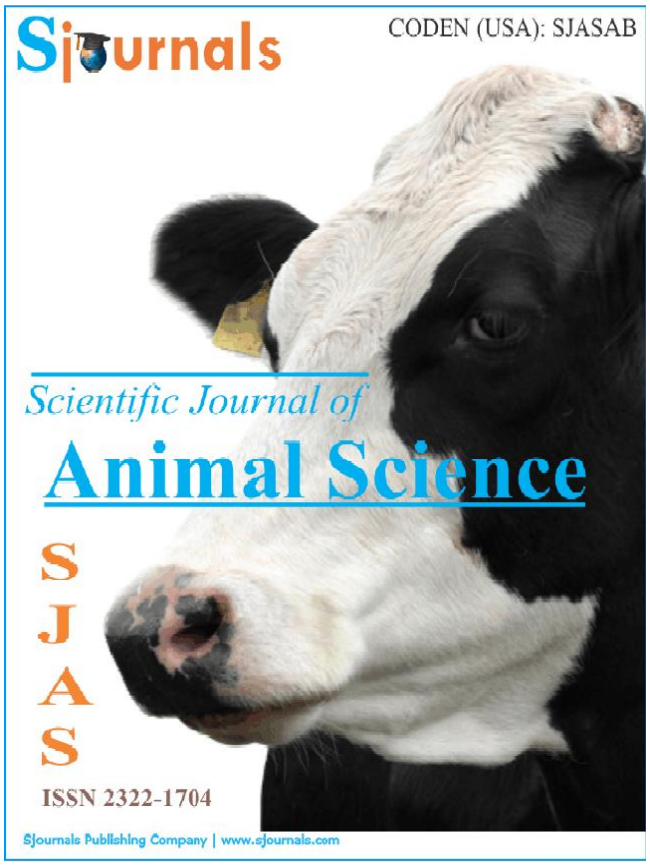

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Original article

Dried *Acacia saligna* (Labil) H.L. Wendi. leaves and wheat bran as alternative supplemental feed for sheep fattening in Tigray, northern Ethiopia

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ABSTRACT

A study was conducted to evaluate the best supplementary practice of dried *A. saligna* leaves on growth performance of rams and its economic importance. It was carried out at Atsbi-Wemberta, Wukro Kilte-Awlaelo and Saesie-TsaedaEmba districts of Tigray. In each district, one peasant association (PA) was selected except two PAs in Atsbi-Wemberta. A total of 120 farmers who have their own intact male sheep (two from each) were participated in the on-farm research. Randomized Complete Block Design (RCBD) was applied. Farmers consider as a block and rams in each farmer randomly assigned to each treatment. Two treatments were used; farmer's practice (CTL) and farmers practice + 200 g/d dried *A. saligna* leaves + 200 g/d wheat bran (AS-WB). Average daily live weight gain (ADLWG) of rams fed on AS-WB was 50 %higher than the CTL group. A higher ADLWG (86.8 g/d) of rams were achieved at Abrha-Atsbeha followed by 70.3 g/d at Hayelom, while rams in Mariam-Agamet and Barka-Adi-Sibuh were exhibited a weight gain of 46.1 and 35.5 g/d, respectively. Hence, supplementation of highland rams with dried AS-WB is economically important for smallholder farmers than free grazing.

1. Introduction

Currently, in Tigray region, there is a tendency to rehabilitate the degraded area by constructing water harvesting structures, exclosures, reseeding and seedling plantation and other conservation activities. This forces farmers to confine their animals at home as these areas are not allowed for grazing. The available feeds at farmers are crop residues and poorly prepared hay. Those feeds are not in a place to support the maintenance need of animals. Alemu (2008) reported that ruminant diets are generally based on fibrous feeds that have low digestibility and are deficient in protein, minerals and vitamins.

Acacia saligna (A. saligna) is the main tree/shrub grows in the rehabilitated areas of Tigray, northern Ethiopia. Shumuye & Yayneshet (2011) also reported that it is one of the introduced browse shrub or tree species, which is widely grown and distributed in different agro-ecological zones of Tigray region. This plant utilized as wind break, fuel wood, and soil and water conservation. Its leaf could offer as a source of fodder, particularly for small ruminant production (Maslin and MacDonald, 2004).

The major limiting factor in using *A. saligna* as ruminant feed is the presence of high concentration of tannin (Moujahed et al., 2005). Similarly, the low protein digestibility of *A. saligna* in sheep was due to the high level of condensed tannin (CT) in its foliage (Degen et al., 1995; Ben Salem et al., 2005). Although the use of Polyethylene glycol (PEG) to deactivate tannin has been recommended (Ben Salem et al., 1997; Moujahed et al., 2000; Ben Salem et al., 2005), its wider use under smallholder farmers is constrained not only by its cost (Moujahed et al. 2005) but also its availability in the market. Air drying improves palatability, intake and digestibility (Shumuye and Yayneshet, 2011). Sun-drying was slightly efficient in reducing CT levels in the acacia foliage and simplifies protein complexes (Ben Salem et al., 1999).

Like other tropical forages, *A. saligna* is deficient in energy and could be provided to ruminants with other energy sources (Nicholas et al., 2007; Ben Salem et al., 2002). Due to the presence of CT in *A. saligna,* which binds protein and other compounds, soluble nutrient supply should be practiced in sheep feeding to increase microbial growth and improve intake (Ben Salem et al., 2002). *A. saligna* could be better if it is provided to ruminants with other energy sources as it is potential for protein sources (Gebreslassie, 2013). Wheat bran is one of the good energy sources and protein and accessible in different milling factories. Furthermore, Wheat is the main crop produced throughout the region and uses its product wheat bran as ruminant feed. This makes to easily avail of the residue of wheat or wheat bran. Therefore, this research work was implemented to evaluate the best supplementary practice of dried AS-WB on growth performance of the rams and its economic importance.

2. Materials and methods

2.1. Area description

The research was carried out at three Acacia project sites, namely, Wukro Kilte-Awlaelo, Atsbi-Wemberta and Saesie-Tsaeda Emba districts. The altitude of these three districts ranges from 1940-2160, 918-3069 and 2256-2954 m.a.s.l, respectively. Mean annual rainfall is 639.2, 642 and 350-500 mm, respectively. The annual mean temperature of Wukro Kilte-Awlaelo ranges from 14^0C - 20^oC and 12°C to 28°C for Saesie-Tsaeda Emba. Four Peasant associations (PA) of the project areas; Abrha-Atsbeha from WukroKilte-Awlaelo, Barka-Adi Sibuh and Hayelom from Atsbi-Wemberta and Mariam-Agamet from Saesie-Tsaeda Emba were selected. Mixed crop-livestock farming is the feature of the areas.

2.2. Chemical composition of feed ingredients

Nitrogen (N) content of the *A. saligna* and wheat bran (WB) analyzed according (AOAC 1990). The CP calculated as N x 6.25. The dry matter content (DM), neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL) and Ash of the experimental feeds examined according to Van Soest et al. (1991) and the condensed tannin content was determined according to Burns (1971).

2.3. Farmers selection

The feeding trial was conducted with the active participation of farmers. A total of 120 farmers; 38 farmers from Wukro-Kilte-Awlaelo district (Abrha-Atsbeha PA), 62 farmers from Atsbi-wenberta district (38 from Barka-Adi-Sibuh and 24 from HayelomPA), and the rest 20 farmers from the SaesieTsaedaEmba district (Mariam-Agamet PA) were selected and each farmer provided two rams with an age of 8-12 months. Those 240 rams were randomly divided into two groups, 120 rams assigned as control and the remaining 120 for the supplemented groups. Farmer Research Group (FRG) was established by Acacia project before starting the feeding trial. Female headed households (FHH) were encouraged to take part in the feeding trial. As a result, 41% of the farmers were FHH.

2.4. Preparation of the feeds

A. saligna leaves were collected by hand plucking from farmers' backyard, ex-closure and other communal areas. The collected leaves were air-dried for 4 to 6 days till easily crushed by hand twisting, kept in sacks and stored in a place where not exposed to moisture and sunlight. Each farmer collected 11 kg of dried *A. saligna* leaves before the experiment started to feed their rams whereas.wheat bran (WB) was purchased from flour factories in Mekelle city and transported to each site before commencing the trial.

2.5. Experimental design and treatments

Randomized Complete Block Design (RCBD) with 120 replications was used. Farmers were managed their own experimental rams in a similar manner. Each farmer was considered as a block. The rams were divided into two groups randomly. The first group kept their rams on free grazing only (CTL) and the second group was free grazing plus 200 g/d dried *A. saligna* leaves, plus 200 g/d wheat bran (AS-WB) fed as supplement after they came back from field grazing.

2.6. Management of experimental rams

Experimental rams were tagged for identification purpose. They were treated against internal and external parasite with anti-helminths (Albendazole) and anti-external parasite (Ivermectine), respectively, as per the recommended dosage before starting the experiment and the house for the rams was constructed from locally available materials in each farmers' house compound.

2.7. Measurements

2.7.1. Feed intake

The amount of supplemental feed offered and refused was measured every day. Refusal feed was collected in the sack for a week; then the total amount of refusal was divided by the number of days. The experiment was carried out for about 90 days following two weeks of adaptation period. Rams were grazed in the pasture equally and considered as the same management from farmer to farmers. The feed intake of the supplemented group was calculated by subtracting the refusal from the offered feed using the formula:

$$\text{Feed intake} = \text{Amount of feed offered} - \text{Amount of feed refused}$$

2.7.2. Live weight gain

Weight gain taken every ten day interval for both treatments as farm measurements were very difficult to undertake every week. The measurement was expressed in kilogram and measured using spring balance. This was continued for the 90 days excluding the adaptation period of two weeks. The live weight gain was calculated with the formula;

$$\text{Live weight gain (LWG)} = \frac{\text{Final weight - Initial weight}}{\text{Number of days}}$$

2.8. Cost benefit analysis

All expenditure, including initial price of the rams (by estimating the current price of the rams) and all feed costs (supplemental feeds) was recorded and considered as expenditure. After accomplishment of the study, rams estimated their selling price. In addition to this, the expenditure related to all the weight changes was recorded and evaluated for cost-benefit analysis. Finally, the net income and the marginal rate of return was

calculated. Partial budget measures profit or losses, which are the net benefits or differences between gains and losses for the proposed change. The net income (NI) 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), and calculated as follows:

$$\Delta NI = \Delta TR- \Delta TVC$$

The marginal rate of return (MRR) was measured the increase in net income (ΔNI) associated with each additional unit of expenditure (ΔTVC).

$$MRR = \Delta NI/ \Delta TVC$$

2.9. Data analysis

The collected data on live weight change subjected to analysis of variance (ANOVA) using JMP5 (SAS Institute Inc., 2002) and mean comparison was done using each pair of student's t test for the comparison of AS-WB and CTL groups at $P \leq 0.05$ for comparison of means by thePA. A statistical model for body weight gain was:

$$Yijk= \mu + \tau i + \beta j + \epsilon ijk$$

Where; Yijk = the overall response; μ= overall mean; τi = ith treatment effect (i= 1,2); βj = jth block effect (j= 1,2,3,....,120); ϵijk = overall treatment and error effect

3. Results and discussion

3.1. Chemical composition and nutrient intake of supplemented feed

A. saligna used in this study has revealed a CP of 14.8 %, which is higher than 12.7 % reported by Mojahed et al. (2005) and comparable with Ben Salem et al. (2005) report, which was 13.6 CP %, but, lower than 18.2 % (Abdel Fattah, 2005). The variation in CP might be due to soil nutrient difference, plant age and leaf to twig ratio. The NDF and ADF are energy and fiber source for the ruminants, which stimulates readily available energy source in the rumen and ease of digestion. The NDF and ADF of *A. saligna* values found in this study were 43.4 % and 30.7 %, respectively, which was similar to the value (43.7 % NDF and 46.2 % ADF) reported by Ben Salem et al. (1997). However, lower than the value (29.2% NDF and 34.9 % ADF) reported by Mojahed et al. (2005). CT content of *A. saligna* (13.8%) found in this study was lower than 17.7%, according to the report by Ahmed (2007) but, higher than 11.3% as reported by Abdela Fattah (2005). The CT content of *A. saligna* may vary by treatment method, plant age, and season. The CT content of *A. saligna* is the attribute of soil type and season of production (Ben Salem et al., 2005). Treating*A. saligna* resulted in reducing CT content of the leaf (Ben Salem et al., 1999). Variation in chemical composition of A. saligna dictated by different research findings as a result soil type, age, treatment application and season of production. In agreement to this, Abdel Fattah (2005) reported that chemical composition of *A. saligna* varied as a result of change in maturity.

3.2. Body weight change

The ADLWG (59.2 g/d) found in rams fed on AS-WB was consistent with the weight gain (63.9 g/d) reported by Gebreslassie (2013) for highland rams fed on grass hay as basal diet and, 200 g/d dried *A. saligna* leaf and 200 g/d WB as a supplement. Similar weigh gain (42.8 - 72.2 g/d) was also reported by Bimrew et al. (2010) for Farat sheep fed on a grass hay basal diet concentrated feed as supplement However, this result was lower than the weight gain (73.2 g/d) reported by Ben Salem et al. (1999) for sheep fed on field dried *A. saligna* and 400 g barely and higher than the weight gain (22 g/d) reported by Brhane & Getachew (2009) for lambs fed grass hay as basal diet plus 300 g/d dried *A. Salgna* leaf as supplement. In the present study, rams fed only on the natural pasture gained a weigh of 19.5 g/d. However, Brhane and Getachew (2009) reported weight loss of 4 g/d for lambs

fed on grass hay only. The higher ADLWG of the rams supplemented with AS-WB could be due to the bypass protein in AS and fermentable N in WB which ensures optimum microbial biomass. As the tannin content protects the protein to digest in the rumen, small amount of these tannins in animal feed are not harmful rather it protects protein breakdown in the rumen and absorption in the small intestine (Ben Salem et al., 1999). The majority of the protein in WB digested in the rumen than in the small intestine (Hadden et al., 1986) which helps the animals to get fermentable nitrogen. The fermentable nitrogen may help to increase the number of micro-flora which help the animals to use fibrous feed.

Table 1
Chemical composition of feeds.

	Feeds	
Parameters (%)	**WB**	**AS**
DM	93.6	92.0
OM	93.7	84.9
CP	16.2	14.8
NDF	48.	43.4
ADF	15.5	30.6
ADL	3.52	8.04
Ash	6.27	15.1
Soluble matter[a]	52.	56.6
Hemicelluloses[b]	32.5	12.8
Cellulose[c]	5.73	7.43
CT	-	13.8

DM= dry matter; OM= organic matter; CP= crude protein; NDF= neutral detergent fiber; ADF= acid detergent fiber; ADL= acid detergent lignin; AS= Acacia saligna; WB= Wheat bran [a'] = 100%-NDF; [b'] = NDF-ADF; [c'] = ADF-(ADL+Ash); g/kg DM= gram per kilogram dry matter; CT= Condensed tannin.

Table 2
Dry matter and nutrient intake of experimental rams.

Parameters(%)	**Dry matter and nutrient intake of the supplemented rams**
DM	371
OM	357
CP	62.1
NDF	183
ADF	92.2
ADL	23.1
Ash	42.7
Soluble matter a	217
Hemicelluloses b	90.6
Cellulose c	26.3
CT	25.3

DM= dry matter; OM= organic matter; CP= crude protein; NDF= neutral detergent fiber; ADF= acid detergent fiber; ADL= acid detergent lignin; AS= Acacia saligna; WB= Wheat bran [a'] = 100%-NDF; [b'] = NDF-ADF; [c'] = ADF-(ADL+Ash); g/kg DM= gram per kilogram dry matter; CT= Condensed tannin.

Table 3
Average Body weight change of highland rams supplemented and control.

	Treatment			
Parameter	**T1**	**T2**	**SEM**	**P value**
Initial weight (kg)	21.6	21.6	0.29	0.99
Final weight (kg)	22.8^{b}	25.2^{a}	0.33	0.01
ADLWG (g d^{-1})	19.5^{b}	59.2^{a}	2.04	0.01

ADLWG= Average daily live weight gain; SEM= Standard error mean; P= P Value; LS= Level of significance; g d^{-1} = gram per day.

In brief, the ADLWG of the AS-WB rams across the PAs ranged from 40 to 80 g/d. The rams in Barka-Adi-Sibuh had the lowest gain compare to Abrha-Atsbeha rams which was the highest. Whereas the, rams in Mariam-Agamet and Hayelom were found intermediate. Overall AS-WB supplemented rams on Abrha-Atsbeha PA do better than rams supplemented in other PAs. The ADLWG found in Abrha-Atsbeha PA (80 g/d) was consistent with the weight gain (85 g/d) reported by Ben Salem et al. (2005) for sheep fed with *A. saligna* leaves and supplemented with 300 g/d concentrate. Similarly, Ben Salem et al. (1999) reported a weight gain of 73.2 g/d for sheep fed with *A. saligna* field-dried foliage adlibitum plus 400 g/d barley plus 30 g/d commercial mineral and vitamin supplement. This implies local feed resources can replace commercial feeds and easily accessible at farm level. However, the browse feeds should be supplemented with other best fit feeds for the healthy microbial environment in the rumen resulted in better weight gain. In CTL group, rams in Hayelom PA gain 6.4 g/d that was lower compared to rams in the other PAs, while rams in Abrha-Atsbeha PA revealed higher (33 g/d) weight gain than others. *A. saligna* leaf following drying and WB may suitably at farm level because of accessibility and complimentary. Abdel fattah (2005) also suggested to use *A. saligna* as supplemental feed to low quality feed.

Table 4
Body weight change of Highland rams supplemented and control at different Peasant associations

Parameters	**Peasant associations**				**SEM**	**P-value**
	B/A/Sibuh	**A/Astbeha**	**M/Agamet**	**Hayelom**		
Initial weight (kg)						
Supplemented	21.8	21.2	21	21.3	0.19	0.43
Control	20.8	21.4	22.3	19.1	0.32	0.07
Final weight (kg)						
Supplemented	23.1^{b}	26.4^{a}	25.9^{a}	22.2^{b}	0.36	0.01
Control	22.6	23.2	22.1	21.7	0.2	0.05
DLWG (g)						
Supplemented	40^{c}	78.9^{a}	60^{b}	55.2^{bc}	3.67	0.01
Control	12.2^{b}	32.9^{a}	18.1^{b}	6.41^{c}	1.73	0.01

DLWG= Daily live weight gain; SEM= Standard error mean; P= P Value; LS= Level of significance; B/A/Sibuh= BarkaAdisibuh; A/Atsbeha= AbrhaAtsbeha; M/Agamet= Mariam Agamet; kg= kilo gram; g= gram.

3.3. Partial budget analysis

The partial budget analysis of this study provides information about the feasibility of the study and helps to further use. The return obtained calculated from the difference between the variable cost and return obtains from the sale of rams is described in Table 5. The financial reward obtained from the AS-WB and CTL ispositive, but higher return obtained from the AS-WB. The AS-WB supplemented rams in Barka-Adi-Sibuh, Abrha-Atsbeha, Mariam-Agamet and Hayelom PA were fetching 2.66, 11.9, 8.65 and 5.08 USD, respectively.

The MRR for the AS-WB rams were 0.04, 0.19, 0.14 and 0.08 USD for PAs of Barka-Adi-Sibuh, Abrha-Atsbeha and Hayelom, respectively. This explains for every spending of 0.05 USD farmers can generate the money described in MRR. Even higher return obtained at Abraha-Atsbeha, the return obtained in the other PAs was also magnificent. MRR inAS-WB brought a higher economic return to the farmers.

Table 5
Partial budget analysis.

	Control				Supplement			
Description	**B/A/Sibuh**	**A/Astbeha**	**M/Agamet**	**Hayelom**	**B/A/Sibuh**	**A/Astbeha**	**M/Agamet**	**Hayelom**
Purchase price of sheep, USD/head	27.5	26.5	27.4	27.5	30.4	28.0	28.2	27.1
Total variable (feed) cost	00.0	00.0	00.0	00.0	3.2	3.2	3.2	3.2
Gross income, USD/head	20	33.1	42.7	40.2	36.1	41.9	59.2	52.8
Total return, USD/head	5.6	16.1	12.8	8.8	11.5	31.2	24.7	17.0
Net return, USD/head	5.6	16.1	12.8	8.8	8.3	28.0	21.5	13.8
Δ NI	-	-	-	-	2.7	11.9	8.7	5.1
Δ TVC	-	-	-	-	3.2	3.2	3.2	3.2
MRR(Ratio)	-	-	-	-	0.8	3.7	2.7	1.6

USD =United states dollar; Δ NI= change in net income; Δ TVC= change in total variable cost; MRR= Marginal rate of return; B/A/Sibuh= BarkaAdi-Sibuh; A/Atsbeha= Abrha-Atsbeha; M/Agamet= Mariam-Agamet.

4. Conclusion

Acacia saligna and wheat bran (AS-WB) are accessible at the farmer's level and used as alternative small ruminant feed resources which helps the rams for better body weight change and give a higher return to the farmers than letting the rams for grazing.

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