Effect of supplying effective microbes on carcass characteristics of Washera sheep fed wheat straw

Efeito do fornecimento de micróbios eficazes nas características da carcaça de ovelhas Washera alimentadas com palha de trigo

Ayalew Fekadie Agidew*
Addisu Abera Wondimie
Chalachew Yitbarek Mengistu

Debre Markos University (DMU), Debre Markos, Ethiopia

*** Correspondence:** ayefek16@gmail.com

Received: 2022 Mar 18 | **Accepted:** 2022 May 23
DOI: http://dx.doi.org/10.7213/acad.2022.20006
Rev. Acad. Ciênc. Anim. 2022;20:e20006

Abstract

The carcass characteristics of intact male Washera sheep which received wheat straw treated with different proportion of effective microbes (EM) were evaluated in this study. Twenty four vaccinated experimental sheep with initial body weight of 19.78 ± 1.97 kg (mean ± SD) were assigned into six blocks of four animals and randomly distributed to four treatments: *ad libitum* EM free wheat straw with concentrate feed (T1), *ad libitum* wheat straw treated by 1% EM with concentrate feed (T2), 3% EM with concentrate feed (T3), and 5% EM with concentrate feed (T4) of total dry matter. The experiment consisted of 90 days of feeding trial followed by carcass parameters evaluation. The slaughter body weight, empty body weight, hot carcass weight, and rib eye muscle area were significantly lower ($p < 0.05$) in sheep in T1 than sheep in T4. Sheep in T4 has significantly higher ($p < 0.05$) dressing percentage on both empty body weight and slaughter body weight basis than sheep in T1. There was no significant difference ($p > 0.05$) in head, tongue, heart, and liver among treatments, but sheep in T4 had significantly higher ($p < 0.05$) kidney and kidney fat than sheep that received T1.

Keywords: Carcass. Edible offal. Empty body weight. Rib eye area. Slaughter body weight.

Resumo

As características da carcaça de ovinos Washera machos intactos, que receberam palha de trigo tratada com diferentes proporções de micróbios efetivos (ME), foram avaliadas neste estudo. Vinte e quatro ovelhas experimentais vacinadas, com peso corporal inicial de 19,78 ± 1,97 kg (média ± DP), foram distribuídas em seis blocos de quatro animais e distribuídas aleatoriamente em quatro tratamentos: palha de trigo ad libitum *sem ME com ração concentrada (T1), palha de trigo* ad libitum *tratada com EM 1% com ração concentrada (T2),* *EM 3% com ração concentrada (T3) e EM 5% com ração concentrada (T4) de matéria seca total. O experimento consistiu em 90 dias de prova de alimentação, seguida de avaliação dos parâmetros de carcaça. O peso corporal de abate, corpo vazio, carcaça quente e área de olho de lombo foram significativamente menores (p < 0,05) nas ovelhas em T1 do que nas ovelhas em T4. As ovelhas no T4 apresentaram porcentagem de cura significativamente maior (p < 0,05) tanto no peso de corpo vazio quanto no peso corporal de abate do que aquelas em T1. Não houve diferença significativa (p > 0,05) na cabeça, língua, coração e fígado entre os tratamentos, mas as ovelhas em T4 tiveram significativamente maior (p < 0,05) rim e gordura renal do que as ovelhas em T1.*

Palavras-chave: *Carcaça. Miudezas comestíveis. Peso do corpo vazio. Área de olho de lombo. Peso corporal de abate.*

Introduction

Ethiopia has the largest livestock population in Africa, with 65 million cattle, 40 million sheep, 51 million goats, 8 million camels, and 49 million chickens in 2020 (CSA, 2020).

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 (Yitayew et al., 2013).

The contribution of the subsector 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).

Despite large number and importance of sheep in the areas, productivity is low due to a number of factors such as 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 high seasonal dynamics in feed sources, fragile ecologies and environments exposed degradation. Moreover, roughage consti-tute a major feed source for animals in crop-livestock mixed farming systems, which is characterized by poor quality. Improving feeds and nutrition through technologies that increase rumen fermentation of roughage feeds, improve protein supply to microorganisms, and reduce methane emission is important to boost the overall productivity, health, and well-being of sheep flocks (Woju, 2012). In improving better use of roughage feeds, the use of effective microbes (EM-Bokashi) for better management of crop residues is thus imperative (Safalaoh and Smith, 2001).

Washera sheep is a short-fat tailed, short-haired, predominantly brown, and both males and females are predominantly polled sheep breed indigenous to Ethiopia (Abegaz et al., 2008). Concerning carcass production, Washera sheep appear to be more efficient and produce about an average of 15.7 kg carcass with dressing percentage (DP) of 47.8% to 51.5% under improved management (Getachew et al., 2011).

Effective microorganisms (EM) were developed by the Japanese horticulturalist Professor Dr. T. Higa, of the University of the Ryukyus in Japan. EM is a solution containing over 80 species of co-existing microorganisms selected from thousands of microbial species. Microbial species commonly utilized in the food and fermentation industries were selected and included in EM technology (Higa and Wididana, 2007). In Brazil EM were included in sheep feed and sheep that were fed EM-treated silage consumed greater amounts of silage per unit of body weight compared with untreated silage, which also improved *in situ* degradability of elephant grass silages (Guim et al., 1998).

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 includes the poor understanding of farmers about ruminant nutrition, 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, economic 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 EM to improve the nutritive value of crop residues.

The application of EM in improving the quality of animal feed has also received much attention in many regions of the world; but using EM technology on small ruminant in general and on Washera sheep breed in 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 carcass characteristics of Washera sheep. Non-conventional supplements such as EM could help efficient utilization of roughage feeds on sheep ration. Therefore, the objective of the study was to determine the effect of different levels of EM supplementation on carcass characteristics of Washera sheep.

Materials and methods

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 411 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 (BOARD, 2012). The district has an altitude of 2000 meter above sea level.

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 the 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.

Feed preparation

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.

Feeding management

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 (21% Noug cake, 55% wheat bran, 23% wheat middling, and 1% salt) was offered at 8 am and 4 pm 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, and the animals were blocked based on initial live weight into six blocks of four animals per block: T1 (control) - wheat straw; T2 - wheat straw + 1% of daily EM ration; T3 - wheat straw + 3% of daily EM ration; T4 - wheat straw + 5% of daily EM ration. In additon to the basal diet and concentrate supplement, clean water was freely available all the time.

Carcass evaluation

Carcass parameters evaluation was done after 90 days of feeding trail. All sheep were fasted overnight, weighed and slaughtered. Empty body weight was determined by subtracting weight of gut content from the slaughter weight. Blood, kidney, kidney fat, omental fat, heart, liver, head with tongue, empty gut and testis were considered as total edible offal while gut fill, skin with feet, penis with urinary bladder, spleen, lungs with trachea and esophagus were considered as total non-edible offal. Dressing percentage was calculated as a ratio of hot carcass weight and slaughter weight or empty body weight. Rib eye area was measured by dissecting the carcass between the 12th and 13th ribs, and average value on left and right rib was taken. Dressing percentage on SW basis = hot carcass weight (kg)/slaughter weight (kg)*100.

Chemical analysis

Chemical analyses of experimental feeds were dried in a forced draft oven at 60 °C for 72 hours. The dried samples of feeds were milled using laboratory mill to pass through 1 mm screen and were stored for subsequent chemical analysis. From each feed sample, DM, OM, CP and total ash was analyzed according to the procedure described by author's name (AOC, 1990). The NDF, ADF and ADL were analyzed according to the procedure of Van Soest et al. (1991).

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 version 9.2. The treatment means was separated using Tukey HSD (Tukey honestly significant difference) test. The experimental model was Yij = μ + ti + bj + eij, where: Yij = the response variable; μ = overall mean; ti = treatment effect (feed); bj = block effect; eij = error component of interaction.

Results

Chemical composition of experimental feeds

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/s. On the other hand, the organic matter/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 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) were 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 (Table 1). The nutrient intake of treatments is given in Table 2.

Table 1 - Chemical composition of feed ingredients used to feed Washera sheep breed and straw refusals

Feed ingredients	DM	Ash (%DM)	CP (% DM)	NDF (%DM)	ADF (%DM)	ADL (%DM)
Wheat straw	92.00	5.43	2.81	75.24	64.13	12.33
Noug seed cake	93.00	13.98	29.16	48.61	38.71	8.67
Wheat middling	90.00	3.33	16.2	23.33	14.44	2.22
Wheat bran	90.00	5.56	15.98	27.77	15.56	2.22
Straw refusals						
T1	91.50	3.28	2.46	77.76	68.84	13.49
T2	93.00	6.69	3.18	80.91	69.47	13.64
T3	91.40	5.47	2.39	80.40	69.30	13.38
T4	91.00	6.59	2.82	80.00	68.13	13.70

Note: DM = dry matter; CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; 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; T4 = concentrate mix plus straw with 5% EM.

Table 2 - Dry matter and nutrient intake of Washera sheep fed concentrate feed with wheat straw supplemented with different level of effective microbes (EM)

Parameters (g/d)	T1	T2	T3	T4	SEM	Sig.
Wheat straw dry matter	324.27^{c}	339.40^{bc}	352.64^{b}	378.20^{a}	11.20	**
Supplement dry matter	282.80^{a}	264.30^{a}	270.20^{a}	266.40^{a}	2.27	ns
Total dry matter	607.07^{c}	609.60^{bc}	616.94^{b}	646.60^{a}	5.36	**
Total organic matter	483.90^{c}	498.54^{b}	485.40^{bc}	526.30^{a}	7.17	**
Total crude protein	55.80^{c}	59.30^{bc}	62.20^{b}	67.90^{a}	3.54	**
Total ash	33.65^{b}	35.80^{ab}	33.02^{ab}	38.69^{a}	5.24	*
Total neutral detergent fiber	360.43^{b}	345.87^{ab}	358.65^{ab}	372.25^{a}	4.75	*
Total acid detergent fiber	112.34^{b}	119.72^{ab}	113.14^{ab}	138.64^{a}	4.16	*
Total acid detergent lignin	18.60^{b}	21.49^{ab}	18.76^{ab}	23.24^{a}	3.55	*

Note: $^{a-c}$Means within a row with different superscripts are significantly different ($p < 0.05$); SEM = standard error of the mean; Sig. = significant level; *$p < 0.05$; **$p < 0.01$; ns = non-significant. Treatments: T1= concentrate mix plus straw alone; T2 = concentrate mix plus straw with 1% EM; T3 = concentrate mix plus straw with 3% EM; T4 = concentrate mix plus straw with 5% EM.

Carcass characteristics

Carcass characteristics and rib eye muscle area (REA) of the experimental sheep is given in Table 3. The slaughter body weight, empty body weight, hot carcass weight, and REA were significantly lower ($p < 0.05$) in sheep in T1 than in sheep in T4. Sheep in T4 had significantly higher ($p < 0.05$) dressing percentage on both empty body weight and slaughter body weight basis than sheep in T1. The result of this study revealed that supplementation of wheat straw treated with 1% (T2) and 3% (T3) EM solution have relatively similar effect on slaughter body weight, hot carcass weight, empty body weight, and dressing percentage at both slaughter body weight and empty body weight basis (Table 3).

Table 3 - Carcass characteristics of Washera sheep fed wheat straw supplemented with experimental diets

Parameters	T1	T2	T3	T4	SEM	Sig.
SBW (kg)	20.70^{b}	21.77^{ab}	23.87^{ab}	26.83^{a}	3.25	*
EBW (kg)	15.93^{b}	16.47^{ab}	18.67^{ab}	19.90^{a}	0.96	*
HCW (kg)	5.93^{b}	6.33^{ab}	7.93^{ab}	8.27^{a}	0.78	*
DP on SBW (%)	28.65^{b}	29.08^{ab}	33.22^{ab}	30.82^{a}	0.37	*
DP on EBW (%)	37.23^{a}	38.43^{a}	42.47^{a}	41.56^{a}	0.80	*
Rib eye area (cm^2)	6.78^{b}	8.35^{ab}	8.67^{ab}	10.12^{a}	0.19	*

Note: $^{a\text{-}b}$Means within a row with different superscripts are significantly different ($p < 0.05$); SEM = standard error of the mean; Sig. = significant level; *p < 0.05; SBW = slaughter body weight; EBW = empty body weight; HCW = hot carcass weight; DP = dressing percentage; Treatments: T1 = concentrate mix plus straw alone; T2 = concentrate mix plus straw with 1% effective microbes (EM); T3 = concentrate mix plus straw with 3% EM; T4 = concentrate mix plus straw with 5% EM.

Edible offal components

The edible offal components of experimental sheep are present in Table 4. There was no significant difference ($p > 0.05$) in head and tongue, heart, and liver among treatments, but sheep in T4 had significantly higher ($p < 0.05$) kidney and kidney fat than sheep received T1. However, tail fat, blood and testis are not significantly different among all treatments. On the other hand, the hot carcass weight of sheep in T4 was significantly greater than sheep in T1 (Table 4).

Non-edible offal components

The average weight of non-edible offal components is presented in Table 5. The current study revealed that there is no significant difference ($p > 0.05$) in weight of skin with feet, trachea, lung, spleen and penis among treatment groups.

Significantly higher weight of full stomach, gut fill and empty gut was recorded in sheep in T4 than the control group. But statistical difference in the weight of stomach, gut fill and empty gut was not detected between sheep in T2, T3 and T4 (Table 5).

Table 4 - Weight of edible offal components of Washera sheep fed wheat straw supplemented with experimental diets

Parameters	T1	T2	T3	T4	SEM	Sig.
Head and tongue (kg)	1.66^{a}	1.58^{a}	1.60^{a}	1.72^{a}	0.52	ns
Heart (g)	115.17^{a}	119.00^{a}	118.17^{a}	126.67^{a}	6.67	ns
Liver (g)	246.67^{a}	230.00^{a}	271.33^{a}	276.33^{a}	0.68	ns
Kidney (g)	52.67^{b}	48.33^{ab}	54.67^{ab}	56.00^{a}	0.90	*
Kidney fat (g)	23.30^{b}	32.00^{ab}	39.33^{ab}	39.67^{a}	13.91	*
Testis (g)	193.00^{a}	208.00^{a}	227.33^{a}	239.67^{a}	11.9	ns
Blood (kg)	1.13^{a}	1.27^{a}	1.41^{a}	1.42^{a}	0.10	ns
Hot carcass weight (kg)	5.60^{b}	8.08^{a}	7.93^{a}	8.68^{a}	2.31	**
Tail (g)	592.80^{a}	565.8^{0a}	639.70^{a}	658.5^{a}	3.31	ns

Note: $^{a\text{-}b}$Means within a row with different superscripts are significantly different ($p < 0.05$); SEM = standard error of the mean; Sig. = significant level; ns = non-significant ($p > 0.05$); *= ($p < 0.05$); **= ($p < 0.01$). Treatments: T1= concentrate mix plus straw alone; T2 = concentrate mix plus straw with 1% EM; T3 = concentrate mix plus straw with 3% EM; T4 = concentrate mix plus straw with 5% EM.

Table 5 - Weight of non-edible offal components of Washera sheep fed wheat straw supplemented with experimental diets

Parameters	T1	T2	T3	T4	SEM	Sig.
Skin with feet (kg)	3.26[a]	3.32[a]	2.65[a]	3.37[a]	0.26	ns
Trachea (g)	59.30[a]	44.3[a]	50.30[a]	51.00[a]	3.67	ns
Lung (g)	190.83[a]	170.17[a]	174.67[a]	204.00[a]	1.53	ns
Spleen (g)	35.50[a]	33.33[a]	34.67[a]	34.50[a]	0.19	ns
Penis (g)	50.33[a]	63.00[a]	67.67[a]	68.50[a]	5.57	ns
Full stomach (kg)	3.82[b]	4.30[ab]	4.50[ab]	5.27[a]	1.12	*
Gut fill (kg)	4.83[b]	5.02[ab]	5.82[ab]	6.55[a]	0.13	*
Empty gut (kg)	1.09[b]	1.24[ab]	1.48[ab]	1.63[a]	0.57	*
Tail (g)	592.80[a]	565.80[a]	639.70[a]	658.50[a]	3.31	ns

Note: [a-b]Means within a row with different superscripts are significantly different ($p < 0.05$); SEM = standard error of the mean; Sig. = significant level; ns = non-significant ($p > 0.05$); *$p < 0.05$. Treatments: T1 = concentrate mix plus straw alone; T2 = concentrate mix plus straw with 1% effective microbes (EM); T3 = concentrate mix plus straw with 3% EM; T4 = concentrate mix plus straw with 5% EM.

Discussion

Chemical composition of experimental feeds

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 Hintsa et al. (2018), but the ash content of wheat straw in this study (5.43%) was comparable with the results of the previous author (5.5 %).

The NDF% and ADF% of ammoniated wheat straw (61.20 and 41.30, respectively) reported by Bazehoze et al. (2009) was slightly lower than in the current study (75.24 and 64.13, respectively). This difference may be due to the effect of ammonization.

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 milling process.

The CP content of NSC found in the current study was lower (29.16 %) than the values (30.03 %) reported by Kitaw et al. (2003) that, however, reported a relatively lower ash, NDF and ADF (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 type of oil extraction methods and quality of the Noug seed used.

The CP content of wheat bran used in the current study (15.98%) was slightly higher than the values (15.01%) reported by Kitaw et al. (2003), and lower than the value 16.27 4 % reported by Kehaliew et al. (2014). In general, the CP value of this study was comparable with most of the previous research results. The NDF value of WB used in the current study was lower (27.77 %) than the values (50.12 %) reported by Kitaw et al. (2003), while ADF value reported from the same authors (12.69 %) was lower than the value found in this study (15.56%). The differences in nutrient composition of wheat bran described above could be due to the processing methods and constituents of the bran. Wheat bran with higher proportion of germ and flour is considered a good source of protein and supplemental energy. Even samples from the same wheat variety and the same region may vary up to 10% and sometimes more in content of protein due to processing and/or milling methods.

Carcass characteristics

A relatively higher ($p < 0.05$) slaughter body weight, empty body weight and hot carcass weight in sheep in T4 than those in T1 is from the fact that EM improves the digestibility of roughage feeds, which in turn brings slaughter body weight, empty body weight and hot carcass weight increment. REA was also significantly lower ($p < 0.05$) in sheep in T1 than in sheep in T4. According to the report of Wolf et al. (1980), greater rib eye muscle area is associated with a higher production of lean in the carcass and higher lean/bone ratio.

Edible offal components

The edible offal components of experimental sheep are presented in Table 4. There was no significant difference in head and tongue, heart, and liver among treatments. But sheep in T4 had significantly higher ($p < 0.05$) kidney and kidney fat than sheep in T1. In the current study, the size of kidney was lower than the sheep fed urea treated wheat straw (81g) as reported by Feleke et al. (2015). This difference may be due to the effect of urea. Tail fat, blood and Testis are not significantly different among all treatments. On the other hand, the hot carcass weight of sheep in T4 was significantly greater than sheep in T1. This study revealed that increasing EM solution to 5% improves the hot carcass weight of washera sheep.

Non-edible offal components

Even though there is no research conducted on carcass parameters of Washera sheep fed wheat straw treated with different proportion of EM solution for comparison, the current study revealed that there is no significant difference ($p > 0.05$) in weight of skin with feet, trachea, lung, spleen and penis among treatment groups. Significantly higher weight of full stomach, gut fill and empty gut was recorded in sheep in T4 than those in T1; however, there was no significance difference between T2 and T3. Statistical difference in the weight of stomach, gut fill and empty gut was not detected between sheep in T2, T3, and T4.

Conclusion

Supplementation of Washera sheep with 5% EM solution treated wheat straw could bring an increment on slaughter weight, hot carcass weight, empty body weight, dressing percentage at slaughter body weight basis, dressing percentage of empty body weight and rib-eye areas, kidney, kidney fat, weight of full stomach, gut fill and empty gut. However, head and tongue, heart, and liver, tail fat, blood and testis will not be affected.

Acknowledgements

The authors would like to extend their deepest gratitude to Debre Markos University for providing inputs and materials needed for the research work. The authors would also like to express their sincere gratitude and heartfelt appreciation to their co-researchers, Dr. Chalachew Yitbarek and Addisu Abera for consistent involvement starting from title selection to final write up. They have no words to express their professional contribution for the research work. They also like to express their appreciation to staff of Animal Science Department for their multi-directional cooperation. They would like to give great thanks to Anteneh Worku, Simachew Goshu, Habtu Birhanie and all other friends for their kind support and cooperation in many ways.

References

Abegaz S, Abebe G, Awugichew K. Sheep and goat production systems in Ethiopia. In: Yami A, Merkel RC, editors. Ethiopia sheep and goat productivity improvement program (ESGPIP). Addis Ababa, Ethiopia: Branna Printing Interprise; 2008. p. 27-32.

AOAC - Association of Official Analytical Chemists. Official methods of analysis. 15th ed. Arlington, VA, USA: AOAC Inc., 1990. p. 12-98.

Assefa F, Urge M, Animut G. Weight gain and carcass characteristics of Adilo sheep fed urea treated wheat straw supplemented with enset (*Ensete ventricosum*), atella and their mixtures. J Biol Agric Healthc. 2015;5(11):187-94.

Bazehoze JM, Yazdani AR, Torbatinejad N. Effect of feeding ammoniated wheat straw on the growth performance and blood metabolites of male Dalagh lambs. Indian J Anim Res. 2009;43(3):168-72.

Biffa D, Jobre Y, Chakka H. Ovine helminthosis, a major health constraint to productivity of sheep in Ethiopia. Anim Health Res Rev. 2006;7(1-2):107-18.

BOARD - Burie district office of Agriculture and Rural Development. Annual Report. Burie, Ethiopia: BOARD; 2012.

Cromwell GL, Cline TR, Crenshaw JD, Crenshaw TD, Easter RA, Ewan RC, et al. Variability among sources and laboratories in analyses of wheat middlings. NCR-42 Committee on Swine Nutrition. J Anim Sci. 2000;78(10):2652-8.

CSA - Central Statistical Authority. Agricultural sample survey. Volume II, Report on livestock and livestock characteristics (private peasant holdings). Addis Ababa, Ethiopia: CSA; 2013.

CSA - Central Statistical Authority. Agricultural sample survey. Volume II, Report on livestock and livestock characteristics (private peasant holdings). Statistical Bulletin 468. Addis Ababa, Ethiopia: CSA; 2010.

CSA - Central Statistical Authority. Agricultural sample survey 2019/20. Volume II, Report on livestock and livestock characteristics (private peasant holdings). Addis Ababa, Ethiopia: CSA; 2020.

Getachew T, Gizaw S, Lemma S, Taye M. Breeding practices, growth, and carcass potential of fat-tailed Washera sheep breed in Ethiopia. Trop Anim Health Prod. 2011;43(7):1443-8.

Guim A, Andrade P, Malheiros EB. Effect of EM on the consumption, nutritive value and digestibility of elephant grass silage by ruminant animals. Proceedings Fourth International Conference on Kyusei Nature Farming; 1995 Jun 19-21; Paris, France. Washington, DC: U.S. Department of Agriculture; 1998.

Higa T, Wididana GN. The concept and theory of effective microorganism. Nagano, Japan: INFRC; 2007.

Hintsa K, Berhe A, Balehegn M, Berhe K. Effect of replacing concentrate feed with leaves of Oldman saltbush (*Atriplex nummularia*) on feed intake, weight gain, and carcass parameters of highland sheep fed on wheat straw in northern Ethiopia. Trop Anim Health Prod. 2018;50(7):1435-40.

Kehaliew A, Kitaw G, Assefa G, Fekadu D, Woendatir Z. Growth Performance of F1 Friesian X Boran Crossbred Dairy Calves Supplemented with Effective Micro Organism (EM) Fermented Wheat Bran (Bokashi) in the Central Highlands of Ethiopia. Glob J Sci Front Res. 2014;14(9).

Kitaw G, Dejene M, Kehaliw A, Getnet A. Comparative evaluation of conventional protein supplements over tagasaste forage on the growth of yearling Horro lambs. Addis Ababa, Ethiopia: Ethiopian Institute of Agricultural Research, Holetta Research Center; 2003.

McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA. Animal nutrition. 6th ed. Harlow, UK: Pearson Educational Limited; 2002.

Safalaoh ACL, Smith GA. Smith. Effective microorganisms as an alternative to antibiotics in poultry diets. Proceedings 6th International Conference on Kyusei Nature Farming; 1999 Oct 28-31; Pretoria, South Africa. Nagano, Japan: INFRC; 2001.

Silverstein RA, Chen Y, Sharma-Shivappa RR, Boyette MD, Osborne J. A comparison of chemical pretreatment methods for improving saccharification of cotton stalks. Bioresour Technol. 2007;98(16):3000-11.

Sisay A. Livestock production systems and available feed resources in different agro-ecologies of North Gonder Zone, Ethiopia [master´s thesis]. Dire Dawa, Ethiopia: Alemaya University; 2006.

Tegegne F, Assefa G. Feed resources assessment in Amhara National Regional State. Bahir Dar, Ethiopia: Ethiopia Sanitary and Phytosanitary Standards and Livestock and Meat Marketing Program, Texas Agricultural Experiment Station; 2010. p. 81-94.

Van Soest PJ, Robertson JB, Lewis BA. Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. J Dairy Sci. 1991;74(10):3583-97.

Woju CW. Impact of effective microorganisms™ (EM™) on nutrient content of feeds, feed intake, digestibility, growth and mixed internal parasitic load on local sheep at Debre Zeit, Ethiopia. J Food Process Technol. 2012;3:10.

Wolf BT, Smith C, Sales DI. Growth and carcass composition in the crossbred progeny of six terminal sire breeds of sheep. Anim Sci. 1980;31(3):307-13.

Yitayew A, Taye M, Amanie A, Zeleke G. Community-based improvement scheme for Washera sheep: Lessons from Yilmanadensa and Quarit districts in Western Amhara Region, Ethiopia. Afr J Agric Res. 2013;8(44):5485-91.