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Research Article

The Potential of Three Vetch Species in Enhancing Feed Intake and Body Weight Gain of Growing Male Lambs

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Abstract

An experiment was intended to evaluate the potential of three vetch species in enhancing feed intake and body weight gain of growing male lambs and to investigate the difference among these three vetch species regarding their effect of supplementation on feed utilization and growth performance of growing male lambs. Twenty-four young male Arsi-Bale lambs of similar body weight were assigned to one of the four treatments in a randomized complete block design. The dietary treatments were 350 g of hay each of *Vicia sativa*, *Vicia Villosa*, and *Vicia narbonensis* for T2, T3, and T4, and ad libitum fodder oat hay alone (T1). Weight measurements of the lambs were made every ten days during the ninety-day feeding trial. Compared to T1 and T3, T2's total dry matter intake (1121.4 g/day) was substantially ($P<0.05$) greater. Lambs fed T2 diets showed significantly higher ($P<0.001$) crude protein intake (153.3 g/day) and average daily body weight increase (152.0 g/day). In conclusion, supplementation with Vicia sativa (T2) resulted in the highest feed intake and growth performance of lambs across all treatments. As a result, efforts should be undertaken to introduce and expand the production of this forage within the farming system.

Keywords

Body Weight Gain, Feed Intake, Lambs, Vetch Species

1. Introduction

The genus Vicia includes over 240 species of flowering plants that are part of the legume family (Fabaceae), commonly known as vetches. These species are distributed across various regions, including Europe, North America, South America, Asia, and Africa.

Vetch has several nutritional benefits, especially for livestock and soil health. Vetch is rich in protein, making it an excellent forage option for livestock [1]. The high protein content supports growth and overall health in animals. Vetch contains essential minerals such as calcium, phosphorus, potassium, and magnesium [2]. These minerals are vital for bone health, muscle function, and overall metabolic processes in animals. Vetch also provides dietary fiber, which aids in digestion and promotes gut health. It also contributes to energy supply, supporting livestock maintenance and production. Vetch contains antioxidants (such as flavonoids) and other phytochemicals that have potential health benefits [1]. These compounds may help protect cells from oxidative damage and support immune function.

Like other legumes, vetch forms a symbiotic relationship with nitrogen-fixing bacteria (rhizobia) in its root nodules. This process allows vetch to convert atmospheric nitrogen into plant-available forms, enriching the soil with nitrogen [3]. When vetch is incorporated into the soil, it contributes to soil

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fertility. When used as a cover crop or green manure, vetch improves soil structure, prevents erosion, and suppresses weeds. Its deep root system helps break up compacted soil layers. Farmers often incorporate vetch into their cropping systems to enhance both livestock nutrition and soil health.

Among the vetch species adapted to the highlands of Ethiopia *Vicia sativa*, *Vicia villosa* and *Vicia narbonensis* are the most common. The agronomic practices of these vetch species are well developed. However, the information regarding their feeding value is limited. Therefore, the current feeding experiment intended to evaluate the potential of these vetch species in enhancing feed intake and body weight gain of growing male lambs and to investigate the difference among these three vetch species regarding their effect of supplementation on feed utilization and growth performance of growing male lambs.

2. Materials and Methods

2.1. Description of the Experiment Area

This feeding trial was undertaken at Sinana Agricultural Research Center (SARC). The research center is located at 07 ° 07' N latitude and 40° 10' E longitude and at an altitude of 2400 m above sea level. The area has a bimodal rainfall pattern, with total annual precipitation ranging from 750 to 1000 mm and average annual maximum and lowest temperatures of 21 ℃ and 9 ℃, respectively.

2.2. Feeds Preparation

The three vetch species and fodder oat used as a basal diet were produced at Sinana On-station. The vetch species were harvested at 50% blooming, whereas fodder oat was harvested at heading stage when they performed best in dry matter production and nutritional value. The collected fresh forages were field-cured and stored as hay in a roofed shelter to avoid rain and direct sunlight. During the feeding time, the oat and vetch hays were cut into 3-5 cm lengths to make sampling uniform and easy for the animals to grab.

2.3. Disease Management and Housing of Experimental Animals

Twenty-four young male Arsi-Bale lambs of similar body weight were obtained at adjacent markets. The lambs were kept in quarantine for 21 days and monitored for health issues. During this time, the lambs received vaccinations against ovine pasteruolosis, anthrax, sheep pox, and deworming against internal and external parasites. The animals were housed in individual pens with buckets and feeding troughs in a well-ventilated concrete floor experimental barn.

2.4. Treatments and Experimental Design

The study used a randomized complete block design. To reduce error owing to variations in beginning body weight, the experimental lambs were divided into six blocks of four animals each based on their starting weight. Lambs in each block were randomly assigned to one of the four nutritional regimens listed in Table 1. The basal feed (fodder oat hay) was provided *ad libitum* to all experimental animals based on the previous day's intake, with about 15% rejection and 350 g/day of the vetch species were supplemented in two equal meals at 8: 00 AM and 4: 00 PM in separate feeding troughs. During the trial, all experimental lambs had free access to drinking water and a common salt block.

Table 1. *Dietary treatments.*

Treatments	Fodder oat hay	Vetch species
T1	*Ad libitum*	-
T2	*Ad libitum*	*Vicia sativa*
T3	*Ad libitum*	*Vicia villosa*
T4	*Ad libitum*	*Vicia narbonensis*

2.5. Growth Period

After a 15-day acclimatization phase to the experimental meals and pens, the feeding trial lasted 90 days. Each lambs's daily feed offer and refusal were weighed and documented. Daily dry matter and nutrient intake were obtained by subtracting the feed refused from the feed offered. Samples of Feed offered were collected in each batch, while refusal samples were obtained daily from each lambs and aggregated per animal individually across the trial period, then stored in plastic bags. Sub-samples of offered and refused feed were collected after thorough mixing to determine nutritional composition, and the sub-samples were dried at 60 ℃ for 72 hours in a forced draft oven to prepare for grinding and chemical analysis.

2.6. Feed Conversion Efficiency and Body Weight Change

The animals' body weight was recorded at the start of the feeding trial and 10-day intervals throughout the 90-day feeding period. All animals were weighed in the morning before being fed, using a weighing balance with a sensitivity of 100 grams. The average daily body weight gain was estimated by dividing the difference between final and initial live weights by the number of feeding days. The feed conversion efficiency was calculated by dividing the daily average body weight gain (ADG) by the animal's daily total DM intake.

2.7. Chemical Analysis

Samples of offered and refused feed were crushed to pass through a 1 mm sieve mesh. The DM, ash, and nitrogen contents were determined using [4] methods. The Kjeldahl method was used to quantify total nitrogen (N) content, whereas crude protein (CP) was calculated as N×6.25. [5] techniques were used to determine neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL).

2.8. Data Analysis

The statistical model used for data analysis was:

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

where: Y_{ij} = Response variable; μ = Overall mean; T_i = Treatment effect; B_j = Block effect; E_{ij} = Random error.

The General Linear Model (GLM) technique of SAS [6] version 9.1 was used to perform analysis of variance (ANOVA) on feed intake and body weight change data. When differences between treatment means were significant, the Least Significance Difference (LSD) test was used to identify them.

3. Results

3.1. Nutritional Composition of Feed Offered

The dry matter content of the feeds used for this experiment ranges from 86.2-88.2%. *Vicia sativa* had the highest CP content and lowest NDF, ADF, hemicellulose, and cellulose contents compared to other vetch species, while *Vicia villosa* had the highest NDF, ADF, and ADL. This variation in nutritional composition might impact feed utilization and weight gain.

Table 2. *Nutritional composition of experimental feeds.*

Nutritional composition (%)	Fodder oat	*Vicia sativa*	*Vicia villosa*	*Vicia narbonensis*
DM	86.2	87.3	88.2	87.5
Ash	10.8	17	15.9	12.9
OM	89.2	83	84.1	87.1
CP	8.7	20.2	19.3	18.2
NDF	54.6	37.3	49.4	40.5
ADF	32	28.4	37.6	29.7
ADL	2.9	5.3	7.8	5.6
HC	22.6	8.9	11.8	10.8
Cell	29.1	23.1	29.8	24.1

ADF=Acid Detergent Fiber; ADL=Acid Detergent Lignin; Cell=Cellulose; CP=Crude Protein; DM=Dry Matter; HC=Hemicelluloses; NDF=Neutral Detergent Fiber; OM=Organic Matter.

3.2. Dry Matter and Nutrient Intake

Throughout the experiment, no lambs refused to ingest the dietary supplement (vetch species). The total dry matter intake of lambs supplemented with *Vicia sativa* (T2) is significantly higher ($P<0.05$) than the total dry matter intake of lambs supplemented with *Vicia villosa* (T3) and un-supplemented group (T1). However, the total dry matter intake of lambs supplemented with V*icia sativa* (T2) and *Vicia narbonensis* (T3) is statistically similar though there is slight variation numerically. The total dry matter intake of lambs in T1, T3, and T4 is also statistically similar. Regarding the effect of supplementation of vetch species on total DM consumption, supplementation with *Vicia sativa*, *Vicia villosa* and *Vicia narbonensis* enhanced the total DM intake by 17.9, 6.0, and 9.4% respectively when compared to un supplemented group (T1). The total dry matter intake on live body weight and metabolic body weight basis is similar ($P>0.05$) among treatments. Organic matter intake is higher ($P<0.05$) for those lambs supplemented with *Vicia sativa* (T2) than those lambs supplemented with *Vicia villosa* (T3) and un-supplemented group, while it is similar with those lambs supplemented with *Vicia narbonensis* (T4).

Table 3. *Average daily dry matter and nutrient intake of lambs fed a basal diet of fodder oat hay and supplemented with different species of vetch hay.*

Intake	Treatments					
	T1	T2	T3	T4	SEM	SL
Total DM (g/day)	950.8^{b}	1121.4^{a}	1008.3^{b}	1040.0^{ab}	20.63	*
DM (%BW)	3.2	3.2	3.2	3.2	0.04	Ns
DM (g/Kg W$^{0.75}$)	75.0	77.9	75.6	76.7	0.97	Ns
OM (g/day)	843.3^{b}	981.8^{a}	880.2^{b}	923.8^{ab}	17.92	*
CP (g/day)	99.8^{c}	153.3^{a}	136.1^{b}	134.8^{b}	4.38	***
NDF (g/day)	460.2	520.4	498.2	475.3	9.31	Ns
ADF (g/day)	252.9^{b}	303.9^{a}	304.3^{a}	289.2^{a}	6.13	**
ADL (g/day)	23.8^{d}	39.9^{b}	43.4^{a}	34.0^{c}	1.60	***
HC (g/day)	207.3^{ab}	216.5^{a}	193.6^{ab}	186.1^{b}	4.43	*
Cell (g/day)	229.1^{b}	264.0^{a}	260.8^{a}	254.8^{a}	4.84	*

a, b, c, means with different superscripts in a row are significantly different; ***= (P<0.001); **= (P<0.01); *= (P<0.05); ADF=Acid Detergent Fiber; ADL=Acid Detergent Lignin; BW=Body Weight; Cell=Cellulose; CP=Crude Protein; DM=Dry Matter; HC=Hemicelluloses; NDF=Neutral Detergent Fiber; Ns=non-significant; OM=Organic Matter; SEM=Standard Error of the Mean; SL=Significance Level.

Supplementation with vetch species enhanced crude protein intake by 53.6, 36.4, and 35.1% for lambs supplemented with *Vicia sativa* (T2*)*, *Vicia villosa* (T3), *and Vicia narbonensis* (T4), respectively compared to the un-supplemented group (T1). The lambs who were supplemented with *Vicia sativa* (T2*)* consumed the highest crude protein, whereas the non-supplemented group (T1) consumed the least. The neutral detergent fiber intake did not vary among treatments statistically although there is a slight variation numerically. Total DM intake followed a similar trajectory across all treatments, growing consistently but at a decreasing rate throughout the period (Figure 1).

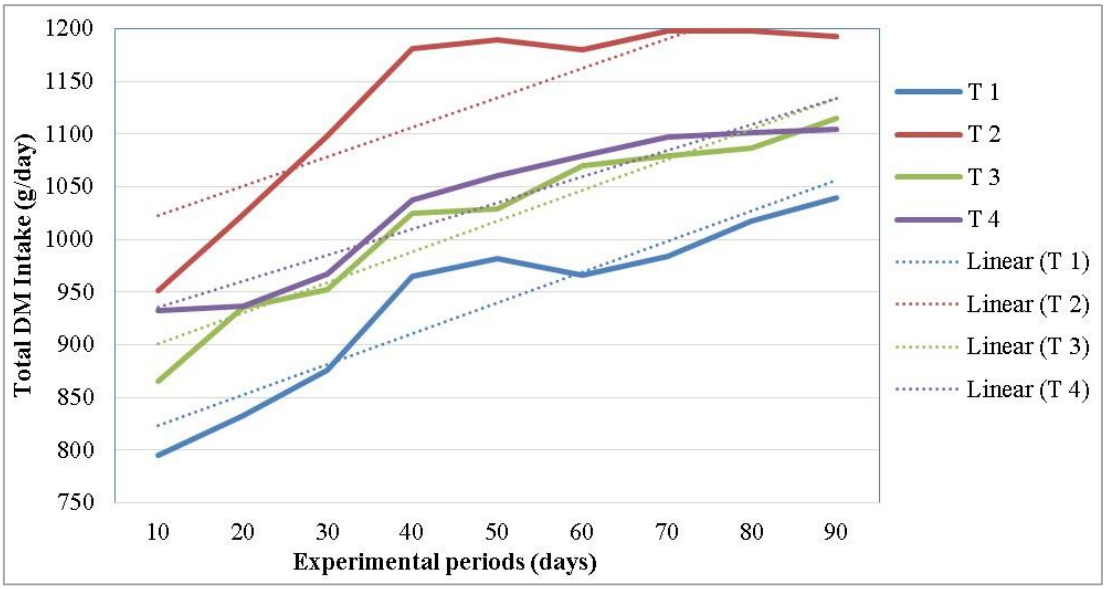

Figure 1. *Trends in total dry matter intake of lambs fed a basal diet of fodder oat hay and supplemented with different species of vetch hay.*

3.3. Feed Conversion Efficiency and Body Weight Change

Initial body weight was similar (P>0.05) among treatments. Final body weight, body weight change, average daily gain and feed conversion efficiency were significantly varied (P<0.001) among treatments with the highest value for those lambs supplemented with *Vicia sativa* (T2) and the lowest value for the un-supplemented group (T1). The growth performance parameters of those lambs supplemented with *Vicia villosa* (T3) and *Vicia narbonensis* (T4) did not vary statistically (P>0.05) though there was a slight variation numerically. Protein conversion efficiency was higher (P<0.05) for those lambs supplemented with *Vicia sativa* (T2) than those lambs supplemented with *Vicia villosa* (T3). The protein conversion efficiency among those lambs supplemented with *vicia sativa* (T2), *Vicia narbonensis* (T4), and the un-supplemented group is similar (P>0.05).

Supplementation of the vetch species enhanced the average daily gain of the lambs by 68.1, 24.8, and 35.2% for those lambs supplemented with *Vicia sativa* (T2), *Vicia villosa* (T3) and *Vicia narbonensis* (T4), respectively, as compared to the un-supplemented group of lambs (T1). Supplementation of the vetch species also enhanced feed conversion efficiency by 42.1, 16.8, and *24.2% for those lambs supplemented with Vicia sativa (T2), Vicia villosa (T3) and Vicia narbonensis* (T4), respectively, as compared to the un-supplemented group of lambs (T1).

Table 4. *Growth performance and feed conversion efficiency of lambs fed a basal diet of fodder oat hay and supplemented with different species of vetch hay.*

Parameters	Treatments				SEM	SL
	T1	T2	T3	T4		
IBW (kg)	21.4	21.3	21.4	21.4	0.13	Ns
FBW (kg)	29.5^{c}	35.0^{a}	31.5^{b}	32.4^{b}	0.51	***
BWC (kg)	8.1^{c}	13.7^{a}	10.2^{b}	11.0^{b}	0.50	***
ADG (g/day)	90.4^{c}	152.0^{a}	112.8^{b}	122.2^{b}	5.53	***
FCE (g ADG/g TDMI)	0.095^{c}	0.135^{a}	0.111^{b}	0.118^{b}	0.004	***
PCE (g ADG/g TCPI)	0.902^{ab}	0.991^{a}	0.823^{b}	0.908^{ab}	0.022	*

a, b, c, means with different superscripts in a row are significantly different; ***= (P<0.001); *= (p<0.05); ADG=Average Daily Gain; BWC=Body Weight Change; FBW=Final Body Weight; FCE=Feed Conversion Efficiency; IBW=Initial Body Weight; ns=not significant; PCE= Protein Conversion Efficiency; SEM=Standard Error of the Mean; SL=Significance Level; TDMI= Total Dry Matter Intake; TCPI= Total Crude Protein Intake.

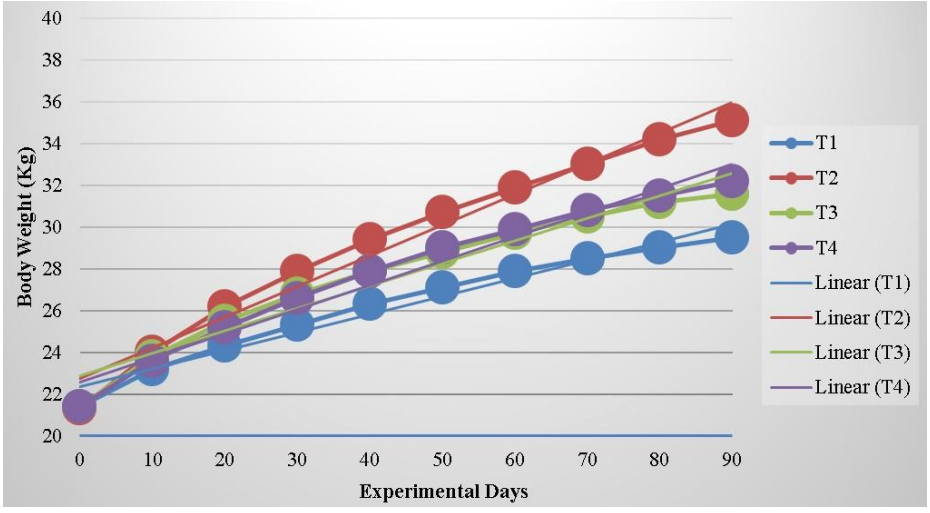

Figure 2. *Trends in body weight change of lambs fed a basal diet of fodder oat hay and supplemented with different species of vetch hay.*

The trends in body weight change revealed a consistent increase during the growing period in all experimental treat-

ments, however, the pace of gain varied (Figure 2). The body weight of the lambs in all treatments increased throughout the trial, however, the rate at which the lambs gained body weight decreased as the experiment progressed.

3.4. Correlations Between Feed Intake and Growth Performance Parameters

Correlations between feed intake and growth performance parameters of Arsi bale lambs fed a basal diet of fodder oat hay and supplemented with three vetch species are given in Table 5. Dry matter intake was positively and strongly (P<0.001) correlated with crude protein intake, organic matter intake, neutral detergent fiber intake, live body weight change, average daily gain, and feed conversion efficiency. Similarly, the growth performance parameters of the lambs were directly correlated with their dry matter and nutrient intake.

Table 5. *Correlations between feed intake and growth performance parameters of lambs fed a basal diet of fodder oat hay and supplemented with different species of vetch hay.*

Parameters	DMI	OMI	CPI	NDFI	BWC	ADG	FCE	PCE
DMI	1.00							
OMI	0.99***	1.00						
CPI	0.83***	0.80***	1.00					
NDFI	0.94***	0.93***	0.75***	1.00				
BWC	0.84***	0.82***	0.88***	0.73***	1.00			
ADG	0.84***	0.82***	0.88***	0.73***	1.00***	1.00		
FCE	0.63***	0.61***	0.78***	0.50**	0.95***	0.95***	1.00	
PCE	0.49*	0.50**	0.30^{ns}	0.38^{ns}	0.71***	0.71***	0.75***	1.00

*= (P<0.05); **= (P<0.01); ***= (P<0.001); ADG= Average Daily Gain; BWC= Body Weight Change; CPI= Crude Protein Intake; DMI= Dry Matter Intake; FCE=Feed Conversion Efficiency; NDFI=Neutral Detergent Fiber Intake; ns=nonsignificant; OMI= Organic Matter Intake; PCE= Protein Conversion Efficiency.

4. Discussion

4.1. Nutritional Composition of Feed Offered

The 86.2-88.2% dry matter contents of the experimental feeds for this study indicate that the feeds used for this experiment were properly cured. The 8.7% CP content of fodder oat hay used in this study was comparable with the CP content of 8.9% reported by [7]. The CP level of the fodder oat hay utilized in this study was higher than the 7% CP required for microbial protein synthesis in the rumen, which can satisfy at least ruminant maintenance needs [8]. *Vicia narbonensis* and *Vicia villosa* have lower CP content than [9], who reported 24.8% and 24.1%, respectively. As the experimental forages were being cured in the field, high CP leaf fractions may have been lost, which could account for the reduced CP content of the feeds recorded in this study.

4.2. Dry Matter and Nutrient Intake

The lambs' complete consumption of vetch species indicates that vetch hay is highly palatable for growing lambs. The higher (P<0.05) total dry matter intake of lambs supplemented with *Vicia sativa* (T2) than the total dry matter intake of lambs supplemented with *Vicia villosa* (T3) and un-supplemented group (T1) indicates that supplementation of *Vicia sativa* has enhanced the utilization of the basal diet as the level of vetch species supplementation was equal among supplemented groups. Feed with a high protein concentration and low fiber content promotes high digestibility and voluntary feed intake, according to [10]. Consequently, the higher CP and lower NDF, ADF, HC, and Cell content of *Vicia sativa* relative to other vetch species may cause the lambs in T2's higher total DM consumption (Table 2).

The rise in total dry matter intake as a result of supplementation may have been caused by the addition of vetch species, which raised the diet's total nitrogen content. This, in turn, probably boosted feed intake and accelerated the rumen's breakdown of the basal diet [11]. The overall DM intake found in this study was significantly higher than the DM intake previously documented for Arsi-Bale lambs by other authors [12-14].

The highest DM intake in T2 and the highest CP content of *Vicia sativa* in comparison to other vetch species may be the causes of the highest CP intake (153.3 g/day) in lambs sup-

plemented with *Vicia sativa* (Table 2; Table 3). The non-supplemented group's lowest documented CP intake (99.8 g/day) may have resulted from both the lack of high protein feed supplementation and the lowest DM intake. According to observations, the total CP intake in this study was significantly higher than the CP intake that other authors had previously reported for Arsi-Bale sheep [12-15]). This may have resulted from the experimental animals' high DM intake and the basal diet's improved CP concentration, which was lower in fiber, more digestible, and had higher CP content than natural grass hay or straw, as was the case in the majority of previous studies.

4.3. Body Weight Change and Feed Conversion Efficiency

The similarity in the initial body weight of the lambs comes from the fact that the lambs were grouped based on their initial body weight at the commencement of the experiment. Increased DM and nutrient intake as well as nutrient digestibility may have resulted from the vetches supplementation, which also improved feed conversion efficiency and body weight metrics compared to the un-supplemented groups. According to [16], consuming a diet with a larger proportion of protein in the diet improves nutrient digestibility, which increases nutrient uptake and supports ADG in animals.

Increases in protein and calorie levels in the diet were also found to improve the ADG and FCE of the animals [7, 13, 17]. Compared to previous reports for Arsi-Bale sheep under various feeding regimes [13, 15, 18], the body weight obtained by feeding sole fodder oat hay (T1) was higher. This suggests that, if harvested at the right stage and stored properly, solo feed oat hay can produce reasonable animal productivity without the need for supplements. It also demonstrates how crucial the quality of the animal's basal feed is to raising productivity levels. The comparatively increased DM and nutritional intake of lambs fed with *Vicia sativa* (T2) may have contributed to their superior performance.

When compared to earlier studies on Ethiopian sheep breeds utilizing various supplement feeds from concentrate and forage sources, the body weight parameters and feed conversion efficiency obtained in the current study by T2 were quite high. *Vicia sativa* is the best-performing for use as supplemental feed in ruminants given roughage-based diets, according to the current research. Though these parameters were not examined in this study, the very high CP intake (Table 3) and vital nutrients like vitamins and minerals found in green feeds like fodder oat and vetch may be responsible for the very high body weight parameters and feed conversion efficiency found in this study.

Thus, this study demonstrated that feeding lambs primarily with fodder oats, and vetch hay is a very high potential feeding strategy that should be given the attention it deserves by producers, policymakers, and livestock experts to specifically enhance lambs productivity under small holder production systems, where these feeds can be produced relatively easily.

4.4. Correlations Between Feed Intake and Growth Performance Parameters

The positive and strong correlation among dry matter and nutrient intake with growth performance parameters shows that DM intake is the major factor influencing nutrient intake and growth rate. [13, 19] also reported a significant and positive correlation of DM intake with growth performance parameters of lambs.

5. Conclusion

From the results of this study, it was concluded that; There was a significant difference between vetch species in terms of feed and nutrient utilization as well as growth performance parameters. Supplementation of *Vicia sativa* (T2) induced the highest dry matter intake. Based on these findings *Vicia sativa* can be recommended as best performing vetch species for use as supplementary feed in the diet of growing lambs.

Abbreviations

ANOVA	Analysis of Variance
FBW	Final Body Weight
GLM	General Linear Model
IBW	Initial Body Weight
LSD	Least Significance Difference
RCBD	Randomized Complete Block Design
SAS	Statistical Analysis System
SEM	Standard Error of Mean
TWC	Total Weight Change
ADG	Average Daily Gain
DM	Dry Matter

Author Contributions

Berhanu Tassew Dassie is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

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