1874-3315/19

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The Open Agriculture Journal

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RESEARCH ARTICLE

Effect of Feeding Different Mixtures of Short Milled Wheat and Sesame Seed Cake on Intake, Digestibility, and Live Bodyweight Changes for Abergelle Sheep in Tigray

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Abstract:

Background:

The use of agro-industrial by-products is an alternative to enhance the performance of animals.

Objective:

To improve feed intake, digestibility, and live bodyweight changes for Abergelle sheep fed different mixtures prepared using short milled wheat and sesame seed cake mixtures.

Methods:

The experiment was designed using yearling male rams and was divided into four blocks based on initial live weight and assigned to each dietary feed randomly. The diets were prepared at a level of 0, 120, 240, and 360 gram dry matter base/day for diet1, diet2, diet3, and diet4, respectively, with a proportion of 65:35 (short milled wheat: sesame seed cake) combinations. Digestibility trial was conducted for 7 consecutive days following the 90 days feeding stage.

Results:

Total dry matter and nutrient intake were significant ($P<0.001$) in the order of diet4> diet3> diet2 level of supplementation than the control group (diet1). Feed conversion efficiency and final bodyweight gain were significant ($P<0.01$) for the supplemented groups. Apparent digestibility of crude protein was observed highest in diet4 (81.32) and lowest in diet1 (61.55). Similarly, dry matter and organic matter digestibility were significantly higher in diet4 (74.47, 76.38) and lowest in diet1 (58.71, 60.42), respectively. In general, supplementation with different levels of sesame seed cake and short milled wheat improves the biological performance of Abergelle sheep.

Conclusion:

The growth performance of rams can be realized supplementing with diets prepared using short milled wheat and sesame seed cake mixtures.

Keywords: Bodyweight, Digestibility, Growth performance, Mixtures, Nutrient intake, Sheep.

Article History	Received: July 26, 2019	Revised: October 18, 2019	Accepted: November 09, 2019

1. INTRODUCTION

A recent report showed that Ethiopia has the largest sheep population (24.1 million) among African countries [1]. In the subsi-stence sector, farmers and pastoralists depend on small ruminants for much of their livelihood, often to a greater extent than cattle, because the short generation interval coupled with high frequency allows for rapid increases [2], in animal numbers.

According to Mushi *et al*. small ruminants fed with low-quality roughage have satisfactory fattening performance when supplemented with concentrate having optimum contents of crude protein and energy. Livestock in general and small ruminants, in particular, get their feed from natural pasture and cultivated forage. Among natural pasture, grass hay is more important than cultivated forage because of the competition for land for human food production [3] and commonly used as a diet for ruminants, although feeding only grass hay does not provide enough nutrients to the ruminants to maintain high production levels due to the low nutritive value of this highly

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DOI: 10.2174/1874331501913010182, 2019, *13*, 182-187

lignified material. As a result, most reports in animal nutrition have been conducted on the supplementation of poor-quality roughages with concentrates [4]. However, concentrate feeds comprised of especially grains and oilseeds are expensive and highly valued as human food [5]. Thus, industrial by-products could be alternative and relatively cheaper sources for the supplementation of animals on fibrous basal feeds. Nowadays in Ethiopia, particularly in the lowland area, farmers and small scale merchants practice traditional oil extraction from sesame seed using draft power, thus enabling sesame seed cake to be available at cheaper costs throughout the year and is the major protein source. Short milled wheat is also produced in large quantities and available in different flour mills industries in the area. These products are currently not efficiently utilized by smallholder farmers for ruminant animals mainly due to lack of experience in the formulation and intensity of supplementation. Therefore, the use of these by-products is a potential alternative through which the productivity of animals can be enhanced.

2. MATERIALS AND METHODS

2.1. Experimental Animals and Feeds

Randomized complete block design with four diets and five replications was employed with 20 uncastrated yearling male Abergelle sheep with an initial body weight (18.58 ±1.9kg) (Mean±SEM) for feeding, digestion, and body weight change trials. The experimental animals were grouped into four blocks based on their initial live body weight, which was determined by two consecutive weighings after overnight fasting. Each animal in each block was randomly assigned to one of the five dietary treatments. The experimental animals were drenched with a broad spectrum anti-helmentic (Albendazole) and sprayed using acaricide against internal and external parasites, respectively. They were also vaccinated against common diseases in the area (pasteurellosis) during the adaptation period of 15 days. The experimental animals were also housed in individual pens and offered grass hay and the supplement for 15 days for adapting to the feeds prior to the beginning of the actual feeding trial. The ingredient feeds such as sesame seed cake, short milled wheat, and basal diet were purchased from local market traders and individual farmers. The feed ingredient was stacked and stored properly before and after mixing to avoid variation among the batch.

2.2. Experimental Design and Treatments

The experiment was conducted using a Randomized Complete Block Design (RCBD) with four dietary treatments that were randomly assigned to each animal in a block. Animals were blocked based on initial live weight into four blocks with five animals per block. The diets were thoroughly mixed with the proportion of 65:35 Short Milled Wheat (SMW) and Sesame Seed Cake (SSC), respectively, on a dry matter basis to achieve estimated body weight gain of 64-101g per day as recommended by Ranjhan [6]. The concentrate mixes were presented in grouped levels in 0, 120, 240, and 360 gram dry matter/head/day bases:

Diet$_1$ = Grass hay *adlib* (Control) which is 0% of short milled wheat and sesame seed cake)

Diet$_2$ = Grass hay *adlib* + 120 gram concentrate mixes (78 gram short milled wheat and 42 gram sesame seed cake)

Diet$_3$ = Grass hay *adlib* + 240 gram concentrate mixes (156 gram short milled wheat and 84 gram of sesame seed cake)

Diet$_4$ = Grass hay *adlib* + 360 gram concentrate mixes (234 gram short milled wheat and 126 gram sesame seed cake)

2.3. Feeding Trial and Managements

The supplementary feeds were thoroughly combined in the specified proportion and the actual data collection for feed utilization and growth trial was done for 90 days. The supplementary diet was offered twice per day at 8:00 and 16:00 hours in two equal portions. Animals were observed closely for the occurrence of any abnormalities and disorders during the experimental periods. Samples of feed offered and refused were collected per animal over the experimental period, pooled on a treatment basis, and sub-sampled for analysis.

2.4. Digestibility Trial

After completion of the 90-day feeding trial, the same animals with the same feeding treatment were employed for digestibility trial and feces were collected for seven consecutive days following three-day adaptation for the harnessed bag. A feces collected and weighed for each animal separately and was stored in a refrigerator at -20^{o}C in airtight plastic containers. At the end of the collection period, the fecal sample for each animal was thoroughly mixed and a sub-sample of a feces was made to dry in a forced air oven at 60 ^{o}C for 48 hours and ground to pass through a 1 mm sieve and was taken for further analysis.

2.5. Feed Intake and Live Weight Gain

The nutrient offered and refused was computed by multiplying the quantity offered and refused with their nutrient content. Daily dry matter DM intake of the sheep expressed as a percent of bodyweight was calculated by dividing daily DM intake with the respective bodyweight of each sheep used throughout the feeding trial. The experimental sheep were not allowed to graze on pasture for controlling the inappropriate factor during the experimental period. Sheep were weighed at the beginning and with an interval of fourteen days throughout the experiment following overnight fasting using a spring balance graduated of 100gm reading interval measured a balance of 50kg. Average daily gain (g/d) was calculated as the difference between final and initial bodyweight divided by the number of feeding days. Feed conversion efficiency was also estimated by dividing daily live weight gain for daily feed intake.

2.6. Chemical Analyses

A representative sample of feed provided, refused and a fecal sample was collected in every phase and analyzed for Acid Detergent Lignin (ADL), Acid Detergent Fiber (ADF), and Neutral Detergent Fiber (NDF) following the procedure described by Van Soest and Robertson [7]. Nitrogen, ash, and dry matter content were determined and CP was calculated as Nx6.25 described by AOAC [8].

2.7. Statistical Analysis

Data were Analyzed Using Analyses of Variance (ANOVA) Genstat 13th edition SP2, (2010) computer software. Treatment means of all parameters were separated using Least Significant Difference (HSD) test. The model used for data analyses was:

$Y_{ij} = \mu + T_i + B_j + E_{ij}$

Where; Y_{ij} = Response variable B_j = Block effect

μ= Overall mean E_{ij} = Random error

T_i = Treatment effect

3. RESULTS AND DISCUSSION

3.1. Chemical Composition of the Experimental Feeds

The dry matter content of grass hay used in this trial (Table **1**) was comparable to the DM content of 92.09 and 91.77% reported by Getachew [9] and Abebaw [10], respectively. The Crude Protein (CP) in (Table **1**) value traced for hay used in the existing observation was slightly higher than the crude protein requirement (7-7.5%) of sheep for maintenance by Van Soest [11], which explained that the hay employed in the current experiment might be of good quality. The CP content of hay was comparable with a value of 6.6% reported by Simret [12]. The differences in CP content among the various studies might be attributed to the composition of the hay, environmental factors in which the curative process during harvesting season, and stage of growth at which hay was harvested [13]. Moreover, environmental factors including light intensity, precipitation and soil moisture content, soil physiochemical characteristics, mainly lime content, soil fertility, and fertilizer application significantly influence plant's nutrient content and its nutritional value for human or animal feed [14].

The high substance of NDF and ADF (Table **1**) in grass hay might involve low intake. Because it is the NDF and ADF component which greatly limited the rumen gut fill and correlated with rumination time [15]. NDF was only partially digested in any species of animals and depend on microbial digestion for consuming principally the tough grass components [16]. Generally, the chemical composition of grass hay used in the experiment was higher in NDF, ADF, and ADL as compared to the values by Matiwos [17] and Michaele [18]. This might be directed that the hay used has a higher deliberation of cellulose and lignin formation of tannin-fiber complexes which could reduce nutrient availability due to the depressing effect of these portions with feed digestibility [13].

Table 1. Chemical compositions of grass hay, sesame seed cake, short milled wheat, and the combined diets.

Variables	Chemical Compositions					
	DM	OM	CP	NDF	ADF	ADL
Hay	91.5	89.2	7.5	74.7	46.7	10.5
Short milled Wheat	90.5	94.2	13.6	47.4	14.6	6.7
Sesame seed cake	92.6	87.5	38.4	17.8	10.8	3.9
SSC and SMW	91.4	91.7	23.6	35.6	13.2	5.6

DM=dry matter; OM=organic matter; CP=crude protein; NDF=neutral detergent fiber; ADF=acid detergent fiber; SSC=Sesame Seed Cake; SMW= Short Milled Wheat.

The CP content for SMW used in the trial was lower than the results by Simret [12] and Genet [19], who reported values of 19.55 and 21.23, 20.1%, but it is comparable with 14.9 and 13.8% as reported by Tesfaye [20]. The CP of sesame seed cake in the current finding was agreed with values of 37.5% and 38.5% as described by Ensminger [21] and Tesfay [22], and higher than the observation reported by Fentie and Solomon [23], but lower than the CP content of 42.21 and 43.7 as reported by Tekeba [24] and Zemichael and Solomon [25], respectively. This might be due to the variation in the capability of the method of extraction within the screw pressing process [21].

Normally, the corresponding character of nutrient content, specifically high CP and low cell wall fiber stuffing in the improvement, and low CP and high cell wall fiber contents in the basal diet could be a reason for increment in grass hay-based supplementation.

3.1.1. Dry Matter and Nutrient Intake

The quantity of grass hay consumed in the control group (diet1) and treatment supplemented with 120 g concentrate per in diet2 was higher than the optimum supplemented groups in (diet4) (Table **2**). This could be related to the fact that sheep presented with low CP and high NDF content of hay were endeavored in utilizing more grass hay to meet the daily nutrient requirement relatively in the supplemented groups which have access to mixed diets. This obviously showed an increase in dry matter intake (grass hay) as the intensity of the supplementation increased from 120 to 360g dry matter. The DM, OM, CP, NDF, and ME intake was obtained significantly different ($P<0.001$) among the treatment groups (Table **2**). As a result, total nutrient intake was significantly increased with the intensity of concentrate mixture supplementation. Correspondingly, the average total DM intake in the current study was almost comparable with the value 737.96 g d^{-1} to 963.74 g d^{-1} DMI as described by Awet and Solomon [26] for Afar sheep fed urea treated straw and supplemented with wheat bran, but higher than 518.75 to 732.05 g d^{-1} DMI showed by Tesfay [22] for Afar goat fed *Teff* straw and enhanced with graded levels of concentrate. In line with this finding, Payne [27] and Kabir [28] noted that total DMI was increased when low CP containing fibrous feed was supplemented with high protein source diets. In the same way, Cheeke [29] and Swanson [30] indicated that supplementation with concentrate feed increases total DMI than animals fed on poor quality roughage alone. Moreover, according to Ewnetu [31], supplementation improved for total DM and OM intake. Thus, the current observation showed that a higher OM intake was obtained when sheep were fed grass hay and supplemented with 360g per day prepared from short milled wheat and sesame seed cake combination.

As the result showed, diets with a high concentrate ratio could result in increased CP constituents and lower fiber content. Thus, the energy and protein requirements of animals might be improved to enhance the digestibility of nutrients. Swanson [30] described that the supply of escape protein improves feed intake and absorbed nutrient balance as a consequence of the supply of additional essential amino acids. Thus, it increases the growth rate which in turn enhances feed intake.

Table 2. Daily feed intake of sheep fed hay and supplemented with different mixes of sesame seed cake and short milled wheat combination.

Feed Intake (g)	Diets				SEM	SL
	Diet 1	Diet 2	Diet 3	Diet 4		
Hay DMI	725.00^{a}	727.20^{a}	701.40^{b}	693.10^{b}	6.6	**
Supplement DMI	0.00	120.00	240.00	360.00	-	-
Total DMI	725.00^{d}	847.20^{c}	941.40^{b}	1053.10^{a}	6.6	***
DMI (% BW)	2.88 ^{ab}	3.00 ^{a}	2.80 ^{b}	2.60 ^{c}	0.06	**
DMI (g/kg $W^{0.75}$)	74.3^{c}	73.6 ^{c}	80.2^{b}	87.9^{a}	1.31	***
TOMI	647.0^{d}	763.2^{c}	855.0^{b}	962.0^{a}	5.83	***
OMI (% BW)	3.2^{ab}	3.4^{a}	3.2^{b}	2.9^{c}	0.08	**
OMI (g/kg $W^{0.75}$)	66.3^{b}	66.0^{b}	72.1^{b}	79.1^{a}	1.16	***
Total CPI	54.9^{d}	84.5^{c}	112.0^{b}	140.8^{a}	0.50	***
Total NDFI	542.7^{d}	589.5^{c}	614.7^{b}	652.8^{a}	4.98	***
Total ADFI	340.0^{c}	356.4^{b}	360.7^{b}	375.3^{a}	3.10	***
Total ADLI	77.2^{d}	83.9^{c}	88.5^{b}	93.9^{a}	0.72	***
EME intake(MJ/day)	10.2^{d}	12.0^{c}	13.4^{b}	15.2^{a}	0.10	***

$^{a, b, c, d,}$ means within a row not bearing a common superscript letter significantly differ; **= (*P*<0.01); ***= (*P*<0.001); NS=not significant; DMI=Dry matter intake; SEM=Standard error of mean; OMI=Organic matter intake; CPI=Crude protein intake; NDFI=neutral detergent fibre intake; ADFI=acid detergent fiber intake; ADLI=acid detergent lignin intake; %BW=percent of body weight; g/$W^{0.75}$=gram per metabolic weight; SL=significant level; Diet1= grass hay *adlib tum* (control); Diet2= grass hay *adlib tum* +45g sesame seed cake+75g Short milled wheat; Diet3= grass hay *adlib tum* +95g sesame seed cake+145g short milled wheat; Diet4= grass hay *adlib tum* +140 sesame seed cake+ 220 short milled wheat; EME= estimated metabolizable energy; MJ= mega joule.

A significant difference (*P*<0.001) was noted among treatments for dry matter intake per unit metabolic body weight (g/kg $^{W^{0.75}}$) as increased the percent of body weight (% BW). Diet4 consumed significantly higher (*P*<0.001) total DM per unit of metabolic body weight than diet 3, diet 2, and diet1. It was also observed that group of rams fed in diet2 and diet1 consumed significantly lower (P<0.001) total DM per unit of metabolic body weight than diet3 and diet4, but there was no significant difference (P>0.05) between diet1 and diet2 (Table **2**). Likewise, higher total DM intake per unit of metabolic body weight was recorded in Ewnetu [31] for Menze (75.5 g/kg), Horro (78.3g/kg), and Tesfay [22] for Afar rams (74.25 g/kg), respectively, when supplemented with 300 g/d concentrate feed. This increasing trend was due to the considerable proportion of feed intake to metabolic body weight as indicated by Abebaw [10]. In line with this, Hirut *et al*. [32] indicated that as the level of concentrate mix supplementation increased from 150-250 gram/day in a basal diet of urea-treated maize stover fed sheep, the total DMI per unit of metabolic body weight increased from 96.5 -106g. From these findings, it can be concluded that tested feeds and the existing supplements could improve the total DM intake per unit of metabolic body weight for animals fed on poor quality basal diets.

Rams supplemented with sesame seed cake and short milled wheat utilized significantly (P<0.001) higher CP content. The increase in CP intake was attributed to an increase in DM intake. The significant difference CP intake (Table **3**) between the control and supplemented groups was expected due to low content of CP and gross energy in the grass which might be made unavailable to microbial digestion due to high lignin, NDF, and ADF profile.

3.1.2. Nutrient Digestibility

There was no significant difference (P>0.05) in NDF and ADF digestibility between control (diet1) and supplemented groups (Table **3**). However, the digestibility for CP, DM, and OM was significantly higher (P<0.05) for supplemented than non-supplemented sheep. Moreover, there was no significant difference (P>0.05) in the digestibility of nutrients for groups supplemented with diet2, diet3, and diet4 (Table **3**). Comparable to the current observation, Simret [12] noted that the digestibility of NDF and ADF did not vary in Somali goats due to supplementation with different levels of concentrate mix. In contrast, Tesfay [22] reported improved digestibility of NDF and ADF in sheep fed on *Teff* straw as a basal diet supplemented with different protein sources. Hence, increased digestibility of CP was observed in diet2, diet3, and diet4 than diet1 which could be correlated with a higher supply of dietary CP in the mixed diets.

Table 3. Nutrient digestibility in sheep fed grass hay and supplemented with mixed levels of short milled wheat and sesame seed cake combination.

Diets	Digestibility of Nutrients (%)						
	DM	OM	CP	NDF	ADF	SEM	SL
Diet 1	58.71^{b}	60.42^{b}	61.55^{b}	58.04	54.51	3.75	*
Diet 2	73.31^{a}	75.03^{a}	74.41^{a}	71.23	69.41	3.49	*
Diet 3	70.81^{a}	72.76^{a}	75.42^{a}	68.05	64.73	3.14	**
Diet 4	74.47^{a}	76.38^{a}	81.32^{a}	70.58	68.61	4.43	Ns
SEM	3.69	3.39	3.08	4.42	4.44	4.46	Ns

^{abc}Means with different superscripts in column are significantly different; *=P<0.05,**=P<0.01 and***=P<0.001; ns=non-significant; SEM=standard error of mean; DM=dry matter; OM= organic matter; CP= crude protein; NDF= neutral detergent fiber; ADF=acid detergent fiber; Diet1= grass hay *adlib tum* (control); Diet2= grass hay *adlib tum* + 45g sesame seed cake+75g short milled wheat; Diet3= grass hay *adlib tum* +95g sesame seed cake+145g short milled wheat, Diet4= grass hay *adlib tum* +140g sesame seed cake+ 220g short milled wheat.

3.2. Live Bodyweight Change

In (Table **4**) Contemporary significantly higher (P < 0.01) final live body weight gain was observed in the supplemented rams compared to the control group but was recorded a non-significant difference among the supplemented groups. However, increasing trend of weight gain was verified with increasing supplementation of mixed diets. This might be attributed to lower nutrient intake and digestibility of the nutrient in the control treatment, and higher dry matter and CP intake as well as better digestibility and nutrient utilization in the supplemented groups which could enhance the growth performance of individuals. Furthermore, according to the finding by Gelgelo *et al*. [33], there was a positive influence of supplementation on the total dry matter intake on small ruminants. Therefore, this study agreed with the results of Simret [12] and Tesfay [22] which showed that live weight change for supplemented groups across the level of supplementation did not differ significantly. Likewise, lack of significant variation among supplemented rams in live weight gain could be inferred that the supplement feeds were similar in an opportunity to contribute nutrients for improving the weight gain. Comparable to the current observation, it was indicated that a weight gain from 77.5 - 120.0 g/day for lambs fed groundnut hay as a basal diet supplemented with a mixture of different levels of rice bran and sesame cake by Njie [34]. Moreover, the level of daily live weight gain observed in this study for ram in diet4 (Table **4**) is comparable to the study described by ILCA [35] for Wello sheep that gained 109 g per day on an elevated plane of dietary.

Even though there was no considerable variation in live body weight gain among the supplemented groups, in diet4, higher live body weight gain was observed than rams assigned in diet2 and diet3. Thus, increasing level of mixed diet could be reflected for higher digestibility of nutrients which was associated with live body weight gain. This might be recognized as a result of higher CP and energy content in the mixed diet. Differing from this, Fentie and Solomon [23] argued that higher amount of inclusion of sesame cakes and their higher intake by animals did not result in substantial weight gain, and the lowest mean average weight gain was recorded for animals provided a higher amount of sesame cake.

Table 4. Live body weight change, feed conversion ratio, and efficiency of sheep fed grass hay and enhanced with concentrate treatment feeds.

Live Body Weight Changes/head	Diets				SL	SEM
	Diet 1	Diet 2	Diet 3	Diet 4		
Initial body weight (kg)	18.8	18.5	18.3	18.3	NS	0.24
Final body weight (kg)	21.0^b	26.4^a	27.2^a	28.1^a	**	0.68
ADG (g)	23.3^b	80.10^a	96.33^a	106.0^a	**	9.21
FCR (g DMI/g ADG)	48.6 ^{a}	12.3 ^{b}	10.1 ^{b}	9.9^b	*	10.68
FCE (g ADG /g DMI)	0.03^b	0.09^a	0.10^a	0.10^a	***	1.02

$^{a, b, c,}$ Means within the same row not bearing a common superscript differ significantly; **=(P<0.01); *** = (P<0.001); ns=not significant; SEM=Standard error of mean; FCR=feed conversion Ratio; FCE=feed conversion efficiency; DMI=dry matter intake; ADG= Average daily body weight gain; Diet1= grass hay *adlib tum* (control); Diet2= grass hay *adlib tum* + 45g sesame seed cake+75g short milled wheat; Diet3= grass hay *adlib tum* +95g sesame seed cake+145g short milled wheat; Diet4= grass hay *adlib tum* +140g sesame seed cake+ 220g short milled wheat.

Sheep fed on grass hay alone retained a slight weight gain showed that the hay supplied satisfactory nutrient for maintenance and slight growth. This positive gain could be due to the availability of high soluble carbohydrate content in quality grass hay. However, the current finding was not in harmony with the observations by Getachew [9] and Mulu [36] who reported loss of 4 and 3 g d^{-1} for Farta and Wogera sheep fed with only grass hay, respectively, which could be attributed due to the quality of grass hay used in the experiment.

CONCLUSION

It was found that a total dry matter intake was significantly (P<0.001) higher in the supplemented sheep than the control group with the highest remark in the optimum supplemented group. There was also increased digestibility of nutrients with the increasing distribution of dietary crude protein for the supplemented groups which could enable them to achieve a higher nutrient utilization and live body weight gain. Thus, it can be concluded that supplementation dietary treatments mixed from short milled wheat and sesame seed cake was the most palatable feed source for ruminant animals. Thus, the growth performance of rams can be realized using sesame seed cake and short milled wheat mixtures which could be contributed to advancing feed conversion competence and biological presentation. Therefore, it is appropriate to add these mixes to the diets of ruminant animals.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study received ethical approval from the ethical review committee of Aksum University, College of Agriculture, Ethiopia.

HUMAN AND ANIMAL RIGHTS

No humans were used in this research. The reported experiments were in accordance with the standards set forth in the 8th Edition of Guide for the Care and Use of Laboratory Animals (http://grants.nih.gov/grants/olaw/Guide-for-thecare-and-use-of-laboratory-animals.pdf) published by the National Academy of Sciences, The National Academics Press, Washington DC, United States of America.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIALS

Data collected were subjected to statistical analyses of variance (ANOVA) using Genstat 13th edition SP2, (2010) computer software.

FUNDING

The author expresses appreciation to Bureau TVET of the Tigray region for financial support to conduct the experiment.

CONFLICT OF INTEREST

The author declares no conflict of interest, financial or otherwise.

ACKNOWLEDGEMENTS

The author acknowledges Aksum University for support to undertake this study.

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