

Effect of Feeding Different Legume Straw Types on Feed Intake and Weight Gain in Turkish Crossbred Lambs

Abdul Khaliq Sahes^{✉1}, Abdul Ghafoor Moradi², Abdul Jamil Ghanizada³, Hamidullah Paiman⁴

^{1,2,3,4} Kabul University, Department of Animal Sciences, Agriculture Faculty, Kabul, Afghanistan

✉ E-mail: abdulkhaliqsahes2022@gmail.com (corresponding Author)

ABSTRACT

This study evaluated the effects of different types of agricultural straw on feed intake and body weight gain in Turkish crossbred ewe lambs. The objective was to assess the effects of diets containing wheat straw, mung bean straw, Zaghr straw, and bean straw on dry matter intake, body weight gain, feed conversion ratio (FCR), and feed conversion efficiency (FCE). The experiment lasted 28 days and involved 16 crossbred ewe lambs, randomly allocated to four dietary groups of four lambs each. Groups 1, 2, 3, and 4 received wheat straw, mung bean straw, Zaghr straw, and bean straw, respectively. Feed intake and body weight were recorded throughout the experimental period, and the data were analyzed using analysis of variance (ANOVA). Differences among treatment means were evaluated using the least significant difference (LSD) test. The results showed a statistically significant difference in body weight gain among the experimental groups ($P < 0.01$). The highest total weight gain was observed in Group 4, which received the bean-straw-based diet, followed by Groups 1, 2, and 3. Dry matter intake did not differ significantly among the groups ($P > 0.05$). The FCR values for Groups 1–4 were 13.51, 20.22, 32.98, and 7.07, respectively, with Group 4 showing the lowest and therefore most efficient FCR. The corresponding FCE values were 7.40%, 4.95%, 3.03%, and 14.15%, respectively. Overall, the bean-straw-based diet resulted in the highest body weight gain and feed efficiency under the conditions of this study.

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INTRODUCTION

Feed availability and cost are major constraints on livestock production, particularly in arid and semi-arid regions. In Afghanistan, where livestock production is a key part of rural livelihoods, seasonal forage shortages and rising conventional feed costs can limit animal productivity. Agricultural residues and by-products may provide locally available and

relatively inexpensive feed resources for ruminants, particularly when conventional forage resources are limited (Ali et al., 2026; Azimi et al., 2025).

Ruminants can utilize fibrous agricultural residues through microbial fermentation in the rumen. Consequently, appropriate use of crop residues can reduce feeding costs while providing a nutrient source for sheep and other ruminants (Eynipour et al., 2019; Kamal et al., 2025). The nutritive value of agricultural residues depends largely on their chemical composition, digestibility, and palatability. In particular, crude protein, fiber concentration, energy content, and mineral composition can influence voluntary feed intake and animal performance (Desta, 2023).

Legume residues are of particular interest because they may contain greater concentrations of crude protein and other nutrients than cereal straws. Previous studies have reported differences in the chemical composition and nutritional value of legume and cereal residues. For example, Desta (2023) reported that mung bean straw contained more crude protein and total digestible nutrients and less crude fiber than wheat straw. Similarly, studies evaluating the replacement of wheat straw with legume residues have reported improvements in digestibility, feed intake, or body weight gain in lambs (Eynipour et al., 2019).

The chemical composition of agricultural residues can also vary according to crop type, genotype, environmental conditions, and management practices (FAO, 2009). Therefore, evaluating locally available residues under specific production conditions is important before recommending their use in practical feeding systems. In the Barkah district of Baghlan Province, wheat straw, mung bean straw, bean straw, and Zaghr straw are locally available agricultural residues that may be used as diet components for sheep (Shaiq et al., 2026). However, their effects on feed intake and body weight gain when incorporated into locally formulated diets have not been adequately evaluated under the conditions of northern Afghanistan (Azimi et al., 2025).

Previous research has mainly focused on replacing wheat straw with legume residues. For instance, Eynipour et al. (2019) reported that replacing wheat straw with mung bean straw increased feed intake in lambs. However, the effect on overall weight gain was not significant during the complete experimental period. Other studies have reported significant improvements in digestibility and weight gain when bean residues were used in lamb diets (Negesse et al., 2007). These findings suggest that the type of agricultural residue used in a diet may influence animal performance; however, differences in diet formulation, animal characteristics, experimental duration, and environmental conditions may contribute to variation among studies (Kamal et al., 2025).

Zaghr straw is another locally available agricultural residue reported to have potential value as a feed resource (El Shaer, 2010). Previous observations indicated that its acceptability to sheep may depend on its form and processing. However, information regarding the performance of crossbred ewe lambs fed diets containing Zaghr straw

compared with diets containing other locally available straws remains limited (Eynipour et al., 2019; Desta, 2023).

Therefore, the present study was conducted to evaluate the effects of four locally available straw types—wheat straw, mung bean straw, Zaghr straw, and bean straw—on dry matter intake and body weight gain of Turkish crossbred ewe lambs. The study also assessed feed conversion ratio and feed conversion efficiency under the formulated dietary treatments during a 28-day experimental period.

MATERIALS AND METHODS

Study Area

This study investigated the effects of feeding wheat straw, mung bean straw, bean straw, and Zaghr straw on feed intake and weight gain in crossbred lamb ewes. The straws used in this study included red wheat straw, speckled bean straw, sour mung bean straw, and Zaghr straw, all sourced from the Barkah district of Baghlan province. To date, no specific research has been conducted on this topic in Afghanistan, and no reference material regarding this subject was available in the country. Therefore, this study was conducted in the Barkah district of Baghlan province during the months of Dalwa and Hut 1401 for a total duration of 31 days, including 3 days for adaptation and 28 days of experimental feeding of 16 crossbred lamb ewes, 11 months old. The lambs were fed the aforementioned straws twice daily, in the morning and evening, and barn temperature and humidity were monitored using a thermometer.

Experimental Animals and Health Management

A total of 16 Turkish crossbred ewe lambs, approximately 11 months of age and of similar body condition, were selected from the flock. The animals had an average initial body weight of 33.82 ± 0.71 kg. Before the experiment began, the animals were visually examined to assess their general health. Animals showing apparent signs of disease or abnormal health status were excluded from the experiment.

The lambs were individually identified and housed in 16 separate partitions within a single 6×5 m barn. Each animal had access to its own feeding and resting space. The barn was cleaned and disinfected before the experiment began. Barn temperature and relative humidity were monitored throughout the study.

During the first three weeks, the average morning and evening temperature was 16.06°C , with an average relative humidity of 74.35%. During the final week, the average temperature increased to 19.93°C , while relative humidity decreased to 66.35%. The animals were observed daily for general health, feed intake, and any visible signs of illness or abnormal behavior.

Feeding Management

The experimental diets were formulated using wheat straw, mung bean straw, Zaghr straw, and bean straw as the straw sources for Groups 1, 2, 3, and 4, respectively. The animals were

fed twice daily, in the morning and evening, throughout the experimental period. The formulated feed was offered individually to the animals according to their assigned dietary treatment. Fresh drinking water was made available to the animals throughout the feeding period.

Feed offered and feed refusals were recorded to determine daily dry matter intake. We recorded the amount of feed offered before feeding, collected the remaining feed, and weighed it before the next feeding. Feed intake was calculated from the difference between the amount of feed offered and the amount refused.

Grouping and Assignment of Lambs

The 16 lambs were randomly allocated to four dietary treatment groups using a lottery-based randomization procedure, with four lambs assigned to each treatment group. Initial body weight was recorded at 6:30 AM before the morning feeding. The four dietary treatments were assigned as follows: Group 1 received wheat straw, Group 2 received mung bean straw, Group 3 received Zaghr straw, and Group 4 received bean straw.

The animals remained on their assigned dietary treatments throughout the experimental feeding period. All animals were managed under similar housing and environmental conditions, and all treatment groups followed the same feeding schedule.

Experimental Feeds and Their Preparation

Wheat straw, an agricultural by-product of cereal production, is abundantly available in Afghanistan, particularly in the Barkah District of Baghlan Province. In the present study, red wheat straw was selected as one of the experimental roughage sources. In addition, straws from leguminous crops were included, namely speckled bean straw (*Phaseolus* spp.) and sour mung bean straw. Zaghr straw was also included as an experimental roughage source.

Alfalfa, mung bean straw, bean straw, and Zaghr straw were obtained locally from the Barkah District to meet the experimental animals' requirements and transported to the experimental site. Barley grain and sorghum grain used in the experimental diets were purchased from the central market in Barkah town. Alcohol was used as a disinfectant during the experimental period. The chemical composition of wheat straw, alfalfa, barley grain, and sorghum grain was obtained from standard animal nutrition tables (Zia, 2016). In contrast, the chemical composition of Zaghr straw was determined experimentally using Near-Infrared Spectroscopy (NIRS).

The NIRS analysis of Zaghr straw indicated a crude protein content of 13.75%, moisture content of 8.93%, crude fat content of 6.80%, crude fiber content of 33.80%, and ash content of 12.23%. The reported starch value of -0.15% was considered an analytical/calibration artifact rather than a biologically meaningful negative starch concentration.

Because NIRS analysis did not provide reliable estimates of metabolizable energy (ME) and mineral concentrations, including calcium (Ca) and phosphorus (P), these parameters were obtained from published feed-composition sources and standard animal nutrition

references. However, values obtained from the literature may differ from the actual nutrient composition of the feeds used in the present experiment. Therefore, we calculated the nutrient composition of the complete experimental diets using the available ingredient-composition data and present it separately in Table X.

The experimental diets were formulated to provide approximately 1.054 kg of feed dry matter per animal per day. The daily feed allowance for each treatment was as follows:

- **Group 1:** 0.274 kg wheat straw, 0.274 kg alfalfa, 0.316 kg barley grain, and 0.190 kg sorghum grain. The diet contained approximately 52% roughage and 48% concentrate.
- **Group 2:** 0.432 kg mung bean straw, 0.432 kg alfalfa, and 0.190 kg barley grain. The diet contained approximately 82% roughage and 18% concentrate.
- **Group 3:** 0.432 kg Zaghr straw, 0.432 kg alfalfa, and 0.190 kg barley grain. The diet contained approximately 82% roughage and 18% concentrate.
- **Group 4:** 0.316 kg bean straw, 0.316 kg alfalfa, and 0.425 kg barley grain. The diet contained approximately 60% roughage and 40% concentrate.

Table 1 presents the ingredient proportions and estimated chemical composition of the four experimental diets. The diets differed in both the type of roughage source and the proportion of concentrate ingredients. Group 1 contained wheat straw, alfalfa, barley, and maize, whereas Groups 2, 3, and 4 contained mung bean straw, Zaghr straw, and bean straw, respectively, as the main experimental roughage sources. The calculated dry matter, crude protein, metabolizable energy, calcium, phosphorus, and energy-to-protein ratio also differed among the dietary treatments. Therefore, the observed differences in animal performance should be interpreted as responses to the overall dietary treatments rather than as the independent effects of the individual straw sources.

Table 1. *Ingredient proportions and chemical composition of the experimental diets*

Feed ingredient / Nutrient	G1	G2	G3	G4
Ingredient composition (%)				
Wheat straw	26	0	0	0
Alfalfa hay	26	0	0	0
Barley grain	30	0	0	0
Maize grain	18	0	0	0
Mung bean straw	0	41	0	0
Alfalfa hay	0	41	0	0
Barley grain	0	18	0	0
Zaghr straw	0	0	41	0
Alfalfa hay	0	0	41	0
Barley grain	0	0	18	0
Bean straw	0	0	0	30
Alfalfa hay	0	0	0	30
Barley grain	0	0	0	40
Total (%)	100	100	100	100
Chemical composition (%)				

Dry matter	88.73	89.78	91.26	89.88
Crude protein	10.027	12.20	14.20	11.40
Metabolizable energy*	2.17	2.25	2.19	2.08
Calcium	0.76	0.0066	0.0087	0.0046
Phosphorus	0.22	0.0019	0.0023	0.0043
Energy-to-protein ratio	0.216	0.184	0.154	0.182

Experimental Design

The experiment was conducted using a Latin Square Design (LSD). Sixteen crossbred ewe lambs of similar age and body condition were randomly allocated to four dietary treatment groups, with four lambs assigned to each group. The four experimental diets differed in the type of straw used as the basal roughage source. Group 1 received wheat straw, Group 2 received mung bean straw, Group 3 received Zaghr straw, and Group 4 received bean straw. The animals remained on their respective dietary treatments throughout the 28-day experimental feeding period. Feed was offered twice daily, in the morning and evening, and all animals had access to drinking water. We recorded body weight and feed intake throughout the experimental period.

Data Recording

Data in this study were recorded for two main parameters: feed intake and body weight gain of crossbred lamb ewes.

Feed Intake

Feed intake was determined for each lamb throughout the 28-day experimental measurement period. We weighed the daily feed allowance for each animal before feeding and offered it twice daily, in the morning and evening. Feed was provided according to the assigned dietary treatment and was offered separately to the animals within each replicate.

Before the morning feeding, all feed residues from the previous feeding period were collected separately for each lamb and weighed using a digital weighing scale. We recorded the quantity of feed refused for each animal and cleaned the feeding troughs before the next feeding. Feed intake was calculated daily as the difference between the amount of feed offered and the amount of feed refused, using the following equation:

$$\text{Feed intake (kg/day)} = \text{Feed offered (kg/day)} - \text{Feed refused (kg/day)}$$

We recorded daily feed intake for each lamb and averaged it over the 28-day measurement period to determine the mean daily feed intake for each animal and experimental group. Because the experimental diets differed in ingredient composition and dry matter content, feed intake was evaluated both on an as-fed basis and, where applicable, on a dry matter (DM) basis. Dry matter intake was calculated using the dry matter concentration of the respective diet as follows:

$$\text{Dry matter intake (kg/day)} = \text{As-fed feed intake (kg/day)} \times \text{DM concentration of diet (\%)} / 100$$

At the end of each measurement day, feed refusals were collected and weighed separately for each lamb to avoid mixing residues among animals. The accumulated feed residues were used to calculate total feed intake during the experimental period.

During the 28-day measurement period, feed refusals were negligible in Groups 2, 3, and 4, which received mung bean straw, Zaghr straw, and bean straw, respectively. In Group 1, which received wheat straw, a total of 1.643 kg of feed residue was recorded during the measurement period. These feed residues were included in the calculation of individual and group-level feed intake.

Body Weight Gain

The body weight of the lambs was recorded weekly, before the morning feeding. After weighing, we calculated the average weekly weight gain for each group. Lambs were weighed on a zeroed electronic scale, and the weighing pan weight was subtracted to ensure accuracy. The first weighing was conducted on 22 Dalwa 1401, with an average initial body weight of 33.82 ± 0.71 kg. Lambs were 11 months old at the start of the experiment. During the 28-day trial, lambs were weighed four times, once at the end of each week. Post-weighing, lambs were fed, and the daily average weight gain was calculated based on the differences between initial and final weights during the feeding period.

Statistical Analysis

Data on dry matter intake and body weight gain were analyzed using Statistix 9. The experiment was analyzed as a Latin Square Design (LSD), with dietary treatment as the main source of variation. Analysis of variance (ANOVA) was used to determine whether significant differences existed among the four dietary treatment groups. When the ANOVA indicated a significant treatment effect, treatment means were compared using the Least Significant Difference (LSD) test. Statistical significance was declared at $P < 0.05$, and highly significant differences were considered at $P < 0.01$.

FINDINGS

Feed Intake

The results for feed intake and body weight gain across the experimental groups, along with statistical analyses and corresponding tables, are presented below.

The average daily total dry matter intake (DMI) of the crossbred lamb ewes is shown in Table 1. According to the data, Groups 2, 3, and 4, which were fed mung bean straw, Zaghr straw, and bean straw, respectively, exhibited similar average daily total dry matter intake. In contrast, Group 1, which was fed wheat straw, showed a slight difference in average daily total dry matter intake, with 1.643 kg of residual feed remaining during the last two weeks of the experiment. Overall, the intake of mung bean, Zaghr, and bean straws was higher than that of wheat straw, and no feed residues were observed for these groups.

Table 2. Average Daily Dry Matter Intake of Crossbred Lambs during the 28-Day Measurement Period

Experimental group	Feed offered (kg/lamb/day)	Feed refused (kg/lamb/day)	Calculated DMI (kg/lamb/day)	DMI (kg/lamb/day), mean $\pm$ SD
G1	1.054	0.0132	1.0408	1.0408 $\pm$ 0.0132
G2	1.054	0.0000	1.0540	1.0540 $\pm$ 0.0000
G3	1.054	0.0000	1.0540	1.0540 $\pm$ 0.0000
G4	1.054	0.0000	1.0540	1.0540 $\pm$ 0.0000

Note: Feed intake was calculated as feed offered minus feed refused. Values represent the mean daily intake per lamb during the 28-day measurement period. G1 = wheat straw-based diet; G2 = mung bean straw-based diet; G3 = Zaghr straw-based diet; G4 = bean straw-based diet. The experimental unit was the individual lamb, and feed was weighed and offered separately to each lamb.

Table 3 presents the weekly average total daily dry matter intake (DMI) of the experimental groups. During the first and second weeks, the average total DMI was similar across all groups. However, during the final two weeks, the average total DMI of Group 1, which was fed wheat straw, decreased, and a small amount of feed residue remained. In contrast, the groups fed mung bean, Zaghr straw, and bean straw showed no feed residue in their average total daily DMI. The weekly average total dry matter intake for Groups 1, 2, 3, and 4 was 1.0408, 1.054, 1.054, and 1.054 kg, respectively.

Table 3. Average Weekly Feed Intake of Crossbred Lamb Ewes by Group (kg)

Days	Group 4 (Bean Straw)	Group 3 (Zaghr Straw)	Group 2 (Mung Bean Straw)	Group 1 (Wheat Straw)
0–7	1.054 $\pm$ 0.00	1.054 $\pm$ 0.00	1.054 $\pm$ 0.00	1.054 $\pm$ 0.00
8–14	1.054 $\pm$ 0.00	1.054 $\pm$ 0.00	1.054 $\pm$ 0.00	1.054 $\pm$ 0.00
15–21	1.054 $\pm$ 0.00	1.054 $\pm$ 0.00	1.054 $\pm$ 0.00	1.0307 $\pm$ 0.25
22–28	1.054 $\pm$ 0.00	1.054 $\pm$ 0.00	1.054 $\pm$ 0.00	1.0257 $\pm$ 0.35
Total	4.216	4.216	4.216	4.164
Weekly Average DMI	1.054 $\pm$ 0.00	1.054 $\pm$ 0.00	1.054 $\pm$ 0.00	1.041 $\pm$ 0.10

Table 4 Daily Dry Matter Intake of Experimental Lamb Ewes Fed Wheat Straw, Mung Bean Straw, Zaghr Straw, Bean Straw, Alfalfa, Barley, and Sorghum. The daily dry matter intake (DMI) of the lamb ewes is presented in Table 3. The daily DMI of Groups 2, 3, and 4, which were fed mung bean, Zaghr, and bean straws, respectively, was 100%. In contrast, Group 1, fed the wheat straw-based ration, had a daily DMI of 98.75%. The average daily feed residue in Group 1 was 13.2 grams. The feed rations for all groups are clearly presented in Table 4.

Table 4. Daily Dry Matter Intake of Crossbred Lamb Ewes Fed Wheat, Mung Bean, Zaghr, and Bean Straws, Alfalfa, Barley, and Sorghum (kg)

Parameters	Group 4 (Bean Straw)	Group 3 (Zaghr Straw)	Group 2 (Mung Bean Straw)	Group 1 (Wheat Straw)
Wheat Straw	0	0	0	0.2608
Mung Bean Straw	0	0	0.432	0
Zaghr Straw	0	0.432	0	0
Bean Straw	0.316	0	0	0
Alfalfa	0.316	0.432	0.432	0.274
Barley	0.422	0.19	0.19	0.316
Sorghum	0	0	0	0.19
Total Dry Matter Consumed (kg)	1.054 ± 0.000	1.054 ± 0.000	1.054 ± 0.000	1.0408 ± 0.0132
Dry Matter Residue (g)	0	0	0	13.2
Dry Matter Intake (%)	100 ± 0.00	100 ± 0.00	100 ± 0.00	98.75 ± 1.25

Analysis of Variance for the Effect of Different Groups on Body Weight Gain of Experimental Ewes

Table 5 presents the analysis of variance (ANOVA) for the effect of different experimental groups on the live weight gain of crossbred lamb ewes. In this study, the differences were statistically significant only among the groups. No significant differences were observed in the rows or columns. The results indicate a highly significant difference in live weight gain among the groups at the 99% confidence level ($P < 0.01$).

Table 5. Analysis of Variance (ANOVA) for the Effect of Different Groups on Body Weight Gain of Experimental Ewes

Source of Variation	Degrees of Freedom (DF)	Sum of Squares (SS)	Mean Square (MS)	F Calculated	F Table (0.05 / 0.01)	P-value
Row	3	0.3516	0.1172	0.7124 ns	4.39 / 8.75	0.001
Column	3	0.3914	0.1304	0.7927 ns	4.39 / 8.75	-
Group	3	13.8356	4.6118	28.0352 ***	4.39 / 8.75	-
Error	6	0.9874	-	-	-	-
Total	15	15.566	-	-	-	-

Notes:

- ns = Not significant
- *** = Highly significant at $P < 0.01$

Table 6 presents comparison of Mean Final Body Weight of Crossbred Ewe Lambs among Dietary Treatment Groups Using the LSD Test. The highest mean final body weight was observed in Group 4 (36.57 kg), followed by Group 1 (35.27 kg), Group 2 (34.86 kg), and Group 3 (33.99 kg). The LSD comparison indicated significant differences among the treatment means, with Group 4 showing the highest final body weight.

Table 6. Comparison of Mean Body Weight Gain of Crossbred Lamb Ewes among Different Groups Based on LSD

Dietary group	Mean final body weight (kg)	Difference
Group 4	36.5718 ***	2.5793
Group 1	35.2681 **	1.2756
Group 2	34.8575 *	0.865

Dietary group	Mean final body weight (kg)	Difference
Group 3 (Reference)	33.992 ns	–

Notes:

- ns = Not significant
- * = Significant at 95% confidence ($P < 0.05$)
- ** = Significant at 99% confidence ($P < 0.01$)
- *** = Highly significant at 99% confidence ($P < 0.001$)

Table 7 presents the changes in live body weight of crossbred ewe lambs during the four-week experimental period. The results show that body weight increased progressively in Groups 1, 2, and 4 throughout the experimental period, although the magnitude of increase differed among the groups. Group 4, which received the bean straw-based diet, had the highest live body weight at the end of 28 days (38.00 kg), followed by Group 1 (35.995 kg), Group 2 (35.29 kg), and Group 3 (34.72 kg).

Group 3 showed a different pattern of body-weight change. Its body weight decreased during the first week, increased during the second week, decreased slightly again during the third week, and increased during the final week. Despite these fluctuations, Group 3 showed an overall increase in body weight by the end of the experimental period. Overall, the results indicate that the magnitude of change in live body weight differed among the dietary treatment groups, with Group 4 showing the greatest increase during the 28-day experimental period.

Table 7. Weekly Live Body Weight of Crossbred Ewe Lambs Fed Diets Containing Different Straw Types during the 28-Day Experimental Period (kg)

Period (days)	Group 4	Group 3	Group 2	Group 1
0–7	35.175 ± 0.84	33.625 ± 0.22	34.535 ± 0.32	34.700 ± 0.32
8–14	36.383 ± 0.68	33.800 ± 0.28	34.795 ± 0.25	35.283 ± 0.16
15–21	36.730 ± 0.68	33.740 ± 0.11	34.810 ± 0.40	35.340 ± 0.10
22–28	38.000 ± 0.66	34.720 ± 0.072	35.290 ± 0.06	35.995 ± 0.10
Total	146.288	135.880	139.425	141.318
Weekly average	36.572 ± 1.16	33.970 ± 0.50	34.858 ± 0.31	35.330 ± 0.52

Table 8 shows that Group 4 gained 1.35 kg in the first week, while Group 3 lost 0.2 kg compared to the initial average live weight. Group 3 then gained weight in the second week, decreased in the third week, and increased again in the fourth week. The table indicates that the total weight gain of crossbred lamb ewes in Groups 1, 2, 3, and 4 was 0.539, 0.365, 0.224, and 1.044 kg, respectively.

Table 8. Weekly Weight Gain or Loss of Crossbred Ewe Lambs During the 28-Day Experimental Period (kg)

Period (days)	Group 4	Group 3	Group 2	Group 1
0–7	1.350 ± 0.70	–0.200 ± 0.67	0.705 ± 0.39	0.875 ± 0.50
8–14	1.208 ± 0.21	0.175 ± 0.20	0.260 ± 0.12	0.570 ± 0.66
15–21	0.347 ± 0.029	–0.060 ± 0.11	0.015 ± 0.026	0.057 ± 0.062
22–28	1.270 ± 0.20	0.980 ± 0.084	0.480 ± 0.24	0.655 ± 0.13
Total weight gain	4.175	0.895	1.460	2.157

Period (days)	Group 4	Group 3	Group 2	Group 1
Average weekly gain	1.044 ± 0.54	0.224 ± 0.46	0.365 ± 0.29	0.539 ± 0.34

Table 9 shows that Group 4, which was fed bean straw, gained 1.35 kg in the first week of the study. Groups 1 and 2, fed wheat straw and mung bean straw, respectively, also gained weight. However, Group 3, fed flax straw, lost weight during the first week compared with the initial average weight. In the second week, Group 3 showed an upward trend, nearly reaching the initial average weight; it then declined in the third week and increased in the last week, surpassing the initial average weight. Overall, Groups 1, 2, and 4 experienced reduced weight gain after the third week, while all groups showed an upward trend in the fourth week.

The total average weight gain of crossbred lamb ewes in Group 4 reached 4.175 kg, representing the highest weight gain among all groups. In Group 1, which was fed wheat straw, the total average weight gain was 2.157 kg; in Group 2, fed mung bean straw, it was 1.46 kg; and in Group 3, fed flax straw, the total average weight gain was 0.895 kg.

The daily average weight gain in Group 4 (fed bean straw) was 149.107 g. The daily average weight gain in Groups 1, 2, and 3 was 77.036 g, 52.143 g, and 31.965 g, respectively, as presented in Table 8.

Table 9. Initial Body Weight, Total Weight Gain, and Average Daily Gain of Crossbred Ewe Lambs during the 28-Day Experimental Period

Parameter	Group 4	Group 3	Group 2	Group 1
Initial body weight (kg)	33.825 ± 1.20	33.825 ± 0.26	33.830 ± 0.71	33.825 ± 0.71
Final body weight (kg)	38.000 ± 0.66	34.720 ± 0.072	35.290 ± 0.06	35.995 ± 0.10
Total weight gain (kg)	4.175 ± 0.47	0.895 ± 0.20	1.460 ± 0.088	2.157 ± 0.142
Experimental period (days)	28	28	28	28
Average daily gain (g/day)	149.107 ± 16.786	31.965 ± 7.143	52.143 ± 3.143	77.036 ± 5.072

Feed Conversion Ratio (FCR)

Table 10 presents the average Feed Conversion Ratio (FCR), calculated as the ratio of total dry matter intake to total body weight gain, for the Turkish crossbred ewe lambs in the experimental groups. The FCR values were 7.069, 13.51, 20.22, and 32.98 for Groups 4, 1, 2, and 3, respectively. Thus, Group 4 showed the most efficient feed conversion, followed by Groups 1, 2, and 3.

In other words, Group 4 required 7.069 kg of dry matter to produce 1 kg of body weight gain, whereas Groups 1, 2, and 3 required 13.51, 20.22, and 32.98 kg of dry matter, respectively, to produce 1 kg of body weight gain. Therefore, the lower FCR in Group 4 indicates better feed conversion efficiency than in the other groups.

Table 10. Average Feed Conversion Ratio (FCR) Based on Total Dry Matter Intake and Total Body Weight Gain of Turkish Crossbred Ewe Lambs in the Experimental Groups

Group	Average Total Dry Matter Intake (kg)	Average Total Body Weight Gain (kg)	Average Feed Conversion Ratio (FCR)
G1	29.143 ± 0.16	2.157 ± 0.142	13.51
G2	29.512 ± 0.00	1.460 ± 0.088	20.22

Group	Average Total Dry Matter Intake (kg)	Average Total Body Weight Gain (kg)	Average Feed Conversion Ratio (FCR)
G ₃	29.512 ± 0.00	0.895 ± 0.200	32.98
G ₄	29.512 ± 0.00	4.175 ± 0.470	7.068

Note: FCR = Total dry matter intake ÷ Total body weight gain.

Feed Conversion Efficiency (FCE)

Table 11 shows the Feed Conversion Efficiency (FCE), calculated as the ratio of total body weight gain to total dry matter intake, expressed as a percentage. Group 4 showed the highest feed conversion efficiency (14.15%), indicating the most efficient dietary treatment. Group 1 followed (7.40%), followed by Group 2 (4.95%) and Group 3 (3.033%). Therefore, Group 4 demonstrated the highest efficiency in converting consumed dry matter into body weight gain, whereas Group 3 showed the lowest efficiency.

Table 11. Feed Conversion Efficiency (FCE) Based on Total Body Weight Gain and Total Dry Matter Intake of Crossbred Ewe Lambs

Group	Total Body Weight Gain (kg)	Total Dry Matter Intake (kg)	Feed Conversion Efficiency (FCE, %)
G ₁	2.157 ± 0.142	29.143 ± 0.16	7.40
G ₂	1.460 ± 0.088	29.512 ± 0.00	4.95
G ₃	0.895 ± 0.200	29.512 ± 0.00	3.033
G ₄	4.175 ± 0.470	29.512 ± 0.00	14.15

Note: FCE (%) = (Total body weight gain ÷ Total dry matter intake) × 100.

DISCUSSION

The findings of this study on flax straw (Zaghar) do not fully align with the results of Whiting (1958). However, he provided dry Zaghar in the form of bundles to lambs and, compared with two-cut barley straw and Zaghar straw, lambs consumed more Zaghar straw. Because the Zaghar straw considered in this study was similar to dry Zaghar in dry matter, crude protein, and crude fiber, mineral content (calcium and phosphorus) and energy were taken from the energy section of dry Zaghar (Howard et al. 1991).

Reports based on farmers' experiences indicate that Zaghar straw has significant value as feed and is highly palatable (Mahala et al., 2007). Sheep preferred fresh Zaghar forage less, but it became more acceptable after cooking. Zaghar straw is a by-product obtained after cooking Zaghar. This finding is consistent with results on palatability (Whiting, 1958; Howard et al., 1991).

The findings of this study on Zaghar straw are inconsistent. In their study, lambs were provided dry bundles of Zaghar, and higher feed intake was observed (Whiting, 1958; Howard et al., 1991). However, in this study, lambs fed Zaghar straw showed lower feed intake. Table 1 shows that the effect of different groups on feed intake of crossbred lamb ewes was not statistically significant ($P > 0.05$). The results of this study are consistent with the findings of (Whiting, 1958; Howard et al., 1991) regarding dry matter intake of leguminous and grass straws. The present findings regarding leguminous straws are also closely similar to those of Ainipour, Chaji, & Sari (2019) (Ainipour et al., 2019). These researchers observed that

replacing 100% wheat straw with mung straw for 16 five-month-old ram lambs increased feed intake, although it was not statistically significant ($0.05 < P$). The results indicate that the bean straw diet was relatively economical compared with the wheat straw diet, and feed intake was higher with no leftovers, whereas the wheat straw diet left some residue. This finding closely corresponds to the report of Ainipour, Chaji, & Sari (2019) (Ainipour et al., 2019).

Regarding non-concentrated leguminous feeds such as wheat, mung, and bean straws, previous studies used them as replacements; however, in the present study, we formulated and implemented a separate ration for each straw type.

Table 4 shows the analysis of variance (ANOVA) results for the effect of different groups on live weight gain in crossbred ewe lambs, which were statistically significant ($P < 0.01$).

These findings are consistent with those of Mehramiri et al. (2018). In that study, bean straw showed the highest difference in weight gain compared to wheat straw. However, in the present study, we did not feed a replacement diet. In the Mehramiri study, replacing 100% of wheat straw with bean residue in lamb diets, compared with the control diet, significantly affected digestibility and weight gain ($P < 0.05$).

These findings are not consistent with those of Mehramiri et al. (2017). In this study, wheat straw led to greater weight gain compared to mung straw, but from an economic perspective, wheat straw was less economical than mung straw. However, both were statistically significant ($P < 0.05$). Researchers observed that replacing 100% of wheat straw with bean residue resulted in a significant difference in weight gain compared to 25% and 50% replacements ($P < 0.05$). The present findings are consistent with those of Ainipour et al. (2019).

Table 10 showed differences in feed conversion ratio (FCR) among the dietary treatment groups. Group 4 had the lowest FCR (7.068), indicating that 7.068 kg of dry matter was required to produce 1 kg of body weight gain. The corresponding FCR values for Groups 1, 2, and 3 were 13.51, 20.22, and 32.98, respectively. Thus, Group 4 showed the most favorable feed conversion among the experimental groups, whereas Group 3 showed the least efficient conversion.

The relatively lower FCR observed in Group 4 may be related to its greater body weight gain, since total dry matter intake was relatively similar among the groups. Therefore, the difference in FCR appears to be associated mainly with differences in the amount of body weight gained from the consumed dry matter. Nutritional characteristics of the complete formulated rations, including nutrient availability, energy supply, protein content, fiber concentration, and potential differences in nutrient utilization, may also have contributed to this response. However, because the diets were separately formulated and nutrient digestibility was not directly measured, the lower FCR cannot be attributed solely to bean straw.

Amiri et al. (2017) reported no significant difference in FCR when 25%, 50%, and 100% mung bean straw replaced wheat straw in diets of 16 Arabian male lambs during a 45-day experimental period ($P > 0.05$). This finding differs from the present study, in which we observed numerical differences in FCR among the dietary groups. The discrepancy may reflect differences in experimental design, animal type, experiment duration, straw replacement level, and diet formulation.

The FCR observed for the bean straw-based diet in the present study was comparable with the findings reported by Ainipour et al. (2019), who investigated the use of bean residues as a replacement for wheat straw. However, their study used a replacement-based feeding strategy, whereas the present study evaluated separately formulated rations. Therefore, interpret the similarity between the findings in light of these methodological differences.

Overall, the results indicate that the bean straw-based formulated diet was associated with the most favorable FCR under the conditions of the present experiment. However, this result should not be interpreted as evidence that bean straw alone improved feed conversion.

Table 11 showed that Feed Conversion Efficiency (FCE) differed numerically among the dietary treatment groups. Group 4 had the highest FCE (14.15%), followed by Group 1 (7.40%), Group 2 (4.95%), and Group 3 (3.033%). Thus, Group 4 showed the greatest efficiency in converting consumed dry matter into body weight gain, whereas Group 3 showed the lowest efficiency.

The higher FCE in Group 4 corresponds to its lower FCR and greater total body weight gain. Because FCE is calculated as body weight gain divided by dry matter intake, a higher FCE indicates that a greater proportion of the consumed dry matter was converted into body mass. The relatively similar dry matter intake among the groups, combined with the greater weight gain in Group 4, therefore contributed to its higher FCE. Nevertheless, differences in the nutritional composition and utilization of the complete formulated diets may also have influenced this response.

Mehramiri et al. (2018) reported higher feed conversion efficiency for mung bean straw compared with other straw types, whereas wheat straw showed lower efficiency ($P < 0.05$). This finding differs from the present results, in which the bean straw-based diet showed the highest FCE, followed by the wheat, mung bean, and Zaghar straw-based diets. Differences in straw composition, diet formulation, animal characteristics, and experimental conditions may explain this discrepancy.

Mahala et al. (2007) reported a significant effect of replacing 100% of wheat straw with bean residues on feed conversion efficiency in lamb diets ($P < 0.05$). This finding is generally comparable with the present results, in which the bean straw-based formulated diet showed the highest FCE. However, the previous study involved a replacement treatment, whereas the present study used separately formulated rations.

(Mehramiri et al., 2018) reported no significant effect of replacing wheat straw with different levels of mung bean straw on feed conversion compared with the control treatment

($P > 0.05$). Similarly, Amiri et al. (2017) found no significant differences in feed conversion efficiency when 25%, 50%, and 100% mung bean straw replaced wheat straw in Arabian male lambs during a 45-day trial ($P > 0.05$). These findings differ from the numerical differences observed among the treatment groups in the present study. These differences may reflect variations in replacement levels, ration formulation, animal characteristics, experimental duration, and management conditions.

Ainipour et al. (2019) reported a significant difference in feed conversion when 100% bean residues replaced wheat straw compared with 25% and 50% replacement levels ($P < 0.05$). This finding is generally consistent with the present observation that the bean straw-based diet had the highest FCE. Nevertheless, because the experimental designs differed, compare the results cautiously.

Overall, the present findings indicate that the bean straw-based formulated diet showed the highest FCE and the lowest FCR among the treatments. This suggests more efficient utilization of dry matter for body weight gain under the conditions of the present experiment. However, the results reflect responses to the complete formulated diets and do not establish that bean straw alone was responsible for the superior feed conversion efficiency.

CONCLUSION

This study evaluated the effects of different formulated straw-based diets on feed intake and body weight gain of crossbred ewe lambs during a 28-day experimental period in Barkah District, Baghlan Province. Researchers randomly assigned sixteen lambs to four dietary treatment groups, with four lambs per group. The groups received formulated rations containing wheat straw (Group 1), mung straw (Group 2), Zaghar straw (Group 3), and bean straw (Group 4). Total feed intake did not differ significantly among the treatment groups ($P > 0.05$). Although Groups 2, 3, and 4 showed relatively similar feed intake, Group 1 had slightly lower intake. In contrast, body weight gain differed significantly among the groups ($P < 0.01$). Group 4 showed the highest total and average daily weight gain, followed by Groups 1 and 2, while Group 3 showed the lowest weight gain. The feed conversion results also showed that Group 4 had the lowest FCR (7.068) and the highest FCE (14.15%), indicating the most favorable feed utilization among the formulated diets under the conditions of this study. However, these findings should be interpreted as responses to the complete formulated diets, not as evidence that bean straw alone drove superior growth or feed conversion. Further studies using nutritionally balanced diets and longer experimental periods, together with measurements of nutrient digestibility, are recommended to determine the specific contribution of each straw type to lamb performance.

Authors' Contributions

1. Abdul Khaliq Sahes: Conceptualization, methodology, investigation, data collection, data analysis, and writing—original draft.

2. Abdul Ghafoor Moradi: Supervision, methodology, validation, interpretation of results, and writing—review and editing.
3. Abdul Jamil Ghanizada: Data analysis, statistical analysis, interpretation of results, and writing—review and editing.
4. Hamidullah Paiman: Supervision, resources, project administration, and writing—review and editing.
5. All authors contributed to the study, critically reviewed the manuscript, approved the final version, and agreed to be accountable for all aspects of the work.

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Conflict of Interest Statement

The authors declare no conflict of interest. No financial, personal, or professional relationships exist that could be construed as influencing the research, its results, or the interpretation of the findings.

Data Availability statement

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request. The data include individual animal feed intake, body weight, weight gain, and feed conversion ratio measurements. Access to the data may be subject to institutional guidelines and ethical considerations.

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