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Effective Microbes (EM) Supplementation Effect on Feed Intake, Digestibility and Live Weight Changes of Washera Sheep Fed Wheat Straw

Research Article

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ABSTRACT

This study evaluated the effect of supplying effective microbes (EM) on feed Intake, digestibility and live weight changes of Washera sheep fed wheat straw. 24 intact male Washera sheep with initial body weight of 19.78 ± 1.97 kg (Mean±SD) were used. The treatments include concentrate feed plus *ad libitum* wheat straw with no EM (T1), concentrate feed plus *ad libitum* wheat straw with 1% EM (T2), concentrate feed plus *ad libitum* wheat straw with 3% EM (T3) and concentrate feed plus *ad libitum* wheat straw with 5% EM (T4) of total dry matter (DM). The experiment consisted of ninety days of feeding trail, 10 days of digestibility trial. Wheat straw used for the experiment had a chemical composition of 92% DM, 5.43% organic matter (OM), 2.81% crude protein (CP), 75.24% neutral detergent fiber, 64.13% acid detergent fiber and 12.33% acid detergent lignin. A progressive increase in wheat straw intake was observed as the level of EM percentage increased from 1% to 5%. Except the concentrate supplement DM intake, significantly higher ($P<0.01$) wheat straw intake (378.2 g/d), total DM intake (646.6 g/d), total CP intake (67.9 g/d) and total OM intake (526.3 g/d) were recorded in T4 than the other treatments. DM, OM and CP digestibility was unaffected by treatment. Final body weight, weight change and feed conversion efficiency was not affected until the straw is treated with 5% EM (T4). The highest net income was obtained in sheep received T4.

KEY WORDS digestibility, effective microbes, feed Intake, Washera sheep, wheat straw.

INTRODUCTION

Ethiopia is a home for about 60.34 million cattle, 31.30 million sheep, 32.74 million goats 1.42 million camels, 56.06 million poultry, 2.01 million horses, 0.46 million mules and 8.85 million donkeys (CSA, 2018).

Ethiopia is second in Africa and sixth in the world in terms of sheep population, though the benefit from this enormous resource has to date been limited due to a multitude of problems (Biffa *et al.* 2006; CSA, 2010). In Ethiopia, sheep significantly contributes towards the livelihood of the farm households in terms of financial income, food and non-food products, and socioeconomic and cultural functions as well (Asresu *et al.* 2013).

Ethiopia being rich in various agroecologies, the highlands are a major source of sheep for slaughter in the cities, and the pastoral lowlands are a major source of sheep and goats for export markets beside their significant importance for domestic utilization (Arend, 2006). The rapid growth in demand for meat products in the world represents a great opportunity for livestock resource-rich countries like Ethiopia (Asfaw *et al.* 2011). In this regard, sheep and goats contribute a quarter of the domestic meat consumption, about half of the domestic wool requirements, 40% of fresh skins and 92% of the value of semi-processed skin export trade (Adane and Girma, 2008).

Food, manure, skins, risk aversion are some of the important resources obtained from sheep for smallholder farmers. However, the contribution of the sub-sector both in smallholder farmer's and the country's economy remains below its potential due to low productivity of animals than the regional and continental average. The average reported carcass yield for Ethiopian sheep is 10 kg which is lower than the neighboring African countries sheep carcass weight such as Sudan (12 kg); Kenya (13 kg) and Djibouti (14 kg) (Tegegne and Assefa, 2010). This low productivity of animals could be reflected by many factors, but shortage of feed in terms of quality and quantity is the critical one in the country. Nowadays, the most important livestock feed resources in Ethiopia are natural pasture, crop residues and grass hay (CSA, 2013). The reliability of natural pasture as a source of feed is, however, restricted to the wet season (Zinash *et al.* 1995) and most of it is degraded because of overgrazing (Alemayehu, 2006). Moreover, the resource is continuously converted to crop land to satisfy the food demand of an alarmingly increasing human population. Consequently, the natural pasture existing in the country has been characterized as poor in botanical composition, low nutritional quality and biomass yield. On the other hand, grass hay harvested from such areas could not satisfy the nitrogen requirements of sheep. Similarly, crop residues are inherently low in quality (Wondatir and Mekasha, 2014).

Despite large number and importance of sheep in the areas, productivity is low due to a number of factors among others feed shortage both in quality and quantity, and health constraints (Sisay, 2006). The limitation in production due to shortage of feeds and poor nutrition is usually profound in mid and highland areas of Ethiopia where are exposed to high seasonal dynamics in feed sources, fragile ecologies and environment degradation. Roughage constitute a major feed source for animals in crop-livestock mixed farming systems. Technologies that improve rumen fermentation of roughage feeds, improve protein supply to microorganisms and reduce methane emission and are important to boost the overall productivity, health, and well-being of sheep flocks (Woju, 2012). In improving better use of roughage feeds, use of effective microbes (EM-Bokashi) for better management of crop residues is thus imperative (Safalaoh and Smith, 2001).

The original use of EM was for agriculture. Hence EM was first applied to enhance productivity of organic or natural farming systems. EM was applied directly into organic matter added to cropping fields, or to compost, which reduced the time required for the preparation of bio fertilizers. EM is also added in the form of Bokashi (compost) made with waste material such as rice husk and saw dust as a carrier, mixed with nitrogen rich material such as rice, corn or wheat bran (WB), fish meal or oil cakes (Sangakkara, 2014).

Various physical and chemical treatments have been tried, which are known to improve feed quality either by increasing digestibility or by enhancing palatability. However, these treatments have their own limitations (Silverstein *et al.* 2007). Crop residues have not been maximally utilized as feed for ruminants, and attempts to treat crop residues to improve their feeding values by farmers have been minimal. The reason for this include the poor understanding of farmers about ruminant nutrition and feeding; and lack of information and training on crop residue treatment techniques partly due to the poor linkages between researchers, extension workers and target farmers. On the other hand, there is reluctance by users to adopt new technologies for livestock production as priority is generally given to crop production in terms of labor use and cash investment. Thirdly, some developed methods per se may not technically and socio-economically suite to the local conditions under the smallholder farmers condition. The question that can arise then is, what are the strategies that can be technically and socio-economically relevant and acceptable to farmers under the local conditions. Despite encouraging results of several techniques that have been developed, none has yet been proved to satisfy all biological, economical and environmental requirements. Though sufficient data is available on the various chemical treatment options there is little or no research with regard to the application of effective micro-organisms (EM) to improve the nutritive value of crop residues.

The application of effective microorganisms, popularly known as EM, in improving the quality of animal feed has also received much attention in many regions of the world. Chernet (2012) tried to investigate the effect of EM on feed Intake, digestibility, growth and internal parasitic load on Afar Sheep breed. However, using EM technology on small ruminant in general and on Washera sheep breed particular is very limited in the study area and in Ethiopia at large. So, there is a need to evaluate the value of EM on feed intake and weight gain of Washera sheep. Non-conventional supplements such as EM could help efficient utilization of roughage feeds on sheep ration.

MATERIALS AND METHODS

Description of the study area

The experiment was conducted at Burie campus of Debre-Markos University, which is found in Amhara National Regional State (ANRS) in West Gojjam Zone at Bure district. The district is located 400 km north of Addis Ababa and 148 km south of the regional town Bahir Dar, capital city of the Amhara Region. The district is located at a latitude of 10.17˚ N – 10.49˚ N and a longitude of 37˚ E – 37.11˚ E. The mean annual rainfall is 1500 mm and the mean temperature is 22 ˚C. The district has an altitude of 2000 meter above sea level (BOARD, 2012).

Experimental animals and managements

A total of 24 male Washera sheep, aged about 10-12 months was purchased from the local market and used for the experiment. The age of animals was estimated by the pattern of eruption of the incisor teeth. In addition, information was obtained from the owners regarding the age of the animals. Animals were transported to the experimental site and were quarantined for about 21 days in order to observe their health condition in the new environment. During this period, the animals were treated against common internal and external parasites and vaccinated against common sheep diseases in the area based on the recommendation of the veterinarian.

Feeds preparation and feeding management

Locally available wheat straw was purchased from the surrounding wheat producer farmers, stored in a shade and chopped (manually to a size approximately 3-6 cm long before providing to the animals). Wheat middling (WM), Noug seed cake (NSC) and wheat bran (WB) used for the experiment was purchased from local market, oil extracting and wheat flour milling factories respectively. EM solution was prepared by mixing stock EM, sugar and chlorine free water in the ratio of 1:0.25:18, respectively. EM solution was then applied to the wheat straw in different proportion.
Chopped wheat straw was weighed and offered to the experimental animals at 20% refusal adjustment throughout the experiment due to low nutrient level. Refusals of wheat straw was collected and weighed every morning before offering fresh feed throughout the experimental period. The supplement of 300 g DM/head/ day was offered at 08:00 and 16:00 h as dry matter basis. Feed offer and refusals was collected, weighed and recorded daily corresponding to each treatment ration for each animal throughout the experimental period. Sample of feed offer and refusal of each animal was collected and bulked on daily basis, over the experimental period for each feed and was sub-sampled for analysis of chemical composition per treatment.

Experimental design and treatments

The design of the experiment was a complete randomized block design (RCBD) and the animals were blocked based on initial live weight into six blocks of four animals per block (Table 1). The feed stuff used in the experiment was wheat straw, conventional concentrates (21% Noug cake, 55% wheat bran, 23% wheat middling and 1% salt) and water. Clean water was freely available all the time.

Table 1 Experimental feeds

Treatments	Basal diet	Concentrate supplements
T1 (Control)	Wheat straw (*ad libitum*)	300 (g/head/day)
T2	Wheat straw (*ad libitum*) + 1% of daily ration	300 (g/head/day)
T3	Wheat straw (*ad libitum*) + 3% of daily ration	300 (g/head/day)
T4	Wheat straw (*ad libitum*) + 5% of daily ration	300 (g/head/day)

Digestibility

After 21 days of quarantine period, animals were acclimatized to the experimental feeds for 15 days. Following the adaptation period, animals was acclimatized to carrying the fecal bags harnessed on them for three days, which was followed by seven consecutive days of total fecal collection.

During this period, feces voided into the fecal collection bag was emptied into a container and weighed for each animal separately, recorded, thoroughly mixed and a subsample of 10% was taken daily and stored in a refrigerator at about -20 ˚C. At the end of the seven days of total feces collection, samples for each animal was thawed; mixed and sufficient amount of sample was taken for chemical analysis. The feed offered and refused to each animal was weighed and recorded daily. Daily feed intake (DFI) of the experimental animals was calculated on DM bases as the difference between the feeds DM offered and refused. Representative feed samples from the offer and refusals was taken per animal daily and then they were pooled, thoroughly mixed and sub-sampled per treatment for chemical analysis. The apparent dry matter digestibility (DMD) of experimental feeds was determined using the following formula.

Apparent DMD (%)= (DMI–Fecal DM excreted/DMI) × 100

Similarly, apparent digestibility of major nutrients was calculated as follows.

Nutrient digestibility (%)= (nutrient intake–fecal nutrient output/nutrient intake) × 100

Body weight change

Following the digestibility trial, the feeding trial was continued using the same design, animals and treatment diets used in the digestibility trial. At the end of the digestibility trial, initial weights were taken after overnight fasting.

Then, the actual feeding trial was started using all animals for 90 days. During the feeding trial, body weight was recorded every 10 days throughout the study period using hanging scale.

Average daily body weight gain was calculated as a difference between final and initial body weight of the lambs divided by the number of experimental days. Feed conversion efficiency of the animal was determined as the proportion of daily body weight gain to the total daily dry matter (DM) intake.

Feed samples

The quantity of wheat straw and concentrate to be offered and refused during the digestibility and feeding trials was recorded using weighing balance every day until the end of the trials. This data will help to calculate the daily feed intake (DFI) of each animal in each treatment diet. Feed conversion efficiency (FCE) of each animal will also be computed as the amount of feed consumed per body weight gain.

Representative feed samples from the refusals were recorded before the morning feeding. Likewise, samples from the offer and refusals of wheat straw and concentrate was thoroughly mixed and taken per animal every day and then they was pooled and sub-sampled per treatments stored in a plastic bag for chemical analysis. The metabolize energy (MJ/day) intake was estimated from digestible organic matter intake (DOMI) values by using the equation of (AFRC, 1993), ME (MJ/d)= 0.0157 × DOMI g/kg DM, where DOMI is digestible OM intake (in gram per kilogram DM) calculated by the product of OMI and its digestibility coefficient.

Partial budget analysis

Partial budget analysis was made to determine the profitability of feedlot growing of Washera sheep by considering the use of different proportion of EM. The analysis was performed considering the main variable input costs (sheep price, feed price, labor and veterinary expenses, etc.) and benefits estimated to be gained from the sell prices of animals. At the end of growth trial, just before the experimental animals are going to be slaughtered for carcass and meat chemical composition analysis, three experienced individuals who are involved in sheep trading was selected to estimate the selling price of each animal. In this profitability analysis, the difference in estimated selling price of sheep and their purchase prices was taken as total return (TR). The calculation for the following economic parameters was done according to the procedure of Upton (1979). Net income (NI) or net benefit was calculated by subtracting total variable cost (TVC) from the total return (TR).

NI= TR – TVC

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).

ΔNI= ΔTR – ΔTVC

The marginal rate of return (MRR), expressed as a percentage, measures the increase in net income (ΔNI) associated with each additional units of expenditure (ΔTVC).
MRR= (ΔNI/ΔTVC) × 100

Chemical analysis

Chemical analysis of experimental feeds, refusals and faeces was carried out by taking representative samples. Feed and fecal samples were dried in a forced draft oven at 60 ˚C for 72 hours. The dried samples of feeds and faeces was milled using laboratory mill to pass through 1 mm screen and was stored for subsequent chemical analysis. From each offer and refusals sample DM, organic matter (OM), crude protein (CP) and total ash was analyzed according to the procedure described by (AOAC, 1990). The neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) will also be analyzed according to the procedure of (Van Soest *et al.* 1991). Hemicellulose was calculated as a difference between neutral detergent fiber (NDF) and acid detergent fiber (ADF).

Statistical analysis

The data was subjected to analysis of variance (ANOVA) in a randomized complete block design using the general linear model procedure of statistical models for (SAS, 2002). The treatment means was separated using Tukey HSD (Tukey honestly significant difference) test. The experimental model will be:

$$Y_{ij}= \mu + t_i + b_j + e_{ij}$$

Where:
Y_{ij}: response variable.
μ: overall mean.
t_i: treatment effect (feed).
b_j: block effect.
e_{ij}: error component of interaction.

RESULTS AND DISCUSSION

The chemical composition of experimental feeds is given in Table 2. The DM content of wheat bran, wheat middling, NSC and wheat straw offered were 90%, 90%, 93%, 92%, respectively.

The least DM was obtained in wheat bran and wheat middling, while wheat straw had medium value. On the other hand, the OM content of wheat bran, wheat middling, NSC and wheat straw offered were 84.44%, 86.67%, 79.02% and 86.57%, respectively. The CP content of wheat straw was 2.81%. The CP content of wheat middling (16.20 %) used in this experiment was relatively lower than Noug seed cake (NSC) (29.16%) and higher than wheat bran (15.98 %). In this study, the DM, OM, Ash, CP, NDF, ADF and ADL contents of concentrate mix (21% NSC, 55% wheat bran, 23% wheat middling) offered were 90 %, 84.44%, 5.56%, 18.99%, 35.55%, 22.22% and 5.55%, respectively.

The ash content of wheat straw and concentrate mix was 5.43% and 5.56%, respectively. The NDF and ADF content of wheat straw (75.24% and 64.13%, respectively) was higher followed by NSC than the other experimental feeds. The ADL value of wheat bran and wheat middling was comparable (2.2%) but lower than other experimental feeds. Wheat straw had relatively higher ADL value (12.33%) than the rest of other experimental feeds. Wheat straw refusals had almost similar chemical components in all nutrient parameters.

The DM and nutrients intake of sheep fed concentrate mix plus wheat straw alone and supplemented with 1% EM, 3% EM and 5% EM is given in Table 3. The total DM intake and straw intake were significantly higher (P<0.01) in sheep received T4 (646.6 g/day) than the other treatment groups; on the other hand, sheep received T1 (607.07 g/day) had lowest straw DM intake. This is in agreement with Chernet (2012) who reported inclusion of 100 mL EM activated solution and 300g supplemental concentrate feed promoted higher (P<0.001) DM intake compared to sheep offered 300g supplemental concentrate feed along with 1%, 3% and 5% EM-bokashi. In addition, OM intake was significantly higher (P<0.01) in T4 (526.3 g/day) and the lowest value was recorded in T1 (485.4 g/day). Sheep fed concentrate mix plus a wheat treated with 5% EM (T4) had significantly highest (P<0.01) CP intake than the rest of the experimental groups while the least was recorded in a sheep received concentrate mix plus straw alone (T1). Estimated ME intake was significantly higher (P<0.01) in 5% EM treated wheat straw offered sheep than the sheep received un treated wheat straw/control group. Similarly, the NDF, ADF and ADL intakes was also significantly higher (P<0.05) in T4 than T1, but there is no significance difference (P>0.05) in NDF, ADF and ADL intakes between T2 and T3.

Dry matter and nutrient digestibility and digestible nutrients intake of experimental diets supplemented to Washera sheep fed wheat straw is given in Table 4. There was no significant difference (P>0.05) in DM and OM digestibility among all treatment groups. This result agrees with Silanikove (2000) who stated "Digestibility is much reduced when a ration has too little CP in proportion to the amounts of soluble carbohydrates and during the dry season pasture protein levels fall below 6-7%". Similarly, Adugna *et al.* (2002) reported as feed that is low in protein and high in fiber content results in low digestibility and voluntary feed intake. This result is also in agreement with Getahun (2006) who reported the *in vitro* digestibility of organic matter of the untreated wheat straw (48.4%). But this figure is slightly lower than the value reported by Yenesew (2010) who revealed an organic matter digestibility (OMD) ranged from 50.3 to 50.5%. This may be due to differences in variety, lignin content and other environmental factors which affect digestibility. CP digestibility was not (P>0.05) affected by the inclusion of different proportion of EM. This was in agreement which show no significant difference in CP digestibility when different levels of EM bokashi and solution are offered to Afar sheep having a basal diet of teff straw.

However, there was significant difference (P<0.05) in NDF digestibility between sheep fed concentrate mix plus a wheat straw treated with 5% EM (T4) and other treatments. Similarly, a higher (P<0.05) ADF digestibility was recorded in T4 (45.5%) than the control group (36.01%). There is no significance difference in digestible DMI, OM intake (OMI) and CP intake (CPI) among treatments. However, an increment in digestible ADF and NDF digestibility was observed when the level of EM inclusion is increased from 1% to 5%.

Body weight changes and feed conversion efficiency of Washera sheep fed basal diet of wheat straw supplemented with experimental diets is given in Table 5. The mean final and average daily weight gain was significantly lower (P<0.05) for EM non-supplemented sheep as compared to EM supplemented sheep. Similarly, feed conversion efficiency (FCE) was significantly higher (P<0.05) for sheep fed 5% EM treated wheat straw than the control group.

Cost benefit evaluation of sheep fed wheat straw supplemented with experimental diets is given in Table 6. The NR was higher in Washera sheep fed wheat straw treated with 5% EM (T4) followed by sheep fed wheat straw treated with 3% (T3) and lower NR was recorded in the control group (T1).

The CP content of the wheat straw used in this study (2.81%) was lower than the minimum CP requirements (7%) to support normal functioning of rumen microbes and maintaining the host ruminant animals (McDonald *et al.* 2002). In the present study, CP content of wheat straw was lower than the CP values (4.7%) reported by (Kidanie *et al.* 2018). This difference might be because of the variation of soil type/nutrients on which the wheat grows. But the ash content of wheat straw in this study (5.43%) was comparable with the results of the previously cited author (5.5%).

Table 2 Chemical composition[1] of feed ingredients used in the experiment and straw refusals

Feed ingredients	DM	Ash (% DM)	CP (% DM)	NDF (% DM)	ADF (% DM)	ADL (% DM)
Wheat straw	92	5.43	2.81	75.24	64.13	12.33
Noug seed cake	93	13.98	29.16	48.61	38.71	8.67
Wheat middling	90	3.33	16.2	23.33	14.44	2.22
Wheat bran	90	5.56	15.98	27.77	15.56	2.22
Straw refusals[2]						
T1	91.5	3.28	2.46	77.76	68.84	13.49
T2	93	6.69	3.18	80.91	69.47	13.64
T3	91.4	5.47	2.39	80.4	69.3	13.38
T4	91	6.59	2.82	80	68.13	13.7

DM: dry matter; CP: crude protein; NDF: neutral detergent fiber; ADF: acid detergent fiber and ADL: acid detergent lignin.
T1: concentrate mix plus straw alone; T2: concentrate mix plus straw with 1% effective microbes (EM); T3: concentrate mix plus straw with 3% EM and T4: concentrate mix plus straw with 5% EM.

Table 3 Dry matter and nutrient intake of Washera sheep fed concentrate feed with wheat straw supplemented with different level of effective microbes

Parameters	Treatments				SEM	Sig.
	1	2	3	4		
Wheat straw DM intake (g/d)	324.27 ^{c}	339.4 ^{bc}	352.64 ^{b}	378.2 ^{a}	11.2	**
Supplement DM intake (g/d)	282.8	264.3	270.2	266.4	2.27	NS
Total DM intake (g/d)	607.07 ^{c}	609.6 ^{bc}	616.94 ^{b}	646.6 ^{a}	5.36	**
Total OM intake (g/d)	483.9 ^{c}	498.54 ^{b}	485.4 ^{bc}	526.3 ^{a}	7.17	**
Total CP intake (g/d)	55.8 ^{c}	59.3 ^{bc}	62.2 ^{b}	67.9 ^{a}	3.54	**
Total Ash intake (g/d)	33.65 ^{b}	35.8 ^{ab}	33.02 ^{ab}	38.69 ^{a}	5.24	*
Total NDF intake (g/d)	360.43 ^{b}	345.87 ^{ab}	358.65 ^{ab}	372.25 ^{a}	4.75	*
Total ADF intake (g/d)	112.34 ^{b}	119.72 ^{ab}	113.14 ^{ab}	138.64 ^{a}	4.16	*
Total ADL intake (g/d)	18.6 ^{b}	21.49 ^{ab}	18.76 ^{ab}	23.24 ^{a}	3.55	*
EME (MJ/d/animal) intake	4.51 ^{b}	4.85 ^{ab}	4.95 ^{ab}	5.06 ^{a}	1.35	**

DM: dry matter; OM: organic matter; CP: crude protein; NDF: neutral detergent fiber; ADF: acid detergent fiber; ADL: acid detergent lignin and EME: estimated metabolizable energy.
T1: concentrate mix plus straw alone; T2: concentrate mix plus straw with 1% effective microbes (EM); T3: concentrate mix plus straw with 3% EM and T4: concentrate mix plus straw with 5% EM.
The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.
** (P<0.01).
NS: non significant.

Table 4 Dry matter and nutrient digestibility and digestible nutrients intake of experimental diets supplemented to Washera sheep fed wheat straw

Parameters	Treatments				SEM	Sig.
	1	2	3	4		
Digestibility (%)						
DM	47.86	52.17	49.98	51.23	1.57	NS
OM	51.76	53.75	55.04	53.95	1.04	NS
CP	75.63	78.46	76.97	78.74	1.20	NS
NDF	42.6 ^{b}	45.9 ^{ab}	47.6 ^{ab}	50.2 ^{a}	1.02	*
ADF	36.01 ^{b}	40.6 ^{ab}	44.9 ^{ab}	45.5 ^{a}	1.16	*
Digestible nutrient intake (g)						
DM	299.39	323.14	331.37	354.426	7.53	NS
OM	286.97	309.12	315.018	322.09	4.71	NS
CP	46	48	47	51	1.32	NS
NDF	176.61 ^{b}	193.68 ^{ab}	212.36 ^{ab}	219.62 ^{a}	13.46	*
ADF	65.13	71.83	67.13	84.57	11.51	*

DM: dry matter; OM: organic matter; CP: crude protein; NDF: neutral detergent fiber and ADF: acid detergent fiber.
T1: concentrate mix plus straw alone; T2: concentrate mix plus straw with 1% effective microbes (EM); T3: concentrate mix plus straw with 3% EM and T4: concentrate mix plus straw with 5% EM.
The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.
* (P<0.05).
NS: non significant.

Table 5 Weight gain and feed conversion efficiency (FCE) of Washera sheep fed wheat straw supplemented with experimental diets

Parameters	Treatments				SEM	Sig.
	1	2	3	4		
Initial body weight (kg)	20.2[b]	19.27[ab]	19.57[ab]	20.07[a]	0.69	NS
Final body weight (kg)	21.26[b]	21.27[ab]	21.87[ab]	23.77[a]	3.56	*
Weight change (kg)	1.06[b]	2[ab]	2.3[ab]	3.6[a]	2.01	*
Average daily gain (ADG, g)	11.7[b]	22.2[ab]	25.56[ab]	40[a]	6.24	*
FCE (g ADG/g DMI)	0.019[b]	0.035[ab]	0.042[ab]	0.062[a]	0.014	*

T1: concentrate mix plus straw alone; T2: concentrate mix plus straw with 1% effective microbes (EM); T3: concentrate mix plus straw with 3% EM and T4: concentrate mix plus straw with 5% EM.
ADG: acid detergent fiber and DMI: dry matter intake.
The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.
* (P<0.05).
NS: non significant.

Table 6 Partial budget analysis of the experiment

Variables	Treatments			
	1	2	3	4
Purchasing price (ETB/sheep)	1710	1720	1710	1710
Selling price (ETB/sheep)	2100	2300	2400	2600
Labor cost (ETB/sheep)	90	90	90	90
Cost of straw (ETB/sheep)	90	135	180	202.5
Cost of supplement (ETB/sheep)				
NSC	62.37	62.37	62.37	62.37
WB	103.95	103.95	103.95	103.95
WM	24.84	24.84	24.84	24.84
Salt	4.05	4.05	4.05	4.05
EM solution	0	16.2	60.75	121.5
Medicament	5	5	5	5
TVC (ETB/sheep/70d)	380.21	441.41	530.96	614.21
TR (ETB/sheep)	390	580	690	890
NR (ETB/sheep)	9.79	138.59	159.04	275.79

T1: concentrate mix plus straw alone; T2: concentrate mix plus straw with 1% effective microbes (EM); T3: concentrate mix plus straw with 3% EM and T4: concentrate mix plus straw with 5% EM.
ETB: Ethiopian birr; NSC: noug seed cake; WB: wheat bran; WM: wheat middling; TVC: total variable cost; TR: total return and NR: net return.

The NDF % and ADF % of ammoniated wheat straw (61.20 and 41.30 respectively) reported by Mehdikhani *et al.* (2009) was slightly lower than the current study (75.24 and 64.13 respectively). This difference resulted from the effect of ammonia treatment. The NDF content of wheat middling in this study was lower (23.33%) than the value reported by (Cromwell *et al.* 2000) who reported 30 to 44%. These chemical composition differences could be due to differences in the type and nature of wheat milling machine and milling process.

The CP content of NSC found in the current study was lower (29.16%) than the values of (30.03%) reported by Getu Kitaw *et al.* (2003). While this author has reported a relatively lower ash, NDF and ADF values (11.10%, 40.64% and 29.73%, respectively) than the results of the current study (13.98 %, 48.61% and 38.71%, respectively). The differences in nutrient content of NSC between current and previous experiments could be due to the geographical area and soil type on which the Noug grown, breed of Noug seed used, the type of oil extraction methods and quality of Noug seed used.

The CP content of wheat bran used in the current study (15.98%) was slightly higher than the value (15.01%) reported by Getu Kitaw *et al.* (2003) and lower than the value (16.274%) reported by Aemiro *et al.* (2014). In general, the CP value presented in this study was comparable with most of the previous research results. The NDF value of wheat bran used was lower (27.77%) than the values (50.12%) reported by (Getu Kitaw *et al.* 2003). While ADF value reported from the same author (12.69%) was lower than this study (15.56%). The differences in nutrient composition of wheat bran described above could be due to the composition of wheat bran resulted from the processing methods used. Wheat bran having greater proportion of flour is described as good source of supplemental energy and protein.

As depicted in Table 3, the total DM intake and wheat straw intake were significantly higher (P<0.01) in sheep received T4 (646.6 g/day and 378.2 g/day respectively) than the other treatment groups. Even though sheep in T3 had a relatively lower total DM intake than T4, it was better than the sheep that received untreated wheat straw (i.e., sheep in T1 (607.07 g/day)). This result is in agreement with Chernet (2012) who reported inclusion of 100 mL EM Activated solution and 300 g supplemental concentrate feed promoted higher (P<0.001) DM intake compared to sheep offered 300g supplemental concentrate feed along with 1%, 3% and 5% EM-bokashi. But this result was not in line with the author Agidew *et al.* (2022) who conduct sheep feeding experiments to determine the effect of EM on intake, nutritive value and digestibility of corn silage (*Zea mays*) and reported as there was no significant difference in DM intake between the EM-treated and untreated corn silages. This progressive improvement in total DM intake from T1 to T4 was because of pleasant odour and attractive nature of EM solution. In addition, it increases the palatability of wheat straw.OM intake was significantly higher (P<0.05) in T4 (526.3 g/day) and the lower value was recorded in T1 (485.4 g/day). Sheep fed concentrate mix with 5% EM treated wheat straw (T4) had significantly higher (P<0.05) CP intake than the rest of the experimental groups. While, the least was recorded in a sheep received concentrate mix with untreated wheat straw (T1). This higher CP intake in sheep offered 5% EM treated wheat straw (T4) might be resulted from the amino acids derived from microbes which constitute EM solution. Wheat straw had CP content below the minimum microbial requirement (7%) in feeds to support acceptable ruminal microbial activity and the maintenance requirement of CP for the host ruminant (McDonald *et al.* 2002). This is also in support of Balogun *et al.* (2016) who stated EM as biological inoculants were believed to improve nutritional quality of poor quality feed resources.

Estimated ME intake was significantly higher (P<0.01) in 5% EM treated wheat straw offered sheep than the sheep received untreated wheat straw/control group. This might be because of the fatty acids derived from microbes which composed EM solution. This result is in agreement with Worku *et al.* (2016) who reported presence of significant difference in metabolizable energy through supplementation of 5% EM-Bokashi compared to the non-supplemented group. But there is no significance difference (P>0.05) in NDF, ADF and ADL intakes between T2 and T3. A 5% EM solution application on wheat straw resulted in fiber intake improvement.

There was no significant difference (P>0.05) in DM and OM digestibility among all treatment groups. This result agrees with Silanikove (2000) who stated “Digestibility is much reduced when a ration has too little CP in proportion to the amounts of soluble carbohydrates and during the dry season pasture protein levels fall below 6-7%”. Similarly, Adugna *et al.* (2002) reported as feed that is low in protein and high in fiber content results in low digestibility and voluntary feed intake. This result was also in line with Chernet (2012) who revealed no significance difference in DM digestibility was not (P>0.05) when EM was included either in its bokashi or solution form. It is also in agreement with that of Agidew *et al.* (2022), who reported no significant difference in DM digestibility when the two silage groups were treated with EM. This result is also in agreement with Getahun (2006) who reported the *in vitro* digestibility of organic matter of the untreated wheat straw (48.4%). But this figure is slightly lower than the value reported by Yenesew (2010) who revealed an organic matter digestibility ranged from 50.3 to 50.5%. This may be due to differences in wheat variety, fiber content and other environmental factors which affect digestibility.

CP digestibility was not (P>0.05) affected by the inclusion of different proportion of EM. This might be due the less interactive nature of wheat straw to sheep digestive enzymes. The current result agreed with Chernet (2012) who reported no significant difference in CP digestibility when different levels of EM bokashi and solution are offered to Afar Sheep having a basal diet of teff straw.

However, there was significant difference (P<0.05) in NDF digestibility between sheep fed concentrate mix plus a wheat straw treated with 5% EM (T4) and other treatments. Similarly, a higher (P<0.05) ADF digestibility was recorded in T4 (45.5%) than the control group (36.01%). This result is in agreement with Kannahi and Dhivya, (2014), fermentation of plant materials with EM was proven to improve fiber digestibility. This is because of the existence of lactic acid bacteria in the EM solution that could boost the decomposition and fermentation of fiber components of the feed. There is no significance difference (P>0.05) in digestible DMI, OMI and CPI among treatments. However, an increment in digestible ADF and NDF digestibility was observed when the level of EM inclusion is increased from 1% to 5%.

In the current study, a relatively better (P<0.05) mean final and average daily weight gain was recorded in 5% EM supplemented Washera sheep (T4) than the rest of the treatment groups. Because treating wheat straw with EM solution encourages sheep to consume more, this in turn brings weight gain. This is in agreement with Tadessu *et al.* (2019) that showed significant difference in an experiment conducted to evaluate the effect of effective microorganism treated grass hay supplementation on feed intake, digestibility and growth performance of Washera sheep fed natural grass hay as a basal diet. But it was in contrast with Chernet (2012) who reported no significant difference in the weight gain of Afar sheep supplemented with different levels of EM (in bokashi and solution form) having a basal diet of teff straw. This final weight increment in T4 might be due to a higher DM intake. Significance differences in final and average daily weight gain were not detected in T1, T2 and T3.

The lower FCE in the control group (T1) than the other treatment groups (T2, T3 and T4) may probably because of the relatively low CP and energy intake and higher fiber content of wheat straw. The higher FCE inT4 might be due to a relatively high level of lactic acid bacteria taken with the EM which enables to degrade the fiber components of the feed and finally improve digestibility and absorption of nutrients.

CONCLUSION

The CP content of the wheat straw used in this study (2.81%) was below standard to satisfy the minimum CP requirements (7%) of Washera sheep. Wheat straw alone shall not be offered to sheep unless it is treated with EM or other solutions. Increasing the level of EM supplementation from 1% to 5% of daily ration can bring a significant improvement in total DM intake, total OM intake and total CP intake. However, supplementation of different proportions of EM solution did not bring significant improvement on organic matter, total DM and CP digestibility. ADF, NDF and ADF digestibility and nutritional value of a poor quality wheat straw can be improved by treating with 5% EM. A relatively better average daily body weight gain, final body weight and feed conversion efficiency could be gained when the wheat straw is treated by 5% EM than the untreated one. Generally, a better weight gain was recorded in the sheep that received 5% EM treated wheat straw compared to sheep offered wheat straw treated with 3%, 1% and 0% (untreated). The profit could also be improved in a similar manner. It necessitates increasing the level of EM treatment up to 5% to get a relatively higher net return.

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