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Research Article

Supplementation of rams with dried *Acacia Saligna* (Labil) H.L. Wendi. leaves improve reproductive performance without compromising carcass quality

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Abstract

The study aimed to provide the appropriate level of *Acacia Saligna* (AS) for ram supplementation that enhances their reproductive performance without compromising carcass and sensory qualities. Sixteen rams with an average initial live body weight of 21.98±1.84kg were fed ad-libitum grass hay and 200 g/d Wheat Bran (WB) with treatment diet; T1: 100; T2: 200; T3: 300; and T4: 400 g/d of air-dried AS leaves. Rams assigned on T4 had 11% and 6% higher DMI than T1 and T2, respectively, and got 5.5%, 3%, and 1.5% more CP than T1, T2, and T3, respectively. Higher impact of AS supplementation observed on development of reproductive organ on T4 than T1. The T4 rams also produced 14%, 7%, and 7.5% more semen volume and 2.5%, 2%, and 1% live sperm cell count than T1, T2, and T3 rams, respectively without jeopardizing semen quality. Furthermore, increasement of AS improved the libido and spermatozoa motility of the rams. Supplementation of AS did not produce a difference in slaughter weight, empty body weight, carcass weight, dressing percentage, and sensory quality of the rams. However, edible offal and usable product of T4 were higher than T1. The liver and kidney the most important organs were heavier in T4 than T1 rams. Hence, smallholder farmers can supplement dried AS with WB as an alternative supplement to improve the breeding efficiency of rams and produce quality meat.

Introduction

Sheep plays a crucial role in the livelihood of smallholder farmers in Ethiopia. However, the emphasis given to improving their performance is negligible because of different reasons express by poor performance. With typical characteristics of the rams; low (60ml) semen volume on yearly rams [1], reach slaughter weight at older age [2], low (35%) dressing percentage [3] and smaller carcass weight (10kg) [4]. Furthermore, it lacks tangible information on ram meat organoleptic quality [5] and reproduction performance of Ethiopian rams' this hampers the improvement mechanism.

This low performance is associated with poor nutrition than the genetic potential of the rams [1]. Observed as nutrition play a great role in the reproduction variation of Ethiopian Horro and Menz rams than their breed difference. The quality meat produced by Menz rams associate with the feed

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resource of the area [6]. In Ethiopia, shoats are predominantly dependent on grazing and browsing [7] however, these feed resources have diminished their quality and quantity [8] noted ruminant DM feed maintenance requirements show a deficit of 12% in Ethiopia. Low nutritional quality of usable forage and dominance of unpalatable forage is the main challenge of ruminant producers in Ethiopia [9]. Hence, to enhance the reproductive efficiency and generate the desired meat from indigenous rams the feeding system must be improved by considering available feed resources. As commercial feed supplementation is not possible in our context because of awareness, availability, and economic reasons rams must be supplemented with available feed resources to overcome the deficit.

Acacia Saligna (AS) is one of the locally available browse feed resources with high CP content [10] but rich in tannin that affects its utilization as livestock feed [11]. Studies have been undertaken to improve the feeding quality of AS by reducing the impact of the tannin [10,12-14]. However, the extensive use of AS as a supplement is dependent on its limited effect on economically important traits such as reproduction performance, carcass quality, and organoleptic tastes. Previous studies that dealt with AS as a supplement gave little emphasis to such traits. Hence, this study was undertaken to provide the appropriate level of AS for ram supplementation that enhances reproductive performance without *compromising* carcass and sensory quality.

Materials and methods

Study area

The study was conducted at Mekelle Agricultural Research Center (MARC) 13°31'23.20"N latitude and 39°30'13.56"E longitude and altitude of 2000 m.a.s.l. The average annual rainfall of the area was 529+108 ml which is erratic and unpredictable. The weather of MARC has been explored as moderately hot and windy with an average annual maximum temperature of 28.8°C and minimum of 11.2°C with 50.30% relative humidity.

Feed preparation

The AS leaves were collected by hand plucking from MARC. The harvested leaves were air-dried for five days and crushed by hand. Native grass hay dominated by *Cynodon dactylon* was also harvested from the MARC field at 50% blooming. Wheat Bran (WB) was purchased from the Lemelem flour milling industry found in Mekelle.

Animals and their management

Sixteen yearling highland sheep rams with an average initial body weight of 21.98+1.84 kg were purchased from the Atsbi local market. These rams were treated against internal and external parasites using anti-helminths Albendazole (7.5 mg/kg weight ingested through the mouth) and Ivermectin (0.2 mg/kg weight, administer through subcutaneous injection), respectively [15]. The housing was made of concrete floor, corrugate sheet, and aerated from the sides with a proper drainage facility. Clean water and salt were provided on free choice throughout the experiment period.

Experimental design and treatments

A Randomized Complete Block Design (RCBD) with four blocks based on their initial weight following overnight fasting was implemented. The four blocks were arranged based on their initial weight consist the following weight ranges: the first, second, third, and fourth block included 24.2+0.94 kg, 22.5+0.58 kg, 21.65+55 kg, and 19.55+0.64 kg, respectively. Each block contained four highland sheep rams and each treatment diet randomly assign to the rams within the block and these blocks consider as replication. The supplementation was scheduled at two equal portions 10:00 am morning and 4:00 pm afternoon for the air-dried AS and WB. Treatments were; T1: 100 g/d; T2: 200 g/d; T3: 300 g/d; and T4: 400 g/d of air-dried AS leaves and the entire group received fixed 200 g/d WB and ad libitum grass hay. The minimum AS leave supplementation we set for this study was based on the recommendation of [16] sheep can eat up to ~100 g/d fresh AS. Hence, we try to set this a minimum value and try to see how the increase in treated AS and WB supplementation can enhance the intake and performance of sheep. All the experimental rams were at the separate cage and allowed free access to grass hay whereas, the supplement dried AS and WB were supplemented in two portions to the supplementing group half in the morning and a half in the afternoon.

Chemical composition of feeds

DM, OM, Ash, and Nitrogen (N) content were determined according to [17]. The Nitrogen (N) content of the feed was also analyzed according to the Kjeldahl method [17]. The fiber content, Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), and Acid Detergent Lignin (ADL), of sample experimental feeds, were analyzed according to [18]. The condensed tannin content was determined according to [19] Tables 1,2.

Measurements

Feed intake: The feed offered and refused for each ram was measured every day for the whole 90 days of the experimental period. The feed intake was calculated by subtracting the refused from the offered feed using the following formula:

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

Live weight change

Live weight record was taken weekly for each ram. The measurement was expressed in kilogram and measured using a spring balance of 50 kg weighing capacity with 5 partitions, 200 g each, in each kg. The live weight change and daily live weight gain were expressed with the following formula:

$$\text{Live weight change} = \text{Final body weight} - \text{Initial live weight}$$

$$\text{Daily live weight gain}\left(\text{DLWG}\right) = \frac{\text{Final weight} - \text{Initial weight}}{\text{Number of days}}$$

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Table1: Chemical composition of experimental feeds.

Feeds	Chemical composition (%)										
	DM	OM	CP	NDF	ADF	ADL	Ash	SM	H	C	CT
GH	94.71	91.77	6.55	76.15	50.62	10.43	8.23	23.85	25.53	31.96	-
WB	93.58	93.73	16.20	48.01	15.52	3.52	6.27	51.99	32.49	5.73	-
AS	92.03	84.91	14.84	43.39	30.56	8.04	15.09	56.61	12.83	7.43	13.78

GH= Grass Hay; WB= Wheat Bran; AS= Acacia Saligna; DM= Dry Matter; OM= Organic Matter; CP= Crude Protein; NDF= Neutral Detergent Fiber; ACF= Acid Detergent Fiber ADL= Acid Detergent Lignin; SM = Soluble Matter; H = Hemicelluloses; C= Cellulose; CT= Condensed Tannin

Table 2: Chemical composition of treatment diets.

Trt	Chemical composition (g/d)										
	DM	OM	CP	NDF	ADF	ADL	Ash	SM	H	C	CT
T1	981.5	898	90	515	317	106	83.4	485	198	128	12.7
T2	1095	996	105	721	451	97	99	279	270	255	25
T3	1168	1057	117	749	471	103	111	251	278	258	37
T4	1227	1106	127	769	468	107	121	231	283	258	47.5

Trt= treatment; DM= Dry Matter; OM= organic matter; CP=crude protein; NDF= neutral detergent fiber; ADF= acid detergent fiber; ADL= Acid Detergent Lignin; SM=Soluble Matter; H=Hemicelluloses; C= Cellulose; CT= Condensed Tannin; g/d = Gram per Day

Reproductive characteristics

Reproductive characteristics of the rams were measured immediately after they were assigned to treatment diets. Parameters like libido, body condition, and Scrotum Circumference (SC) were measured both at the initial and final of the study. Whereas, the testicle weight, semen volume, live and abnormal semen count, mass motility, consistency, and semen color were evaluated at the end of the study period. Equipment used to undertake this measurement include Artificial Vagina (AV), microscope, water bag, chemicals like (Xylen, 10% nigrosin solution, Eosin-Nigrosin stain) and tubes prepared with the collaboration of Mekelle University Faculty of Veterinary Science. Semen characteristics are evaluated according to the measurement of [20]. Artificial Vagina (AV) filled with warm water 37.5°C to 40°C consistent to natural ewe vagina temperature prepared for semen collection. Then, each ram was allowed to mount the ewe on oestrus but not to serve rather they ejaculated in the prepared AV. Following semen collection, the evaluation continued to see the quality undertaken in the laboratory.

Semen volume measured using a measuring test tube which fitted to the tip of AV and recorded to each ram and finally summarized according to their treatments. Semen mass motility measured using grades (1 to 5) that is 1 for the low motility (poor) and 5 to very high motility following direct observation in the microscope by putting a drop of semen in a slide. By preparing a smear following adding a solution of Eosin-Nigrosin to the collected semen, live and abnormal sperm cells counted in the microscope by 100 magnifying power and putting oil. Counting live and abnormal semen was done till the total number reached 400. Semen consistency and color were identified by physical observation on the microscope. Consistency measured using 4 grades (very thick, thick, thin, and very thin) 4 grade given for very thick and 1 for very thin, while the color was measured using 4 grades (cream whitish, creamy, brown, and light brown) 1 for creamy whitish and 4 for light brown. Testicle weight measured right after slaughtering using sensitive balance. Mass motility, body condition, color, consistency, and libido were measured by four panelists.

Scrotum circumference measured using a tape meter by circling the scrotum at the center. Ewes in the heat were used for measuring their libido instead of teaser rams but not allowed to serve. The ewes and rams were separated the whole knight and allow them to stay together for up to 4 hours to evaluate the ram libido. Their libido measured by observing individual ram's sexual desire and recorded in five grades (excellent, very good, good, fair, and poor), higher sexual desire (excellent) mount the ewe continuously for more than four times got grade 5 if it mounts four times got grade 4 and continued till poor grade rams no mount and low interest to sniff. Body condition was measured by physical observation of the rams according to manually prepared by [7] graded as 1 to 5 namely (5= excellent (very fat), 4= very good (fat), 3= good (moderate), 2= fair (thin) and 1= poor (very thin)).

Hot carcass parameters

Hot carcass parameters were measured following the 90 days feeding trial. The experimental rams stayed for one week before they slaughter under ad libitum grass hay and 200 g/d WB following this, starved for 24 hours before slaughtered, but they were provided water in free choice. Slaughtering was done in Mekelle City's municipal abattoir. All the edible and non-edible offal parts were measured. Classification offal to edible and non-edible parts was based on the society who lives in that area. In the study area heart, liver, empty gut, and kidney are considered edible offal. Total Edible Offal Component (TEOC) includes rumen, reticulum, abomasum-omasum, tail, visceral fat, small intestine, and large intestine. In the Total Non-Edible Offal Component (TNEOC) category spleen, skin, testicles, hoof, horn, and gut contents are included. The empty body weight was calculated as follows;

$$\text{Empty body weight} = \text{Slaughter weight} - \text{Gut fills}$$

The dressing percentage was calculated as the proportion of hot carcass weight or empty body weight on slaughter body weight;

$$\text{Dressing percentage hot carcass base} = \frac{\text{Hot carcass weight}}{\text{Slaughter body weight}} \times 100$$

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$$\text{Dressing percentage empty body base} = \frac{\text{Empty body weight}}{\text{Slaughter body weight}} \times 100$$

Rib eye muscle area

The carcass was divided into two parts: hind and forequarter between the 9th and 10th ribs. The four ribs from (10^{th} to 13^{th}) were chilled overnight in the deep freezer and the rib eye (longissimus dorsi) area was measured at the 11th and the 12th rib site [21]. The rib-eye area value was taken as the mean of the left and right sides. The cross-sectional area of the rib eye muscle (longissimus dorsi) area was marked out first on transparent plastic paper after it was cut at the 11th and 12th ribs perpendicularly to the backbone. The transparent plastic paper was attached to the square paper and calculates the number of squares within the traced transparent plastic paper manually. The size of the square paper was 0.5cm x 0.5cm. The area of the squares that fell within the tracer paper was counted on both sides and the average of the two sides was used to calculate the rib-eye muscle area.

Sensory evaluation

The sensory evaluation was undertaken by a slight modification of [22] for marbling (measured on 4 scales: abundant, moderate, small, and none), color (measured on 6 scales: deep red, bright red, purplish, brown, reddish brown and green), odor (measured on 4 scales: gassy/carbony/, alcoholic, putrid and no smell), juiciness (measured on 5 scales: salty, bitter, metallic, sweet/sugary/ and watery) and tenderness (measured on 4 scales: very soft, soft, coarse and very coarse/not edible/). The evaluators were four people that are experienced in sensory quality evaluation. The evaluators filled out every parameter for every ram and then the result was summarized according to treatments. A meat sample from 10 cm deep at the shoulder, hind leg, and neck was taken for the evaluation. The pH was evaluated using pH paper by immersing this paper into the fresh meat and record the value.

Statistical model and data analysis

The collected data on nutrient and dry matter intake, organic matter intake, CP intake, NDF intake, live weight change, ADLWC, FCE, carcass parameters, the sensory quality of meat, scrotum circumference, testicle weight, semen volume, live semen count, and abnormal semen count subjected to analysis of variance (ANOVA) using Statistical Analysis System [23] and mean comparison was done using Tukey HSD at $P<0.05$. For organoleptic measurement, body condition, libido, semen mass motility, consistency, and semen color analyzed using non-parametric measurement of K independent samples and mean rank compared using Kruskal-Wallis H [24]. The mean rank value explained, the group with the lowest mean rank is the group with the greatest number of lower scores in it, and similarly, the group with the highest mean rank shows a greater number of high scores within it.

The ANOVA model used for data analysis was:

$$Y_{ij} = \mu + \alpha_i + \beta_j + e_{ij}$$

Where Y_{ij} is response variable in i^{th} treatment and j^{th} block, μ is the overall mean, α_i is the i^{th} treatment effect, βj is the j^{th} block effect and e_{ij} is random error.

Result

Feed intake and live weight change

DMI of T4 rams was higher by 11% and 6% from rams assigned in diet T1 and T2, respectively. The T4 rams also showed higher OM and NDF intake than T1 rams. The CPI constantly rose with increase AS level for all groups of rams. However, increased levels of AS didn't produce a significant impact on the final weight, ADLWG, and FCE of the rams (Table 3).

Reproductive characteristics

The increased level of AS had a positive effect on the growth of the reproduction organs like SC and testicle weight. Additionally, semen volume and live sperm cell count significantly increased in the high amount supplemented T4 rams (Figure 1) than lower AS supplemented rams T1 Table 4.

No clear impact was shown in rams body condition, semen consistency, and semen color as a result of an increased level of AS. However, the increased level of AS had drastically improved the libido and spermatozoa mass motility of the rams which are important reproductive characteristics. The value with a higher mean rank (9.25-10.75) in the supplement group

Table 3: Feed intake and live weight change of rams.

Parameters	Treatments				SEM	P value
	T1	T2	T3	T4		
DMI (g/d)	981.5^{c}	1095^{bc}	1168^{ab}	1227^{a}	30.7	0.001
OMI (g/d)	898.1^{b}	996^{ab}	1057^{a}	1106^{a}	28.1	0.001
CPI (g/d)	90^{d}	105^{c}	116.7^{b}	127^{a}	2.2	0.0001
NDFI (g/d)	665^{b}	721^{ab}	749^{ab}	769^{a}	23	0.037
Initial body weight (kg)	21.9	22.45	21.6	21.95	0.35	0.42
Final body weight (kg)	25.8	28.2	27.2	27.1	0.76	0.23
ADBWG (g/d)	42.8	63.9	62.2	57.8	6.7	0.17
FCE (g LWG/ g DMI)	0.04	0.065	0.061	0.066	0.01	0.41

Letters with different superscript are significantly different; DMI= dry matter intake; OMI= organic matter intake; CPI= crude protein intake; NDFI= neutral detergent fiber intake; ADBWG= Average Daily Body Weight Gain; FCE= Feed Conversion Efficiency; LWG= Live Weight Gain; g/d= Gram per day; Kg= Kilogram; g= Gram; SEM= Standard Error Mean

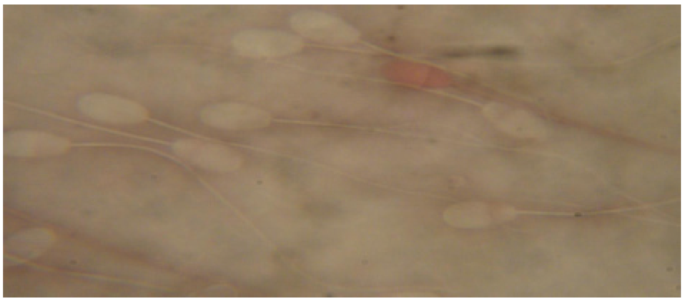

Figure 1: Normal semen with white color and abnormal semen with purple color.

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explains higher libido than the smaller mean rank value (3.5) for the control group Table 5.

Carcass parameters

Rams fed on grass hay basal diet and supplemented with the increased level of AS produced similar slaughter weight, empty body weight, and hot carcass weight. However, fresh meat pH of the higher level AS supplemented rams assigned on T2, T3, and T4 was higher than T1. Dressing percentage both in terms of hot carcass and empty body weight bases was not affected by the increased level of AS. In this study, T4 rams exhibited higher rib eye muscle area than the rest treatments Table 6.

Edible and non-edible offal's

The liver, kidneys, and empty gut weight tend to increase their weight with the increased level of *AS*. Furthermore, TEOC was heavier in rams assigned at T3 and T4 than T1 and T2. The TNEOC content was superior in T2, T3, and T4 rams than in T1. Similarly, the total usable product was also higher for the high level of AS supplemented rams except for T2 Table 7.

Sensory quality of meat

Fresh rams' meat sensory quality was not affected by the basal diet of grass hay, WB, and increased level of supplementation of AS. The value described in (Table 8) explains the mean rank value of each trait and was not affected by supplementing AS. Hence, the characteristics of the meat color for all the treatment groups were bright red, smell-less odor, watery type, and very soft tenderness.

Table 4: Semen characteristics and reproduction organ of the rams.

Parameters	Treatment				SEM	LS
	T1	T2	T3	T4		
Scrotum Circumference Initial (cm)	22.62	22.86	22.63	22.63	0.331	NS
Scrotum Circumference Final (cm)	24.75^{b}	26.25^{ab}	26.00^{ab}	28.25^{a}	0.9816	*
Testicle weight (g)	242.85^{b}	306.30^{a}	325.75^{a}	336.0^{a}	7.0782	***
Semen Volume (ml)	0.4625^{b}	0.65^{ab}	0.6375^{ab}	0.825^{a}	0.07517	*
Live sperm cells count	271.75^{b}	280.5^{ab}	287.0^{ab}	299.0^{a}	7.9605	*
Abnormal Sperm count	101^{b}	113^{ab}	119.5^{ab}	128.25^{a}	7.9605	*

$^{a, b}$; means the same row with different superscripts differ significantly, *** =(p<0.001); *= (p<0. 05); SEM= Standard Error of Mean; SL= Significance Level; NS = Not Significance; cm= Centimeter; g= gram; ml= milliliter

Table 5: Body condition, libido, and semen characteristics of rams.

Parameters	Treatment Mean Rank				χ^2	LS
	T1	T2	T3	T4		
Body condition initial	10.50	10.50	6.50	6.05	3.75	NS
Body condition final	7.00	9.00	9.00	9.00	1.154	NS
Libido initial	8.50	8.50	8.50	8.50	0.00	NS
Libido final	3.50	10.50	9.25	10.75	6.925	*
Spermatozoa mass motility	3.62	8.12	9.38	12.88	8.549	*
Consistency	6.50	8.50	6.50	12.50	7.50	NS
Semen Color	8.50	8.50	8.50	8.50	0.00	NS

* = (p<0. 05); χ^2= chi square; LS= Level of Significance; NS = Not Significance

Table 6: Carcass characteristics of highland sheep rams.

Variables	Treatments				SEM	P-value
	T1	T2	T3	T4		
Slaughter weight (kg)	22.80	24.00	24.10	24.00	0.37	0.01
Hot carcass weight (kg)	10.00	10.50	10.40	10.65	0.28	0.44
Empty body weight (kg)	17.5	18.2	18.0	18.3	0.29	0.28
pH	5.60^{c}	5.67^{b}	5.68^{ab}	5.70^{a}	0.006	0.0001
Dressing percentage						
Hot carcass weight base (%)	43.35	44.1	44.01	44.39	0.32	0.20
Empty body weight base (%)	76.76	75.7	76.5	76.4	0.30	0.14
Rib eye muscle area (cm^2)	13.8^{b}	14.1^{b}	14.4^{b}	15.6^{a}	0.28	0.01

$^{a, b, c,}$ means in the same row with different superscript differ significantly; SEM = Standard Error of the Mean

Table 7: Edible non-edible offal's of highland sheep rams.

Variables	Treatments				SEM	P-Value
	T1	T2	T3	T4		
Heart (g)	87.3	93.6	94.5	89.1	2.3	0.13
Liver (g)	270^{b}	308^{ab}	342^{a}	330^{a}	12.2	0.009
Kidneys (g)	58.5^{b}	56.1^{b}	65.8^{a}	63.9^{a}	0.88	0.0001
Empty gut (kg)	1.67^{b}	1.75^{b}	1.82^{ab}	1.97^{a}	47.7	0.005
TEOC	5.60^{b}	5.61^{b}	6.31^{a}	6.12^{a}	0.10	0.0001
TNEOC	7.00^{c}	7.59^{b}	8.7^{a}	7.51^{b}	0.235	0.052
Total usable product	18.2^{c}	18.4^{bc}	19.5^{ab}	19.6^{a}	0.28	0.007

a, b, c, d; means the same row with different superscripts differ significantly, TEOC= Total Edible Offal Component; TNEOC= Total Non-Edible Offal Component; SEM= Standard Error of Mean

Table 8: Sensory evaluation of highland sheep ram's meat.

Parameters	Treatments				χ^2	P-Value
	T1	T2	T3	T4		
Marbling	26.5	26.5	22.5	22.5	4.27	0.23
Color	23.5	27.5	23.5	23.5	1.04	0.67
Odor	23.5	23.5	25.5	25.5	2.04	0.56
Juiciness	21.0	25.0	27.0	25	4.15	0.25
Tenderness	31.9	23.3	23.3	19.4	6.9	0.08

χ^2 = Chi-square

Discussion

Feed intake and live weight change

DMI, OMI, CPI, and NDFI drastically increased when the rams supplemented from the lowest to the highest level of *AS* (Table 3). This increased in intake of rams may attribute to the quality of the plant material used as supplemental feed (Table 1) [25] reported AS has the potential to produce a feed of acceptable quality to ruminants. Most, tanniferous feed stuffs at a higher rate of provision to ruminants cause delay in feed passage and lower their feed intake as they require more rumination [26]. The treatment method applied in this study might also help for the improvement of intake and performance. This indicated the highest provision of AS in this study was safe for supplementation of ruminants (Table 2). As browse plants contain secondary compound degrading enzymes within their membrane; treatment of the plant material helps to disrupt the membrane and facilitates these enzymes to inhibit the antinutritional effect of the plant [27] in turn, improve the performance of the rams [28] explained when AS air dry and supplement to ram's their performance is comparable to ram's supplement with cotton seed cake. According to [29] ewe supplement with sole AS or mixed with

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concentrate have a similar result in the final weight. Overall, in this study, ram feed intake, ADLWG, and final weight were not negatively affected by supplementing up to 400 g/d of AS. This might be attributed to the supplementation of an additional 200 g/d WB to the rams could contribute to enhancing the ram performance. The utilization of energy source feeds as a supplement in ruminant nutrition helps the animals to prevent secondary compounds absorption to the small intestine [27], as the microbes got energy feed which facilitate their growth and help them to degrade complex feed compounds. As an outcome, it frees up desirable nutrients from the binder secondary compounds and ready for absorption. Besides the WB, the presence of a little amount of secondary compounds in AS benefit the rams, by protecting the dietary protein from degradation in the rumen or inhibiting microbes involve in protein degradation at rumen [30] and absorbed in the small intestine.

Reproductive characteristics

Ram reproduction efficiency is mainly affected by the plane of nutrition and under poor nutrition rams show a delay in puberty, poor reproduction organ development, and low efficiency [31] reported beyond season ram reproduction efficiency is influenced by plane of nutrition. Delay to reach puberty observed on grazing rams [32], is associated with lack of supplementary feed during the critical growth period [1,33,34] highlighted nutrition plays a crucial role in developing reproductive organs and enhancing the reproductive performance of rams. Plane of nutrition has a direct relationship with rams body weight, under good nutrition their reproductive organ develop early i.e: testicle and SC grow well and help to produce high quality semen and improve the number of progeny produce by the rams over their life time. The SC observed on (T4) rams compare to (T1) in this study, explained the positive impact of the increased level of supplementary AS on reproduction organ development (Table 4). This result gave a clue as this feed could be a potential supplement for breeding rams where other options are limited and help the rams to start breeding as early as possible. A similar impact of nutrition on rams reproductive trait development, positive attributes of quality feed is characterized by improving reproductive organs especially the testicular circumference [34], as this trait is associated with semen quality. The addition of browse feed staffs on ram nutrition generally tends to improve the testicular circumference of rams and reach early puberty [32], contribute to producing more offspring at the highest heritability age. The higher AS supplementation did not only help the rams to develop their reproduction organs but also to produce more semen and live sperm cells. These traits improve the breeding efficiency of the rams. In agreement with this finding [35] reported feed type and treatment methods have a positive result in the early development of testicle weight which results in higher semen production of rams [36] reported scrotum circumference of rams is a reliable predictor of sperm characteristics [37] observed feeding is not only improved semen production it also contributes to higher offspring survival. When the rams were supplemented with high AS, their sexual desire (libido) increased and produce more motile sperm cells (Table 5). This might be associated with, the supplemented AS facilitated early growth of the reproductive organs which resulted to show early sexual desire [38] supported this incidence, early maturation of reproductive organs is the character of high performing rams and results in higher scrotum circumference, semen production, libido, and overall reproduction performance of rams [32] reported the addition of browse plants up to 30 % stimulates motility and concentration of ram semen. Rams assign to high quality diet are superior in semen volume and live semen count [34]. However, the disparate result reported concerning supplementation of diets, negative effect in ram semen motility when they supplement with 5% sunflower oil (Linoleic) and extra virgin olive oil (Oleic) diets [39] and the plane of nutrition does not have any effect on physico-morphological and biochemical attributes of ram semen [40]. This discrepancy explained as all feed stuff did not have a positive impact on semen characteristics of rams and the potential of AS was one of the available feed resources for enhancing semen quality in many parts tropics. Overall, ram semen characteristics are highly influenced by nutrition [1,41].

Carcass parameters, Edible offal's and sensory quality

The increased level of AS had no impact on the hot carcass, empty body weight, and dressing percentage of the rams (Table 6). In agreement with this result [42] reported AS supplementation up to 40% of their diet to Awassi rams does not bring a difference in their hot carcass weight and dressing percentage [43] presented carcass characteristics of Dohne Merino sheep are not affected by the plane of nutrition. The similarity in carcass weight and dressing percentage of the rams in this study might be associated with less variation in their final weight [44] reported carcass weight and dressing percentage variation mainly associate with weight at slaughter and daily weight gain of the animals. Out of many meat quality attributes, pH value is one of the greatest concerns by customers as the perishability of the meat at an early stage is detected with this measurement. The Australian MLA set 5.7 pH as the quality standard for sheep meat. The meat pH value of 5.6 to 5.7 obtained in this study fulfills the stetted quality standard and explains as *Acacia Saligna* supplementation didn't hamper the pH standard. The pH value obtained in this study is consistent with the previous 5.68-6.25pH value obtain for Menz sheep rare under smallholder farmers management and consider as quality meat [7]. Meeting the standard of pH requirement is highly associated with the feed type the animal obtained. As ruminants get a quality diet, they enhanced their glycogen level which helps them to maintain the optimum pH level [45] explained feed source from Acacia plants species that contain tannin help ruminants to maintain lower pH in their meat, might be attributed to [46] these plant species help them to maintain desirable muscle energy. Hence, the energy obtained by the rams to maintain low meat pH could be generated from the supplement feed AS. Beyond the scope of this study [45] also explained compare to tannin-free diets low tannin content diet does not only help to lower the meat pH rather it also benefits by decreasing cooking loss.

Rams supplemented with higher AS demonstrated heavier liver, kidney, empty gut, and TEOC weight than rams assigned

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to lower AS (Table 7). This's because the offal weight of rams directly associates with the type and amount of feed they eat as all feed stuff is process through these organs. Visceral organs consume the majority of maintenance energy with a major share take by the liver [47]. Higher CP intake in ruminants expresses by the heavier liver as this organ associate with hepatic protein synthesis [44,48] our study also concorded with these results as higher AS supplemented rams get more CP and heavier liver. Hence, the feed type we provided to ruminants primarily expressed in these organs [30], presented when browsing feed stuff contains higher secondary compounds, they affect the rumen system by binding proteins and inhibiting the growth of essential microflora which force excretion of desirable nutrients without utilization. These animals expressed by minimum gain or lost weight which results in reducing offal weight but, not the case of this study as the rams respond with higher weight gain and heavier offal at higher AS supplementation.

In agreement with this study [49] explained sensory characteristics such as flavor, tenderness, juiciness, and overall acceptability are not affected by different dietary treatments. The sensory quality of meat from highland sheep is not affected by AS feed (Table 8) this agrees with [50] feed types do not bring difference overall nutritive values, organoleptic attributes, and acceptability of meat from ruminants. Tenderness, flavor, and, more importantly, the overall acceptability of the meat of Temasco de Aragon commercial type does not affect changes in weight [51]. Inconsistent with the plane of nutrition [52] also insisted aroma, flavor, and sustained juiciness of South African sheep are not affected by breed and sex. Color and shelf life of Apenninica sheep meat are not affected by the increase in carcass weight [53]. This gave the confidence to utilize AS to ram's supplementation with the intention of meat production.

Conclusion

Supplementation of dried *Acacia Saligna* leaves up to 400 g/d had no harmful impact on feed intake, carcass, and organoleptic qualities. This level of supplementation also led to improving the reproductive performance of the rams. Hence, smallholder farmers can use dried *Acacia Saligna* leaves as an alternative supplement to produce quality meat and improve the breeding efficiency of their rams.

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