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Effect of adding Berseem to sugar beet leaves silage on productive performance of sheep

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Abstract

This research was conducted to investigate nutritive value, growth performance, economic efficiency, nitrogen balance, digestion coefficient and blood constituents of lambs fed on varying propitiations of silage composed of sugar beet leaves and berseem (SBL+B). with concentrates feed mixture (CFM) plus 1% of live body weight (LBW) wheat straw (WS). The experiment involved 18 growing Saidi lambs with 20.6 ± 0.29 kg as an average LBW. R1 lambs were fed 3% CFM+ 1% of LBW WS as control, R2 lambs were fed 3% CFM+ (SBL+B) silage as 2:1 and R3 were fed 3% CFM+ (SBL+B) silage as 1:1. Digestibility and nutritive values were higher with (SBL+B) silage rations, showing significantly higher ($p < 0.001$) values for nitrogen balance and nitrogen absorption compared with control group R1. By increasing (SBL+B) silage in feeds, growth performance showed substantial ($p < 0.001$) improvements in final weight, total gain, and daily weight gain compared to control. The addition of (SBL+B) silage to rations resulted in a substantial decrease in feed intake as measured by DM, TDN, and DCP ($p < 0.001$), whereas R2 and R3 should be the best feed conversions as measured by DM, TDN, and DCP gain compared to lambs fed the control diet. As a result, lambs fed SBL+B silage had the best conversion and the lowest feed cost compared to lambs fed the control diet. Glu, Tp, Al, Gl, T3, and T4 blood component results were considerably ($p < 0.001$) different from the rest of the constituents (cholesterol, triglycerides, AST, and ALT).

Keywords: Chemical analysis, performance digestibility, nutritive value, sugar but leaves, silage.

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1. Introduction

Sugar beet pulp (SBP) is characterized by its low crude protein (CP) content and high crude fiber (CF) content, as noted by Papadomichelakis *et al*. (2004). Due to its lower lignin content, SBP is easier to digest (Ashry *et al*., 2000). Animal feed becomes more digestible when it contains SBP. According to Sherien (2005) and El-Badawi *et al*. (2003), its energy level rises. Many nations cultivate SB, but they do not use it as animal feed. To enhance the nutritional value of low-quality roughages, researchers used chemical or biological treatments, making them more palatable and easier to digest (Fayed *et al*., 2009; Omer *et al*., 2011). Chemically, roughages were treated with urea to improve feedstuff digestion, urea exposes the structural carbohydrates to microorganisms (Singh, 2004). Biological treatments employ certain microbes to enhance the digestibility of feed materials (Fayed *et al*., 2009; Mohamed and Abou-Zeina, 2008). In Egypt, Sugar beet cultivation has increased from 504,000 feddans (feddan = 4200 m² = 0.420 hectares = 1.037 acres) in 2015 to 597,923 feddans in 2022, producing about 20.964 tons/feddan (Agricultural Research Center, 2015; 2022). The sugar beet industry provides SBP as livestock feed, especially in hot climates, which are the primary source of sugarcane and sugar beets (Biancardi *et al*., 2012). SBP contains high levels of fiber and energy. According to Talha *et al*. (2002), SBP comprises 9% CP, 6% sucrose, 6% DM, 0.5% EE, 4% soluble ash, and 3% insoluble ash. Papadomichelakis *et al*. (2004) also demonstrated that SBP has high amounts of CF and low concentrations of CP. Ashry *et al*. (2000) reported that SBP contains a low level of lignin; therefore, it has highly digestible nutrients. Suliman and Mohamed (2024) worked on sugar beet leaves silages treated with two levels of urea (0.3 and 0.6%) with mechanical treatment (chopped at 1-2 cm length), The findings demonstrated that urea-containing meals with mechanical treatment had improved nutritional values such as TDN, DCP, DE, and ME (kcal) and digestion coefficients of DM, OM, CP, CF, EE, and NFE digestibility. Meanwhile, those containing SBLS showed better nutritive values than those of the control group. Rustam *et al*. (2023) and Omer *et al*. (2013) indicated that SBP is a source of energy as it contains soluble and insoluble NDF, which has the best digestion, growth performance and growth of consumed feed daily. Also, SBP treated with 2% and 4% urea increased daily feed intake, body weight, daily gain, and feed conversion ratio (FCR). Compared to animals that fed Ureated SBP, those given a 4% urea concentration with SBP demonstrated greater weight gain, high profitability, superior economics, and high consumption. Suliman *et al*. (2013) found that out of all the silages, SBLS had the best digestibility coefficients, nutritional values, nitrogen absorption and nitrogen balance, daily weight gain (gm), total weight gain (Kg), feed conversion as kg DM, TDN, and DCP/kg gain, economical revenue, and efficiency percentage. In contrast, the lowest values were recorded by silage of green maize stems, while the intermediate values were observed by diets containing sugar beet leaves silage. On the contrary, other studies on SBLS with urea (0.25 and 0.50% urea SBLS) with mechanical treatment (chopped and unchopped), Deraz *et al*. (2016) found that while those having SBLS showed superior nutritional value as compared to the control group, those including OM, DM, and NFE had better digestibility coefficients but poor digestibility coefficients as CF, CP, and EE and nutritive values as TDN. Similar findings were observed by Ahmed *et al*. (2003) and Gaafaar *et al*. (2011). However, when compared to the control group, the nitrogen balance findings were highest for lambs given urea treated and mechanical SBLS feeds. These outcomes were consistent with Suliman and Mohamed (2024) findings about the best digestibility, nutritional values, nitrogen balance, total and daily gain, feed conversion and consumption, and cost efficiency of aerated and mechanical SBLs. This study's objective was to ascertain how (SBL+B) silage affected approximate chemical analysis, digesting coefficients, nutritional values, nitrogen balance, growth performance and efficiency, and the cost-effectiveness of different blood and diet components.

2. Materials and methods

From April to August 2023, this research was performed at the Animal Production Research Station in Mallawi, which is a part of the Animal Production Research Institute, Agriculture Research Center, Ministry of Agriculture Egypt. Digestibility experiments were carried out to estimate digestion coefficients, feeding values, and nitrogen balance, while growth performance experiments were conducted to estimate feed consumption and conversion, daily and total gain, economic efficiency, and blood constituents in Saidi lambs fed on sugar beet leaves and berseem (SBL+B) silage levels of as 2:1 and 1:1.

2.1. Collection of sugar beet leaves

2.1.1. Making silage

When sugar beets were harvested, sugar beet leaves (SBL) were collected and wilted for 48 hours to reduce the moisture content from 60% to 70% before ensiling. The wilted sugar beet leaves were then mixed with berseem and ensiled in the halls with diameters of 2 x 1.75 x 1.25 meters. In addition, 1% minerals, 1.4% limestone, and 5% molasses were added. After being covered with a plastic sheet, silages were compacted by foot workers, firmly pressed with a 25 cm soil layer, and then ensiled or stored for 45 days.

2.2. Experimental animal

Eighteen Saidi male lambs within seven months of age with 20.63 ± 0.29 kg live body weight (LBW), were selected for the growth performance trial. In addition, nine mature rams with an average 45 kg LBW were chosen for the digestibility trial as a Latin square design (3x3).

2.3 Growth performance experiment

Three groups of six Saidi male lambs

each were formed from the selection of eighteen Saidi male lambs. The lambs in the control group (R1) received 1% live body weight wheat straw (WS) in addition to a 3% concentrate feed mixture (CFM). Lambs in Group R2 were given 3% CFM plus sugar beet leaves and berseem (SBL+B) silage as 2:1 *ad libtum*. Lambs in Group R3 were fed 3% CFM + (SBL+B) silage as 1:1 *ad libtum*. Rations were provided twice a day at 9:00 AM and 4:00 PM in two equal quantities; water, block minerals, and vitamins were available freely for lambs during the experimental period; lambs were weighed every two weeks in the morning before nutrition and drinking during the empirical period (120 days).

2.4 Digestibility experiment

Nine mature Saidi rams with an average LBW of 45 kg were used in digestibility trials as a Latin square design, with three rams for each treatment. Each animal was fed by one of the previous rations. Each trial continued for 21 days, with fourteen (14 days) as a preliminary period and seven days as the main period. Rations were offered twice daily in two equal portions at 9:00 am and 4:00 pm; water and block minerals and vitamins are always freely available for rams. Every day during the main period, urine and feces were weighed and collected. The entire amount of feces was then sent to a dehydration oven set at 60°C for 24 hours. Dried samples were taken for analysis. Also, 10 ml of acidified urine daily was kept in the refrigerator in plastic until analysis.

2.5 Economical study

The cost of one kilogram of lambs' LBW was assumed to be 150 Egyptian pounds (LE) in order to compute the economic research for experimental rations; the price of one kg dry matter intake from CFM was 9.70, 9.64, and 9.64 for R1, R2 and R3 respectively, but the price of total gain for lambs was 2937, 3252, and 3378 LE, respectively, for lambs fed R1, R2 and R3 respectively. When the lambs reached marketable weight (45–50 LBW), the experiment was completed.

2.6 Blood constituents

Blood samples were obtained three hours after the morning meal on the final day of the trial. Using heparinized tubes, each sample was extracted from the jugular vein, centrifuged for 10 minutes at 3000 rpm to separate the blood plasma, and then stored in a dry, clean glazier at -18°C until analysis.

2.7 Biochemical analysis of blood plasma

Siest *et al*. (1981) reported that plasma glucose (g/dL) was measured calorimetrically, total protein (g/dL) was measured as Armstrong and Carr (1964) described and Doumas *et al*. (1971) measured albumin (g/dL) and globulin (g/dL) by subset action from total protein, but the A/G ratio was calculated, urea (mg/dL) was measured using Curtius and Marce (1972) method, alanine aminotransferase (ALT) (units/dL) of plasma, and aspartate aminotransferase (AST) was measured calorimetrically according to Reitman and Frankel (1957). Triglycerides and cholesterol were also measured in accordance with Young, (2001).

2.8 Laboratory analysis

Urine, feces, and feed were analyzed in accordance with A.O.A.C. (1999).

2.9. Statistical analysis

One-way ANOVA was used for statistical analysis, and the data are shown as mean ± SE. The three experimental diets were tested for differences using the general linear model. According to the SAS Institute (2003), P-values below 0.05 were regarded as statistically significant. The significant variations between means were examined using Duncan's test (Duncan, 1955). The following formula was used to calculate analytical analysis:

$$Yij = M + Ti + Eij$$

Where: Yij = experiment observations; M = the overall mean; Ti = the effect of dietary treatment; i = 1 = control, 2 = CFM + (SBL+B) silage as 2:1; 3 = CFM + (SBL+B) silage as 1:1; Eij = the experimental error.

3. Result and discussion

3.1 Approximate chemical analysis

Table (1) presents the estimated composition of experimental diets and their chemical composition on a dry matter basis. When comparing sugar beet leaves silage (SBLS) with the concentrate feed mixture (CFM), SBLS showed higher average concentrations of CP and ash (15.48% and 29.98% versus 14% and 11.99%, respectively). In contrast, CFM had greater contents of organic matter (OM) and nitrogen-free extract (NFE), at 88.01% and 57.43% compared to 70.02% and 37.79% in SBLS. The inclusion of SBLS influenced the CP and ash levels in the experimental diets.

Table (1): Chemical analysis of tested feedstuffs and experimental rations used in feeding lambs.

Items	DM%	Chemical analysis % (on DM basis)						
		OM	CP	CF	EE	NFE	Ash	GE, MJ/kg
CFM	93	88.01	14	14.08	2.5	57.43	11.99	1.71
WS	88.90	89.01	2.45	40	1.5	45.06	10.99	1.68
(SBL+B) silage as 2:1	27.28	69.85	15.25	15	2.15	37.45	30.15	1.38
(SBL+B) silage as 1:1	31.06	70.02	15.48	14.40	2.35	37.79	29.98	1.39
Calculated composition of the experimental rations (%)								
R_1		88.81	11.50	20	2.31	55	11.19	1.71
R_2		84.72	14.50	14.20	2.30	53.72	15.28	1.65
R_3		84.89	14.79	14	2.25	53.85	15.11	1.65

Gross energy MJ /Kg DM= 0.0226 CP + 0.0407 EE + 0.0192 CF + 0.0177 NFE (MAAf, 1975), concentrate feed mixture (CFM) 37% wheat bran. 40% corn, 17% sunflower meal solvent extract, 3% molasses, 2% limestone powder and 1% common salt, straw (WS), sugar beet leaves and berseem (SBL+B).

Silages typically have lower NFE levels than CFM, and SBLS is characterized by higher CP and lower CF contents (Suliman, 2001). Moreover, as a source of structural carbohydrates, silages generally contain more CF and less NFE compared to concentrates (Deraz *et al*., 2016; MARSS, 1997). Part of the NFE is also lost through fermentation during the ensiling process. These results align with those reported by Suliman *et al*. (2013) and Suliman and Mohamed (2024). Additionally, Bendary *et al*. (2000) observed that the ash content in SBLS averaged 30.07%, while in sugar beet tops silage (SBTS) it reached 30.21%. They suggested that this high ash content could be due to soil contamination, a conclusion also supported by Valderrama and Anrique (2011).

3.2. Nutrient digestibility

Table (2) presents the digestion coefficients of experimental rations. All rations showed significant differences (P < 0.001) in nutrient digestibility. Rations containing SBL+B silage specifically R2 and R3 demonstrated higher dry matter (DM) digestibility compared to the control ration (R1), with values of 67.96%, 70.80%, and 61.70% for R2, R3, and R1, respectively. A similar pattern was observed in the digestibility of OM and CP. OM digestibility increased to 72.50% in R2 and 76.30% in R3, versus 69.20% in R1. CP digestibility followed suit, with values of 68.95% in R2 and 71.80% in R3, compared to 60.50% in R1. These findings are consistent with those of Ahmed *et al*. (2003), who reported improved DM and OM digestibility with higher levels of corn stover silage. Similarly, Deraz *et al*. (2016) found parallel trends. Increases in urea levels also significantly enhanced the digestibility of all nutrients (P < 0.001), potentially due to the addition of molasses, which improved palatability, and mineral additives, which contributed to a more nutritionally complete silage (Weiss and Underwood, 2009). Comparable results were reported by Suliman *et al*. (2013) and Suliman and Mohamed (2024).

Table (2): Digestion coefficients and feeding values for sugar beet leaves and berseem silage tested rations on different levels.

Items	Treatments			MSE	P- Value
	R1	R2	R3		
Digestion coefficients (%)					
Dry Matter	61.70 ^{c}	67.95^{b}	70.80^{a}	0.40	<.0001
Organic Matter	69.20 ^{c}	72.50^{b}	76.30 ^{a}	0.20	<.0001
Crud Protein	60.50 ^{c}	68.95^{b}	71.80 ^{a}	0.23	<.0001
Crud Fiber	59.50 ^{c}	65.34 ^{b}	69.01 ^{a}	0.50	<.0001
Either Extract	73.50 ^{c}	79.20^{b}	82.98 ^{a}	0.64	<.0001
Nitrogen Free Extract	67.40 ^{c}	75.23^{b}	78.23 ^{a}	0.60	<.0001
Nutritive values					
Total Digestible Nutrients(kg)	59.80 ^{c}	64.95 ^{b}	68.60 ^{a}	0.48	<.0001
Digestible Crude Protein(gm)	8.30 ^{c}	9.50 ^{b}	11.10 ^{a}	0.20	<.0001
Digestible Energy (DE)(kcal)	1314.8 ^{c}	1377.50 ^{b}	1449.70 ^{a}	4.40	<.0001
Metabolic Energy (ME)(kcal)	1078.14^{c}	1129.55 ^{b}	1188.76 ^{a}	3.79	<.0001

a, b, and c Means within the same row with different superscripts differ(P<0.05) and (P<0.01). DE and ME calculated according to MAAF (1975) Digestible Energy = Digestible organic matter x 19, Metabolic Energy = DE x 0.82.

3.3. Nutritive value

The nutritional value results, presented in Table (2), reflected the trends observed in digestibility coefficients, with all changes among rations being highly significant (P < 0.001). According to Suliman and Mohamed (2024), the total digestible nutrients (TDN), digestible crude protein (DCP), digestible energy (DE), and metabolizable energy (ME, kcal) are strongly associated with improved DCP and other nutrients. Rations containing SBL+B silage showed the highest nutritional values across all indicators (TDN, DCP, DE, and ME) when compared to the control diet. These differences were statistically significant (P < 0.001). The observed improvements can be attributed to the superior chemical composition of SBL+B silage (as shown in Table 1), as well as the inclusion of berseem, molasses, and minerals, which likely enhanced palatability and nutrient utilization. The enhanced nutrient digestibility coefficients from Table (2) further support these results. These findings are in agreement with those reported by Suliman and Mohamed (2024) and Suliman *et al*. (2016), who also found significant improvements in feed nutritional value with the inclusion of silage and supplemental ingredients.

3.4 Nitrogen balance

Table (3) presents the results of nitrogen balance (NB), nitrogen absorption (NA), total nitrogen intake (TNI), urinary nitrogen (UN), fecal nitrogen (FN), total nitrogen excretion (TNE), the NB-to-NA ratio, and the microbial biomass nitrogen-to-total nitrogen intake ratio (MB/TNI). All parameters showed highly significant differences among rations (P < 0.001), except for the NB/NA ratio. Rations containing SBL+B silage, specifically R2 and R3, showed significantly improved nitrogen metabolism compared to the control ration (R1).

Table (3): Nitrogen balance for different levels of sugar beet leaves and berseem silage fed to lambs.

Item	Treatment			MSE	P- Value
	R1	R2	R3		
Total Nitrogen Intake (TNI)	22.00 ^{c}	27.70 ^{b}	30.10 ^{a}	0.20	<.0001
Nitrogen Fecal	6.10 ^{b}	8.80 ^{a}	10.30 ^{a}	0.19	<.0001
Nitrogen Urinary	3.37 ^{b}	4.40 ^{a}	4.50 ^{a}	0.18	0.0003
Total Nitrogen Execration	9.47 ^{c}	13.20 ^{b}	14.80 ^{a}	0.31	<.0001
Nitrogen Balance (NB)	12.23 ^{c}	14.50 ^{b}	15.30 ^{a}	0.34	<.0001
Nitrogen Absorption (NA)	15.90 ^{c}	18.90 ^{b}	19.80 ^{a}	0.30	<.0001
NB/NA%	78.79 ^{c}	76.72 ^{b}	77.29 ^{a}	0.64	0.1389
NB/TNI%	56.97 ^{a}	52.36 ^{b}	50.83^{b}	0.85	0.0027

a, b and c Means within the same row with different superscripts differ(P<0.05) and (P<0.01).

Ration R3 recorded the highest values across most indicators, followed by R2, while R1 consistently had the lowest values. This trend suggests improved nitrogen utilization in rations supplemented with SBL+B silage. These improvements can be attributed to the enhanced utilization of CP, increased DCP content, and the contribution of urea to microbial protein synthesis. The effects are further supported by the improved chemical composition and digestibility values shown in Tables 1 and 2, particularly in the 2:1 and 1:1 SBL+B silage combinations. These findings are consistent with the results reported by Suliman *et al*. (2013), Deraz *et al*. (2016), and Suliman and Mohamed (2024), who also observed improved nitrogen efficiency with silage-based diets.

3.5. Feeding experiment

3.5.1 Average daily gain

Table (4) presents the performance outcomes of the experimental rations, revealing highly significant differences ($P < 0.001$) among the three groups in final body weight (FBW), total gain (TG), and daily gain (DG). Rations supplemented with SBL+B silage (R2 and R3) showed markedly better performance metrics compared to the control ration (R1). Specifically, the final body weights were 45.46 kg for R2, 43.44 kg for R3, and 40.08 kg for R1. Total gain (TG) was 22.52 kg in R3, 21.68 kg in R2, and 19.58 kg in R1. Daily gain (DG) followed a similar trend: 0.188 kg/day in R3, 0.181 kg/day in R2, and 0.163 kg/day in R1. These differences were statistically significant ($P < 0.001$). The enhanced growth performance in R2 and R3 can be attributed to more efficient utilization of CP, energy from molasses, added minerals, and improved diet palatability. The inclusion of berseem and balanced silage composition likely promoted better feed intake, improved nutrient digestibility, and higher levels of TDN, DCP, and ME. These factors contributed to enhanced fermentation processes and microbial protein synthesis, leading to better body weight gain. These findings are consistent with previous research by El-Nahas *et al*. (2009), Suliman *et al*. (2013), and Suliman and Mohamed (2024). Additionally, Charmley (2001) reported a positive correlation between body weight gain and the solubility of silage protein, further supporting these results.

3.5.2 Feed intake and feed conversion

Table 4 presents the results for feed intake and feed efficiency (feed conversion ratio). Significant differences ($P < 0.001$) were observed across rations in terms of intake of dry matter (DM), total digestible nutrients (TDN), and DCP. Lambs fed rations containing SBL+B (R2 and R3) consumed lower amounts of DM compared to the control group (R1), with values of 120.50 kg (R3), 123.40 kg (R2), and 135.43 kg (R1), reflecting reductions of 11.02% and 8.88% in favor of R3 and R2, respectively. Despite lower DM intake, R3 and R2 groups showed higher TDN and DCP consumption. Specifically, TDN intake was 83.15 kg (R3), 81.21 kg (R2), and 80.99 kg (R1), while DCP intake was 13.38 kg (R3), 11.72 kg (R2), and 11.24 kg (R1). These findings are in line with those reported by Gaafaar *et al*. (2011), who found that DCP intake increased with higher levels of urea-treated SBLS ($P < 0.05$). Feed conversion ratios, measured as kg of DM, TDN, and DCP per kg of gain, also showed significant improvement ($P < 0.001$) in R2 and R3 compared to the control group. The best feed efficiency was observed in lambs fed rations containing SBL+B silage at 2:1 and 1:1 ratios. These improvements can be attributed to lower feed intake, better nutrient utilization, and enhanced digestibility. The primary factor influencing improved feed conversion was efficient feed consumption, particularly in terms of DM, TDN, and DCP. This efficiency likely contributed to the superior growth performance observed in lambs receiving SBL+B silage. Lambs fed CFM combined with SBL+B silage ad libitum recorded the highest ($P < 0.001$) final body weight, total gain, and daily gain compared to those on the control ration (R1). This may be due to more effective rumen fermentation, increased production of volatile fatty acids, ammonia (NH_3), and microbial protein, which support higher growth rates (El-Bedawy, 1994). These results are supported by previous studies including Suliman *et al*. (2013), Suliman et al. (2016), Rustam *et al*. (2023), and Suliman and Mohamed (2024). Furthermore, Abd El Tawab *et al*. (2017) found that microbial treatment of sugar beet leaf silage reduced oxalate content and enhanced rumen microbial activity, thereby improving the nutritive value and digestibility of the feed.

Table (4): Growth performance and feed efficiency of sugar beet leaves and berseem silage on different levels fed to lambs .

Items	Treatment			MSE	P-Valus
	R_1	R_2	R_3		
Initial body weight (kg).	20.50	20.48	20.92	0.29	0.4417
Final body weight (kg).	40.08 ^{c}	42.16^{b}	43.44 ^{a}	0.31	<.0001
Total gain (kg).	19.58 ^{c}	21.68 ^{b}	22.52 ^{a}	0.09	<.0001
Daily gain (kg).	0.163 ^{c}	0.181 ^{b}	0.188 ^{a}	0.001	<.0001
Feed consumption/ kg					
dry matter(g)	135.43 ^{a}	123.40 ^{b}	120.50^{c}	0.00	<.0001
Total Digestible Nutrients(g)	80.99^{c}	81.21 ^{b}	83.15^{a}	0.00	<.0001
Digestible Crude Protein(g)	11.24 ^{c}	11.72 ^{b}	13.38 ^{a}	0.00	<.0001
Feed Efficiency (kg/ kg gain)					
dry matter	6.92 ^{a}	5.69 ^{b}	5.35 ^{c}	0.03	<.0001
Total Digestible Nutrients	4.14 ^{a}	3.70 ^{b}	3.69^{C}	0.02	<.0001
Digestible Crude Protein	0.574 ^{b}	0.541 ^{c}	0.594 ^{a}	0.002	<.0001

[a, b and c] Means within the same row with different superscripts differ($P<0.05$) and ($P<0.01$). R1= 3% CFM+ 1% of LBW WS as control, R2 = 3% CFM+ (SBL+B) silage as 2:1 ad libtum and R3= 3% CFM+ (SBL+B) silage as 1:1 ad libtum.

3.6 Economical study

Table (5) presents the economic efficiency outcomes of the experimental rations. The highest feeding cost was recorded for the control ration (R1), at 1389.75

LE/ton, while rations containing SBL+B silage (R2 and R3) had significantly lower feeding costs of 1267.00 LE/ton and 1231.53 LE/ton, respectively. This difference was primarily due to the higher quantity and cost of concentrate feed mixture (CFM) consumed in the control group. In contrast, R2 and R3, which incorporated SBL+B silage, not only lowered feed costs but also yielded higher daily weight gains, resulting in better economic returns. The total gain returns were 2146.47 LE for R3, 1985.00 LE for R2, and 1547.85 LE for R1. Consequently, economic efficiency (measured as the ratio of gain return to feed cost) was highest in R3 (174.29), followed by R2 (156.67) and R1 (111.33). Compared to the control group, R2 and R3 achieved improvements in gain returns of 28.29% and 38.73%, respectively. Economic efficiency was enhanced by 40.71% in R2 and 56.55% in R3 relative to R1. These gains were mainly due to the lower cost of silage compared with the CFM and wheat straw (WS)-based control ration, combined with better performance outcomes. These findings are consistent with previous studies by Deraz *et al*. (2016), Suliman *et al*. (2016), Rustam et al. (2023), and Suliman and Mohamed, (2024), all of which reported similar improvements in economic efficiency from silage-based diets.

Table (5): Economical efficiency for different levels of experimental rations fed to lambs.

Items	Experimental treatments		
	R1	R2	R3
Total dry matter intake (kg)	135.43	123.4	120.5
Coast of concentrate feed mixture intake(LE)	1314.75	1205.04	1162.5
Coast of rough (LE)	75	61.93	69.03
Total feed coast (B)	1389.75	1267	1231.53
Total gain (kg)	19.58	21.68	22.52
Price of kg gain (LE)	150	150	150
Price of total gain (A)	2937	3252	3378
Return of gain (LE)	1547.25	1985	2146.47
Economic efficiency % Y = A – B / B	111.33	156.67	174.29

R1= 3% CFM+ 1% of LBW WS as control, R2 = 3% CFM+ (SBL+B) silage as 2:1 adlibtum and R3= 3% CFM+ (SBL+B) silage as 1:1 adlibtum.

3.7 Biochemical constituents of blood

The results of blood constituents are presented in Table 6 and revealed significant differences among the experimental rations in several blood traits. Specifically, there were significant differences ($P < 0.0003$, 0.0007, 0.02, and 0.05) in glucose (GL, g/dL), total protein (TP, g/dL), albumin (AL, g/dL), and globulin (GLB, g/dL) concentrations, respectively. Rations containing SBL+B silage (R2 and R3) showed significantly higher values compared to the control ration (R1). Glucose levels were 96.33 g/dL in R2 and 99.00 g/dL in R3, compared to 81.00 g/dL in R1. Total protein values followed a similar trend: 7.90 g/dL (R2), 8.23 g/dL (R3), and 6.73 g/dL (R1). Albumin concentrations were 4.00 g/dL (R2), 4.20 g/dL (R3), and 3.50 g/dL (R1), while globulin levels were proportionately higher in R2 and R3. These improvements can be attributed to the nutritional composition of the SBL+B silage rations, including molasses, minerals, berseem, and the effects of fermentation during ensiling, which influence metabolic profiles and blood constituents. Thyroid hormones also responded positively to SBL+B inclusion. Triiodothyronine (T3) levels were 156.73 ng/dL (R2), 165.93 ng/dL (R3), and 116.67 ng/dL (R1), while thyroxine (T4) concentrations were 7.43 ng/dL (R2), 8.20 ng/dL (R3), and 5.50 ng/dL (R1). These increases may result from higher digestibility of nutrients (e.g., TDN), higher nitrogen-free extract (NFE), and lower fiber content in SBL+B silage, which likely enhanced propionic acid production. This, in turn, supports increased gluconeogenesis and energy availability (Eriksson, 2003). Higher microbial protein synthesis due to improved fermentable substrates in SBL+B silage also likely contributed to the elevated levels of total protein, albumin, and globulin (Mansour and Al-Zahar, 2018).

Table (6): Blood constitutes for lambs fed different levels of experimental rations.

Items	Experimental treatments			MSE	P-Valus
	R1	R2	R3		
Glucose (g/dl)	81.00^{b}	96.33^{a}	99.00^{a}	1.38	0.0003
Total protein (g/dl)	6.73^{b}	7.90^{a}	8.23^{a}	0.14	0.0007
Albumin (g/dl)	3.50^{b}	4.00^{a}	4.20^{a}	0.15	0.02
Globulin (g/dl)	3.23^{b}	3.90^{ab}	4.03^{a}	0.11	0.05
Urea (g/dl)	38.67	37.67	39.67	1.15	0.421
Total cholesterol (mg/dl)	78.00	77.50	77.00	1.30	0.773
Triglyceride (mg/dl)	116.33	114.00	114.67	1.86	0.550
AST (units/dl)	20.67	20.00	20.33	1.25	0.903
ALT (units/dl)	104.67	103.67	106.00	9.43	0.988
T3 (ng/dl)	116.67^{c}	156.73^{b}	165.93^{a}	1.87	<.0001
T4 (ng/dl)	5.50^{c}	7.43^{b}	8.20^{a}	0.12	<.0001

A, b, c and d means with different superscripts on the same row are different at ($P<0.05$) and ($P<0.01$).

The increased microbial protein production raises the concentration of true protein nitrogen (TPN) in the rumen, improving amino acid absorption and overall protein status. On the other hand, no significant differences ($P > 0.05$) were observed among the rations for other blood parameters, including urea (g/dL), alanine transaminase (ALT, units/dL), aspartate transaminase (AST, units/dL), triglycerides (mg/dL), and total cholesterol (mg/dL), confirming the absence of negative metabolic effects from the experimental diets (Alert *et al*., 1994).

4. Conclusion

Recent findings in this study suggest that rations containing sugar beet leaves and berseem (SBL+B) silage improved approximate chemical analysis, experimented rations, digestibility efficiency, nutritive values, nitrogen balance, growth performance, feed conversion, daily gain, and economical efficiency. Therefore, sheep can be fed on sugar beet leaves and berseem silage as 2:1 and 1:1.

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