System (GIS)

2.3. Microbiological analysis

The microbiological analysis was done at the laboratory of Food and Chemical Engineering, Bahir Dar University. Microbiological analysis of the CL was performed using three pooled samples. Samples were collected aseptically and transported to the food and chemical engineering laboratory. For the analysis, 450g of pooled samples were tested for various microbial parameters including *Aerobic plate count*, *Yeast* and *Mold* counts, *Staphylococcus aureus*, *Coliform* count, *Fecal coliforms*, *E. coli*, *Enterobacteriacea* and isolation of *Salmonella* pathogen. All tests were determined in accordance with the ISO (2003), Mazizi *et al*. (2017) and microbiological guidelines for ready to eat food (2014).

2.3.1. *Materials and equipment*

Weighing balance, petri-dishes, spatula, measuring cylinder, test tubes, test tube rack, aluminum foil, Autoclave, glass slide, Bunsen burner, boiling water bath, homogenizer, homogenizer bag, distilled water, and various medias were used. All glassware were washed very well in water using detergent,

disinfectant and brushes and sterilized it by hot air oven at 160 °C for 30 minutes to achieve maximum sterilization. The incubator, hot air oven and other equipment used in this study were all thoroughly cleaned, disinfected and sterilized.

2.3.2. *Aerobic plate count*

Aerobic plate count of CL was determined by using Molten plate count agar medium (MPCA) (Hi media). First 25g of CL was mixed with 225 ml peptone water diluents in a homogenization bag and blended by using the homogenizer for 2 minutes. From this 1:10 dilution of the original sample, serial decimal dilutions (10^{-2}-10^{-6}) were prepared. Then 1 ml of respective dilutions (10^{-2}-10^{-6}) was inoculated on-agar plate. Then 20ml of MPCA in duplicated Petri-dish were prepared for each respective dilution. Molten plate count agar medium and the dilution were thoroughly mixed by back- and-forth motion on a flat level surface. After the agar had solidified, the Petri-dishes were incubated at 35 ± 1°C for 48 h in an inverted position (Larry and James, 2001).

2.3.3. *Detection and enumeration of staphylococcus*

Staphylococcus was detected and enumerated by using Mannitol salt agar (MSA) (Hi media). First 20g of CL samples were mixed with 180 ml of maximum recovery diluents in a sterilized homogenizer bag and then homogenized to yield 1:10 dilution (10^{-1}). The samples were further serially diluted in order to achieve 10^{-2}-10^{-6} dilutions. Mannitol salt agar was prepared according to the instructions, and cooled to 48 ^{0}C before use. Then 15-20 ml of the tempered MSA was poured into a Petri-dish and allowed to solidify. Then 0.1 ml sample from each dilution was inoculated on the corresponding MSA plates in duplicate using a glass spreader. The plates were incubated 35 – 37 ºC for 48hr. After incubation, the plates were examined the presence of yellow colonies (Aryal, 2016).

2.3.4. *Isolation of yeasts and molds*

Yeasts and *molds* were isolated on Potato Dextrose Agar with tartaric acid to pH 3.5 (PDA) (Hi media). First 25g of CL was mixed with 225ml peptone water diluents in a homogenizer bag, blended by using the homogenizer for 2 minutes to yield 1:10 dilution. From this sample, serial dilutions (10^{-2}-10^{-5}) were prepared. Potato Dextrose Agar was prepared according to instructions and 0.1 ml of respective dilutions was inoculated on pre-poured solidified PDA plates and was spread evenly with a sterile glass spreader in duplicate. After the plates were dry they were incubated it at 22-25 ºC for 5 days. After incubation, colonies with a filamentous, cotton-like/ powdery appearance (characteristic of *Molds*) were scored as *Molds*, and the remaining colonies as *yeasts* or bacteria. Microscopic observation of simple stained smears was also performed in order to distinguish *Yeasts* colonies from bacterial colonies. Cells that appeared in oval shape were confirmed as *Yeasts* (Isenberg, 2004).

2.3.5. *Detection and enumeration of Coliforms*

Coliforms were detected and enumerated using violet red bile agar (VRBA) (Hi media). First 20g of CL sample was homogenized in 180 ml of maximum recovery diluents in order to yield 1: 10 dilution. To obtain (10^{-2}-10^{-6}) dilutions, 0.1 ml of the original dilution was serially diluted. Then 1ml of respective dilutions was inoculated on to VRBA plates using the pour plate technique. And the plates were incubated at 35 °C for 24 h. Colonies that appeared red-purple in color with a size of 0.5mm or larger in diameter with reddish zone were scored as *Coliforms* (Peter *et al.*, 2002).

2.3.6. *The MPN method for fecal coliforms and E. coli*

For isolation and identification of *Fecal coliforms* and *E .coli* 10 g of CL was mixed with 90ml of maximum recovery diluents solution and homogenized to yield a 1:10 dilution. Further dilutions (10^{-2}-10^{-4}) supplemented with lactose were prepared by using the serial dilution technique in triplicate. Durham tubes were inserted into all the serially diluted tubes in an inverted position and incubated at 37 °C for 24-48 hrs. Gas formations in the inverted Durham tube at the end of incubation were indicative of presumptive *Coliforms*. For the confirmation of *fecal coliforms*, a loopful of each suspected samples were transferred to tubes containing 2% Brilliant Green Agar (BGA) Broth and *E. coli* Broth (EC), supplemented with lactose. Observation of growth with the production of gas in the BGA tubes, after 24–48 hr. incubation at 35 °C, was considered confirmative of fecal *coliforms*. Growth with gas production in the EC tubes, after 2hr

incubation at 45.5°C was considered confirmative of *E. coli* (ISO, 2003).

2.3.7. *Detection of Salmonella*

Salmonella was detected using Xylose-Lysine-Dexychlate (XLD) Agar (Hi media). First 25g of CL was mixed with 225ml of Buffered Peptone Water (BPW) and incubated at 37 ºC for 24hr. Then 0.1ml of this sample was inoculated into 10 ml of Rappaport Vasilidas Broth then incubated at 41.5 ºC for 24 h. At the end of incubation, the RV culture tubes were mixed by vortexing and a loopful of the sample was inoculated and spread plated into XLD and BGA Medias separately. Then the plates were incubated at 37 °C for 24hr in an inverted position. The presence of Pink/red colonies with or without black centers was indicative of *Salmonella* Pink/ (red) colonies surrounded by a reddish zone were also indicative of *Salmonella* (Global Salm-Surv, 2003).

2.3.8. *Detection and enumeration of Enterobacteriacea*

Enterobacteriacea were detected and enumerated using Violet Red Bile Glucose Agar without Lactose (VRBGA) (Hi media). First 20g of CL sample was mixed with 180 ml of maximum recovery diluents and homogenized, thus yielding 1:10 dilution (10^{-1}) and serially diluted to obtain (10^{-2}-10^{-6}). Then, 1 ml from each respective dilution was pour-plated onto VRBGA without lactose medium by gently swirling the plates on the bench surface to assure even mixing. After setting, the plates were overlaid with molten VRBGA without lactose and incubated at 35 ºC for 24 h in an inverted position. Colonies that appear pink, red, light pink and pink red with bile precipitate are indicative of *Enterobacteriacea* (Kukier *et al*., 2005).

2.4. Experimental animals and their management

Twenty-five yearlings intact male Washera lambs with mean body weight (BW) of 21.9±1.01Kg (mean ± SD) were used in the current study. The experimental lambs were housed in individual pens equipped with feeding and watering troughs. The pen had 80 cm width 130 cm height and 150 cm length. The lambs were quarantined for 21 days, 15 days of adaptation and 90 days of growth and 10 days of digestibility trials. The experimental animals were vaccinated against ovine pasteurellosis, sheep pox, blackleg, and anthrax, dewormed against internal parasites, and sprayed against for common prevalent external parasites in the area. The vaccines were obtained from the national veterinary institute, Addis Ababa, Ethiopia. The experimental animals had free access to clean water and salt throughout the experimental period.

2.5. Experimental design and treatments

The experimental design was randomized complete block design with five treatments and five replications. Blocking of sheep was done based on the initial BW of sheep, which were the averaged values of two consecutive weighing. The treatments were 100% concentrate mix (CM) (T1), 75% CM + 25% dried students cafeteria leftover (CL) (T2), 50% CM+ 50% CL (T3), 25% CM+ 75% CL (T4), and 100% CL (T5) and all experimental sheep had a basal diet of Desho grass (*Pennisetum pedicellatum*) hay throughout the experimental period diet.

2.6. Feed intake and body weight change

The sheep were offered basal diet *ad libitum* at 25% refusal adjustment every week throughout the experimental period. The amount of refusal was adjusted to the mentioned amount as the hay had a relatively poor quality. Sheep were fed in an individual feeding trough. Daily feed intake of individual sheep was calculated as the difference between the amounts of feed offered and refused. Subsamples of feed offered and refused were taken and prepared for chemical analysis. The body weight change of each animal was measured every ten days. The average daily body weight gain (ADG) in gram was calculated as the difference between final body weight and initial body weight divided by the number of experimental days. The feed conversion efficiency (FCE) of sheep was determined by dividing the ADG by the amount of feed consumed per head per day.

2.7. Digestibility of dry matter and nutrients

The digestibility of dry matter and nutrients was conducted at the end of the feeding experiment. In the digestion experiment, each sheep was fitted with a fecal collection bag and allowed to adapt for four days. The fecal collection from each sheep was done for seven consecutive days. Feces voided were

weighed and recorded every morning, thoroughly mixed, 20% of representative samples taken, frozen at −10 °C, and pooled over the collection period for each animal. At the end of the collection period, the sample from each day per animal was mixed and dried at 60 °C for 72 hours. The digestibility of dry matter and nutrients was determined as the difference between dry matter and nutrient intakes and that recovered in the feces, and expressed as the proportion of dry matter and nutrient intakes.

2.8. Chemical analysis of feeds and feces

To determine the nutrient constituents of sample feeds, refusals, and feces samples were ground using a laboratory mill to pass through a one mm sieve. The dry matter (DM) content was determined by oven drying samples at 105°C for 6 hours. Total nitrogen (N) was determined by the Kjeldhal method (AOAC, 1990). The crude protein (CP) content was determined as N× 6.25. Organic matter (OM) content was calculated as the difference between DM and ash contents. The ash content was determined after burning representative sample DM in muffle furnace at 550 °C to a constant weight. Neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL) were determined according to Van Soest and Robertson (1985). The chemical analyses were done at Debre Berhan Agricultural Research Center Animal Nutrition laboratory.

2.9. Carcass parameters

The carcass yield and quality of experimental sheep were analyzed at the end of the experiment. All the Washera lambs in treatments were slaughtered after 24 hours of fasting. The edible offal components (EOC) namely: liver, kidney, heart, tongue, reticulo-rumen, omasum and abomasum, hindgut, tail and fats (kidney, heart, omental, scrotal and pelvic) were weighed and recorded individually. Total edible offal components (TEOC) were calculated as the total sum of the edible offal components. The non-edible offal components (NEOC) namely: blood, head (without tongue), skin, lung plus trachea, pancreas, spleen, bladder, gallbladder, gut fill, genital organ and feet with hooves were weighed and recorded. Total non-edible offal components (TNEOC) were calculated as the total sum of the non-edible offal components. The carcass was cut perpendicular to the backbone between the 12th and 13th ribs to measure the cross-sectional area of the rib-eye (*longissimus dorsi*) muscle area.

2.10. Partial budget analysis

The partial budget analysis was employed using the procedure of Upton (1979). All costs related to feed preparation were added to the total variable cost. At the end of the experiment, experienced lamb dealers estimated the selling price of the sheep. The difference between the purchasing and selling price of the sheep in each treatment was considered as total return (TR). The net income (NI) was calculated by subtracting the total variable cost (TVC) from the total return (TR). The change in net income (ΔNI) was calculated as the difference between the change in total return (ΔTR) and the change in total variable cost (ΔTVC). The marginal rate of return (MRR) measures the increase in net income (ΔNI) associated with each additional unit of expenditure (total variable cost) (ΔTVC). MRR (%) =ΔNI/ΔTVC × 100.

2.11. Statistical analysis

DM intake, body weight change, DM and nutrient digestibility coefficients, carcass yields were analyzed using analysis of variance (ANOVA) with general linear model (GLM) procedure of SAS 9.1.3. Mean separations were done using the Duncan's Multiple Range Test (DMRT) for variables whose F-values declared a significant difference among them. Differences were considered statistically significant at 5% significance level. The statistical model for data analysis is indicated below.

$$Yij = \mu + ti + bj + eijk \quad [1]$$

Where: Y_{ij} = the response variable; μ = the overall mean; t_i = the treatment effect; b_j = the block effect; e_{ijk} = the random error

3. Results and Discussion

3.1. Microbiological analysis of leftover feed

The microbiological analysis of the feed from dried student's cafeteria leftover is presented in Table 1. The *Aerobic plate count (APC*) for the CL was found to be 2.36 x 10^6 CFU/g. The count obtained in this study was found to be 2.5- fold lower than the count previously reported (Cabarkapa *et al*., 2009).

According to the Microbiological guidelines for ready to eat food (2014), the satisfactory level for *S. aureus* is < 20CFU/g. However, in this study, *Coagulase*$^{+ve}$ *S. aureus* count was not detected. However, pink colonies indicative of *Coagulase*$^{-ve}$ *S. aureus* was detected. This could be indicative of *Staphylococcus sp.* such as *S. epidermidis* which are normal bacteria commonly present in human nasal passage, throat, hair and skin without causing any discomfort. The occurrence of *S. epidermidis* may be due to contact with food handler's hands, especially in the cases where the food is handled after cooking, during consumption by the students as well during drying.

The *Yeasts* and *Molds* count for CL was estimated to be 1.2 x 10^6 /g. This was ten times lower than the maximum allowable level of 107 CFU/g (FSAI, 2016). Coliform bacteria are lactose fermenting bacteria that belong to the *Entrobacteriacea* family, which includes Escherichia coli and *Entrobacter* species, and are a fecal contamination marker. The obtained coliform counts were 2.15x103, which were found to be 100 fold lower than the *coliform* counts reported by Michael *et al*. (2005). While the fecal *coliforms* and *E. coli* were less than 1.8 MPN/g, this was significantly lower than the guidelines' limit (Microbiological guidelines for ready to eat food, 2014).

Table 1: Microbiological analysis of dried student's cafeteria leftover feed

Specific Microorganisms	Microbes in CL (CFU/g)/ MPN/g	Microbiological quality for ready to eat food for human consumption*/animal feed✦			References
		Unsatisfactory	Border line	Satisfactory	
Aerobic plate count	2.36 x 10^6	-	-	6x10^6	Cabarkapa *et al*., 2009✦
Staphylococcus aureus	ND	> 10^4	20 - <10^4	< 20	Microbiological guideline for ready to eat food, 2014 *
Yeast and molds	1.2 x 10^6	-	-	10^7	FSAI, 2016 *
Coliforms	2.15 x 10^3	-	-	>1.96x10^5	Michael *et al*., 2005 ✦
Fecal coliforms and *E. coli*	<1.8 MPN/g	-	-	700 MPN/100g	Microbiological Guidelines for ready to eat food, 2014 *
Salmonella	ND	D	-	ND	Microbiological Guidelines for ready to eat food, 2014 * and FSAI, 2016 *
Enterobacteriaceae	6.5 x 10^3	> 10^4	-	-	Microbiological Guidelines for ready to eat food, 2014 *

ND = not detected; D = detected; MPN = most probable number: CFU = colony forming unit; CL = cafeteria leftover

Salmonella and *Staphylococcus aureus* are capable of producing acute and chronic infections in all or most types of animals (Mallinson, 1984). However, the study showed that *Salmonella* was not detected in the CL, which also corresponds well to the guideline which indicates *Salmonella* should be absent in 25g of feed (Microbiological guidelines for ready to eat food, 2014; FSAI, 2016).

The number of *Enterobacteriaceae* was enumerated to be 6.5 x 10^3 CFU/g. considering the unsatisfactory limit of > 10^4 CFU/g for ready to eat food for human consumption, CL was deemed to be suitable for feeding lambs as a supplement. In general, the microbiological analyses indicated that the CL sample fulfilled the established criteria for microbiological quality and food safety and therefore it fit for animal feeding.

3.2. Chemical composition of feeds

The chemical composition of feeds and refusals of Washera lambs fed basal diet of Desho grass and supplemented with CL, CM and their mixtures at different proportion are presented in Table 2. The result showed that DM, OM, CP, NDF, ADF, ADL, and ash contents of CL were 92%, 87.66%, 12.72%, 20%, 13.18%, 6.59% and 4.34%, respectively.

The CP content of CL (12.75%) was lower than previously reported CP contents (15.10%) for kitchen leftover feeds (Sadao, 2005). However, the CP content of CL in the current study was found to be higher than the report of Tesfaye *et al*. (2016) which was 9%. The ash content of CL in this study (4.34%) is found to be within the range of 3-6% for leftover food in different areas (Kornegay *et al.,* 1970; Ferris *et al*., 1995). However, it was found to be lower than reported values (7.60 and 7.70%) by Tesfaye *et al.* (2016) and Negasa (2015), respectively. The discrepancy of current finding from other reports might be related to the nature of the food, processing methods followed and handling methods.

Regarding the CP content of basal diet desho grass (10.90%), Van Soest (1994) noted that a roughage diet with 7% CP composition can satisfy the minimum level of CP required for microbial function in adult ruminants. Hence, the current desho hay used for the basal diet had sufficient CP for maintenance requirement of experimental sheep. The current CP content of basal feed desho grass is higher than earlier findings, which might be related to the environmental conditions associated with the area where the grass was grown. If the CP content is high at the beginning, the refusal CP content may also similarly increase.

3.3. Dry matter and nutrient intake

The DM and nutrient intakes for the diets of all the groups are presented in Table 3. Among treatments, sheep in T2 had the highest ($P<0.001$) basal DM intake. Sheep in T5 had the lowest mean daily DM intake of the basal diet, although T1, T3 and T4 are statistically similar ($P>0.05$). Sheep under T2 had higher ($P<0.001$) total DM intake and organic matter (OM) intake whereas, sheep under T1 and T5 had lower total DM intake and OM intake. The CP intake of sheep was higher ($P<0.05$) for the dietary treatment groups (T2 to T4) than the sheep in T1 and T5 diet groups. However, there was no difference among them, thus dietary treatments whereas T1 and T5 had lower CP intake.

In the current study, a lower daily DMI for the sheep in the T5 diet group could be attributed to the slow degradation of CL, which in turn suppresses the basal diet intake. The reason might be related to the low content of some nutrients like CP, which otherwise improves microbial digestion. Moreover, in the treatments with T2, T3 and T4, better digestibility could be related to the presence of relatively balanced nutrients that caused relatively better digestibility rather than T1 or T5 alone. Similarly, Grovum and William (1977) reported that longer feed retention in the rumen results in reduced feed intake. The higher total DMI in T2 might be due to the favorable rumen environment created by the mixed supplementation, which enhanced the microbial growth. The current results are in consistence with previous studies of Melese *et al*. (2014) and Hirut *et al.* (2011) which reported increased in total DMI as a result of supplementation of different types of feed for different sheep breeds. The CP intake of sheep was higher for the dietary treatment groups T2, T3 and T4 this is due to the higher digestibility of the feed that leads to increase CP intake. Whereas protein level of T1 and T5 was lower because it takes much time to digest, which might mean amino acid level was low. Dietary protein supplementation is known to improve intake by increasing the supply of nitrogen to the rumen microbes, which increases the microbial population and efficiency, enabling an increased rate of breakdown of the digest, which in turn increases feed intake (McDonald *et al*., 2002). The CP intake of sheep in this experiment was found to be in the range of 95.80-111.71 g/d.

Table 2: Chemical composition of experimental feeds and refusals

Feeds	DM	OM	CP	NDF	ADF	ADL	Ash
Desho grass hay	89.0	87.90	10.90	67.31	42.60	20.70	12.10
CL	92.0	95.66	12.72	20.00	13.18	6.59	4.34
Maize grain	90.0	97.78	9.10	15.55	8.88	2.22	2.22
Soya bean meal	90.0	91.12	48.88	18.88	11.00	4.44	8.88
Wheat bran	91.0	95.61	19.72	18.68	10.98	2.22	4.39
Mixed CM	88.85	94.88	23.02	16.94	12.16	2.85	5.12
Desho grass hay refusal							
T1	88	87.50	6.14	82.77	68.88	28.33	12.50
T2	88	85.23	8.21	72.77	57.77	27.11	14.77
T3	88	87.50	8.50	69.44	53.33	23.77	12.50
T4	88	86.37	7.19	68.33	53.33	22.66	13.63
T5	87	86.37	6.27	73.88	59.09	26.00	13.63

DM = dry matter; OM = organic matter; CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; ADL = Acid detergent lignin; CM = Concentrate mix (48.5% Maize grain + 20% wheat bran+30% soya bean meal +1.5% lime stone); CL = cafeteria leftover; T = treatment

Table 3: Daily dry matter and nutrient intake of Washera sheep fed basal diet of Desho grass and supplemented with CL, CM or their mixtures in different proportion

Parameters	T1	T2	T3	T4	T5	SEM	SL
Basal DMI (g/day)	417.5^{b}	540.9^{a}	439.0^{b}	370.5^{b}	254.1^{c}	0.53	***
CM DMI (g/day)	241	180.75	120.5	60.25	0	-	-
CL DMI (g/day)	0	106.75	213.5	320.25	427	-	-
Total DMI (g/day)	658.5^{c}	828.4^{a}	773.0^{ab}	751.0^{b}	681.1^{c}	0.83	***
OMI (g/day)	543.6^{c}	697.2^{a}	653.3^{ab}	628.8^{b}	571.3^{c}	0.52	***
CPI (g/day)	98.3^{b}	111.7^{a}	109.8^{a}	107.6^{a}	95.8^{b}	0.35	*
NDFI (g/day)	306.5^{b}	378.3^{a}	346.3^{ab}	340.0^{ab}	315.2^{b}	0.44	*
ADFI (g/day)	179.9^{b}	233.7^{a}	208.6^{ab}	200.2^{ab}	182.4^{b}	0.54	**

Means in the same row with different superscripts are different at $P< 0.05$ (*), $P< 0.01$ (**) and at $P< 0.001$ (***); DMI = dry matter intake; CPI = crude protein intake; NDFI = neutral detergent fiber intake; ADFI = acid detergent fiber intake; SEM = standard error of mean and SL = significance level; T = treatment

3.4. Dry matter and nutrient digestibility

Apparent digestibility of nutrients for the sheep of all the groups fed basal diet of Desho grass and supplemented with CL, CM and their mixtures in different proportion are shown in Table 4. The DM digestibility was higher values (P<0.01) for T2 to T4 than T1 and T5 but no significant difference among them. On the other hand, sheep supplemented T5 had lower DM digestibility, whereas T1 had no different (P>0.05) with other treatments. The combination of CL and CM improved feed DM, OM and CP digestibility compared to CL alone. The improvement observed in digestibility in dietary treatment groups (T2-T4) might be due to the level of optimal energy to protein ratio. This showed that loss of undigested nutrients is decreased. The protein digestibility coefficient of the current study was significantly higher (p<0.01) for the mixed supplement and lower for solely CL. Foster *et al.* (2009) indicate that digestibility of CP generally increases as CP intake increase. The CP content of feeds is important for increasing the microbial population in the rumen to

support optimum ruminal activity. The digestibility of NDF was significantly higher (P<0.01) for mixed supplement (T2-T4) and lower for solely CM (T1) and solely T5. ADF was significantly higher (P<0.05) in mixed supplement and lower in solely T1 whereas solely CM showed no significantly different (P>0.05) with other treatments.

The digestibility of a feed is influenced by the composition of other feeds consumed with it and the associative effects could be negative or positive (McDonald *et al.* 2002). Therefore, the higher DM and OM digestibility for T1 to T4 might be due to the positive effect of the feeds. The higher CP digestibility in T2, T3 and T4 might be due to higher nutritional components which enhance the rumen fermentation, which in turn leads to consume more basal feed. Foster *et al.* (2009) indicate that digestibility of CP generally increases as CP intake increase. Higher digestibility of DM and nutrients might be explained by the fact that feeds rich in protein content promotes high microbial population and facilitates rumen fermentation (McDonald *et al*., 2002). The lower digestibility of CP in sheep fed only CL compared to all the treatments, this can affect the microbial growth and fermentation in the rumen of sheep (Bonsi *et al*., 1995). The increased digestibility of CP in mixed supplement could be due to higher digestibility rate of the feed and this lead to consume more basal feed not only this but also the mixed supplement feed which were digested were not lost with their feces. Lower CP digestibility in T5 lambs might be associated with the decreased microbial function that leads to a reduction in degradation and consequently lowers feed intake. This result was in line with Seyoum *et al.* (2007). Generally, higher digestible nutrient in the mixture supplement of CL and CM supplement (T2 to T4). This situation clearly indicates that they did not lose higher proportion of the nutrients consumed in their feces and those treatments played a significant role in improving digestibility in sheep diet. The CP content of feeds is important for increasing the microbial population in the rumen to support optimum ruminal activity. Lower CP digestibility in T5 might be associated with slow degradation of CL aroused from its low CP contents, which in turn suppresses the basal diet intake. This result was in line with Seyoum *et al*. (2007) who studied various feed staffs in Ethiopia.

3.5. Body weight change and feed conversion efficiency

The body weight change parameters and feed conversion efficiency data for all groups are presented in Table 5. There was no difference (P>0.01) in initial body weight among treatments. The average daily gain of lambs in treatments T2, T3 and T4 were in part but significantly higher (P<0.01) than T1 and T5, which were not statistically significant (P>0.05). The reason for higher ADG in T2 to T4 diet groups might be because of their higher total DM and nutrient intake of the animals. This helped the sheep to have high protein absorbed by the body. Ensminger (2002) showed 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. The higher feed conversion efficiency in T2 to T4 indicated that diets with higher digestibility values result in higher final body weight gain, average daily gain and feed conversion efficiency. The possible reason for the similarity in parameters might be an inclusion of CL with CM has a more important contribution for rumen fermentation than either of supplements T1 (CM alone) or T5 (CL only). In addition, the combinations of lower CL or higher CL with CM have a similar rate of improving the biological performance of lambs in the current study that producers could use one of the combinations based on the availability of CL.

Table 4: Apparent digestibility of nutrient intake of Washera sheep fed basal diet of Desho grass and supplemented with CL, CM or their mixtures in different proportion

Parameters	T1	T2	T3	T4	T5	SEM	SL
DM	72.5^{ab}	79.1^{a}	78.8^{a}	78.1^{a}	66.6^{b}	0.019	**
OM	71.2^{ab}	80.8^{a}	79.4^{a}	79.1^{a}	65.0^{b}	0.262	**
CP	74.3^{b}	81.2^{a}	79.7^{a}	79.0^{a}	68.1^{c}	0.015	**
NDF	70.1^{b}	82.3^{a}	80.7^{a}	81.0^{a}	66.3^{b}	0.375	**
ADF	63.5^{ab}	69.2^{a}	68.1^{a}	67.6^{a}	60.9^{b}	0.0261	*

Means in the same row with different superscripts are different at $P< 0.05$ (*) and $P< 0.01$ (**); T = treatment; DM = dry matter; OM = organic matter; CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; SEM = standard error of mean; SL = significance level

Table 5: Body weight parameters and feed conversion efficiency of Washera sheep fed a basal diet of Desho grass supplemented with different levels CL and CM at different proportion

Parameters	T1	T2	T3	T4	T5	SEM	SL
Initial BW (Kg)	22.0	21.8	22.0	21.9	22.1	1.01	NS
Final BW (Kg)	27.02^{ab}	30.01^{a}	29.16^{a}	29.16^{a}	25.7^{b}	1.22	**
BWC	5.02^{ab}	8.21^{a}	7.16^{a}	7.26^{a}	3.6^{b}	1.00	*
ADG (g/d)	55.7^{b}	91.2^{a}	79.6^{a}	80.6^{a}	40.1^{b}	3.35	**
FCE (g ADG/g TDMI)	0.08^{ab}	0.11^{a}	0.10^{a}	0.10^{a}	0.05^{b}	0.01	**

Means within rows having different superscript are significantly different at $P< 0.05$ (*) and $P< 0.01$ (**); NS = not significant; BWC = body weight change; ADG = average daily gain; FCE = feed conversion efficiency; SEM = standard error of means; SL = significance level; BWC = body weight change

3.6. Carcass parameters

Carcass characteristics of Washera lambs fed Desho grass basal diet supplemented with CL, CM and their mixtures in different proportion are given in Table 6. The average empty body weight (EBW) and hot carcass weight (HCW) showed higher ($P<0.01$) treatments (T2 to T4) than T1 and T5. The higher slaughter weight (SW), empty body weight (EBW) and HCW for the mixed supplements was demonstrated by their high average daily gain (ADG) and digestibility. This implies that most of the nutrients digested were absorbed and assimilated into body tissues as compared to sheep in T1 and T5. The mean SW and EBW ranged between 24.32-29.1 Kg and 20.02-25.76 Kg, respectively.

The higher EBW and HCW for T2, T3 and T4 was demonstrated by their high ADG and digestibility, implying that most of the nutrients digested were absorbed and assimilated into body tissues as compared to T1 and T5. The mean SW and EBW in ranged from 24.32-29.10Kg and 20.02-25.76Kg, respectively. The higher body weight and the lower proportion of gut content in T2, T3 and T4 leads to higher EBW, since EBW is the difference between SW and gut content. The rib eye area, which is an indicator of muscling, showed significantly higher values in sheep fed T2 to T4 and lower in T1 and T5. This might be due to higher slaughter weight for T2, T3 and T4. The current result was in line with the previous study of Shadnoush *et al.* (2004) and Fernandes *et al.* (2008) who reported rib- eye area is positively correlated with slaughter weight which was impacted by nutrition.

Table 6: Carcass characteristics of Washera sheep fed Desho grass and supplemented with CL, CM or their mixtures in different proportion

Parameters	T1	T2	T3	T4	T5	SEM	SL
SW (Kg)	26.10^{ab}	29.10^{a}	28.31^{a}	27.95^{a}	24.32^{b}	1.14	**
EBW (Kg)	21.01^{b}	25.76^{a}	25.00^{a}	24.93^{a}	20.02^{b}	0.97	**
HCW (Kg)	11.94^{b}	14.02^{a}	13.80^{a}	13.92^{a}	11.01^{b}	0.55	**
DPSW basis (%)	45.01^{b}	48.43^{a}	48.10^{a}	48.05^{a}	44.54^{b}	1.04	*
DPEBW basis (%)	52.51^{ab}	56.75^{a}	56.04^{a}	56.18^{a}	50.34^{b}	1.58	**
REA (cm^2)	11.23^{b}	14.22^{a}	13.97^{a}	13.97^{a}	10.82^{b}	0.45	**

Means within a rows having different superscript are significantly different at $P< 0.05$ (*) and $P< 0.01$ (**); SEM = standard error of mean; SL = significant level; SW = slaughter weight, EBW = empty body weight, HCW = hot carcass weight, DPSW = dressing percentage; REA = rib eye area

3.6.1. *Edible offal components*

The edible offal of the carcass obtained from the slaughter of the sheep in all the groups fed Desho grass and supplemented with CL, CM or their mixtures in different proportion are presented in Table 7. In countries where offal is used in the food habit such as Ethiopia, salable offal adds values to the carcass. Because of cultural differences in eating habits and social taboos, what is salable and edible in one part of the country may not be in another. Therefore, in this study, categorization of offal as edible or non- edible offal was made based on the eating habit of the people in the locality where the study was conducted. Among the edible offal components effect of significant of diet (P<0.05) was observed in kidney, liver, hindgut, kidney fat, omental and mesenteric fat, pelvic and total edible offal component whereas heart, tongue, reticulo rumen and omasum have no difference among the treatments (P>0.05). The increase in liver weight in T2 to T4 might be related to the storage of reserved carbohydrates, such as glycogen, when animals are fed with energy dense diets. The current result was in line with (Lawrence and Fowler, 1998). This might be as a result of increased intake of dietary energy. The higher abdominal fat content for T2 to T4 might be due to the greater CP supply that may result to more fat in viscera. In line with the current study, Ulfina *et al.* (1999) reported a significant effect on omental and mesenteric fat and kidney fat. Higher weight of TEOC in T2, T3 and T4 indicated that increased in BW has a positive effect on the weight of TEOC in the current study.

3.6.2. *Non edible offal components*

The non-edible offal of the carcass obtained from the slaughter of the sheep in all the groups fed Desho grass and supplemented with CL, CM or their mixtures are presented in Table 8. The weight of testicle, lung with trachea and bladder were higher (P<0.05) in T2 to T4 than in the other two groups. The amount of blood was higher (P<0.01) for the sheep in T1 to T4 than in T5. The skin weight of the sheep was higher in T2, T3 and T4 than in T5. However, it did not differ between T1 and the other four groups.

According to Lawrence and Fowler (1998) the higher skin weight might be due to an increase in subcutaneous fat deposition under the skin this result was in line with the current result. The higher gut content in T5 might be due to CL had stayed for a long time in GIT whereas T2, T3 and T4 had high rate of digestion and faster passage rate of the diet through the digestive tract due to consumption of more digestible feed. This result was in line with the views of Van Soest (1994) and Pond *et al.* (1995) which stated that feed which will not digest easily will stay for a longer time in the gastro-intestinal tract (GIT).

Table 7: The edible offal component of Washera sheep fed Desho grass and supplemented with CL, CM or their mixtures in different proportion

Edible carcasses (g)	T1	T2	T3	T4	T5	SEM	SL
Heart	114.33	127.18	124.18	121.08	102.65	0.34	NS
Kidney	69.7^{ab}	74.75^{a}	72.62^{a}	72.9^{a}	64.7^{b}	1.32	*
Liver	335.1^{b}	377.2^{a}	372.7^{a}	372.4^{a}	324.6^{b}	0.32	*
Tongue	118.9	138.5	122.58	120.6	112.2	1.06	Ns
Reticulo rumen	628.8	665.6	653.2	631.1	520.1	0.55	Ns
Omasum	280.4	301.1	300.3	290.3	275.2	2.32	Ns
Hindgut	841.7^{ab}	920.9^{a}	914.6^{a}	917.1^{a}	817.5^{b}	0.36	*
Kidney fat	88.7^{ab}	109.1^{a}	103.2^{a}	103.0^{a}	68.7^{b}	0.02	*
Omental & mesenteric fat	169.1^{b}	278.1^{a}	267.3^{a}	269.6^{a}	83.6^{c}	0.34	*
Pelvic fat	47.3^{ab}	77.4^{a}	77.3^{a}	70.1^{a}	26.3^{b}	0.04	*
TEOC (Kg)	2.69^{ab}	3.06^{a}	3.07^{a}	2.96^{a}	2.39^{b}	0.21	*

$^{a, b, c}$= means the same row with different superscripts differ significantly at $P<0.05$ (*); NS = not significant; TEOC = total edible offal component; SL = significant level; SEM = Standard error of mean

Table 8: Non edible offal of the carcass obtained from the slaughter of Washera sheep fed Desho grass and supplemented with CL, CM or their mixtures at different proportions

Non Edible carcasses (g)	T1	T2	T3	T4	T5	SEM	SL
Blood weight	1035.2^{a}	1166.1^{a}	1140.3^{a}	1112.9^{a}	767.4^{b}	0.45	**
Skin	3155.4^{ab}	3703.9^{a}	3595.7^{a}	3600.0^{a}	2745.8^{b}	0.04	*
Feet	711.3	735.8	721.2	725.1	705.6	0.55	NS
Head without tongue	1408.3	1441.5	1436.9	1426.5	1316.6	0.67	NS
Penis	47.5	60.4	58.9	49.3	46.1	0.02	NS
Testicle	186.2^{b}	349.7^{a}	384.1^{a}	340.8^{a}	157.5^{b}	0.05	*
Gut content	4269.2^{ab}	3349.1^{b}	3416.7^{b}	3568.4^{b}	4777.0^{a}	0.86	*
Lung with trachea	276.2^{b}	376.5^{a}	373.7^{a}	371.2^{a}	261.7^{b}	0.41	*
Gall bladder with bile	18.0	32.3	21.5	21.3	17.4	0.02	NS
Spleen	44.6^{ab}	52.2^{a}	50.3^{a}	49.8^{a}	38.6^{b}	0.03	**
Esophagus	41.2	45.1	43.9	42.9	24.5	0.05	NS
Bladder	37.3^{b}	74.7^{a}	75.7^{a}	73.1^{a}	31.5^{b}	0.047	*
TNEOC (Kg)	11.23^{ab}	11.38^{a}	11.32^{a}	11.38^{a}	10.88^{b}	2.42	*

Means in the same row with different superscript letter are significantly different; NS = non-significant; * = $p<0.05$; ** = $p<0.01$; SL = significant level; SEM = standard error of mean; TNEOC = total non- edible offal components

3.7. Partial budget analysis

Partial budget analysis result in all the groups fed Desho grass and supplemented with CL, CM or their mixtures in different proportion is presented in Table 9. In the mixed supplement treatment groups (T2 to T4), the relatively higher total returns per animal were based on their higher body weights and good body condition, resulting in higher market price per animal. The net return from T1, T2, T3, T4 and T5 were 1402.2, 1690.03, 1708.2, 1718.43 and 1263.59 ETB/head, respectively.

The relatively higher total returns in T2, T3 and T4 than in the other groups were based on their higher body weights and good body condition, resulting in higher market price per animal. Comparing with T1, T2, T3 and T4, sheep in T5 gained lower BW. As a result of this, the sheep in T5 had a lower net return. Even though T2 to T4 had a higher net return, T4 had

a particularly higher return. At the level, T4 feed had more satisfactory daily BW gain (80.60 g/d), highest NR (1718.43 ETB) and highest ΔNI (316.23 ETB) compared to the other supplemented treatments. Generally, sheep which had a better CP intake had superior ADG. As a result of this, sheep in T2 to T4 had higher sale price to earn higher net return, especially the sheep in T4 had the highest net return. Because CL had lower cost and are easily available for sheep farmers, supplementation with T4, which resulted in the highest net return, could be selected as the best supplement.

Table 9: Partial budget analysis of Washera sheep fed Desho grass and supplemented with CL, CM or their mixtures at different proportion

Variables	Treatment				
	T1	T2	T3	T4	T5
Number of animals	5	5	5	5	5
Purchase price of sheep (ETB/head)	1160	1158	1156	1155	1160
Total feed consumed (Kg/head)	59.26	74.55	69.57	67.59	61.29
Total basal diet consumed (Kg/head)	37.57	48.69	39.56	33.97	22.86
Total CL consumed (Kg/head)	0	9.6	19.21	28.82	38.43
Total CM consumed (Kg/head)	21.69	16.26	10.84	5.42	0
Cost of basal diet (hay) (ETB/head)	75.14	97.38	79.12	67.94	45.72
Cost for grinding CL (ETB/head)	0	9.6	19.21	28.82	38.46
Cost of CM (ETB/head)	162.67	121.95	81.3	40.65	0
Additional labor cost for drying CL (ETB)	0	23.04	46.10	69.16	92.23
Total variable cost (ETB/head)	237.8	251.97	225.73	206.57	176.41
Gross income (selling price of sheep) (ETB)	2800	3100	3090	3080	2600
Total return (ETB)	1640	1942	1934	1925	1440
Net return (ETB)	1402.2	1690.03	1708.2	1718.43	1263.59
Δ TVC	-	14.17	-12.07	-31.23	-61.39
ΔNI	-	287.83	306	316.23	-138.61
MRR (ratio)	-	20.31	-25.35	-10.12	2.25

ETB = Ethiopian Birr; ΔNI = change in net income; ΔTVC = change in total variable cost; MRR = marginal rate of revenue

4. Conclusion and Recommendation

The microbiological analysis of the CL revealed acceptable limits suitable for ruminant animal feeding. Sheep fed ration containing the mixed CL and CM utilized feed efficiently than solely concentrate or solely CL. This meant that the different proportions of CL in CM had no effect on feed intake, but rather improved nutrient utilization. Indeed, the availability and low cost of CL make it an alternative protein supplement for fattening Washera lambs. This also benefits livestock keepers by minimizing the cost of concentrate mixes and replacing the CL for concentrate mixture. It is recommended that supplementation of CL at an optimal 75% proportion with CM is more beneficial than feeding solely with CM; since it is biologically and economically superior to the feeding of growing Washera lambs. Drying and processing of the entire student cafeteria leftover imposed due to sun drying of laxative food leftover such as pasta. As food leftover contains more moisture and is easily spoiled, guidelines for collecting, transporting, drying, and storing raw materials should be developed to ensure the safety of food leftover for ruminant animal feed. Thus, further research is required to investigate technological options for properly drying laxative food leftovers such as pasta so that such food leftovers can be used for ruminant animal feed.

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Data availability statement
Data will be made available on request.

Declaration of interest's statement
The authors declare no competing interests.

Ethical guidelines
The authors genuinely declare there was no anesthetic or surgical procedure used during the experiment. Also, we attest that experimental animals were handled properly to avoid animal suffering at each stage of the experiment.

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