Turkish Journal of Agriculture - Food Science and Technology, 12(12): 2491-2496, 2024
DOI: https://doi.org/10.24925/turjaf.v12i12.2491-2496.6929

Turkish Journal of Agriculture - Food Science and Technology

Available online, ISSN: 2148-127X | www.agrifoodscience.com | Turkish Science and Technology Publishing (TURSTEP)

Cost-Benefit Analysis of the Fattening of Morkaraman Lambs with Different Dietary Plant Protein Sources

Mazhar Burak Can[1,a,*], Alperen Varalan[2,b], Halit İmik[3,c]

[1]*Animal Health Breeding and Aquaculture Branch Directorate, Bayburt Provincial Directorate of Agriculture and Forestry, Bayburt, Türkiye*
[2]*Department of Animal Health Economics and Management, Faculty of Veterinary Medicine, Atatürk University, Erzurum, Türkiye*
[3]*Department of Animal Nutrition and Nutritional Diseases, Faculty of Veterinary Medicine, Atatürk University, Erzurum, Türkiye*
[*]*Corresponding author*

ARTICLE INFO

Research Article

Received : 10.06.2024
Accepted : 05.08.2024

Keywords:
Corn
Cost
Gluten
Profitability
Protein

ABSTRACT

This study investigated the effects of different plant protein sources incorporated into feed concentrates on the live weight gain and feed conversion ratio of Morkaraman lambs by days 28, 42 and 56 of fattening, and presents a cost-benefit analysis. The study animals included 24 male Morkaraman lambs with a mean age of 9 months, which were assigned to 3 study groups. The dietary plant protein sources provided to the animals were soybean meal and safflower meal in Group I, wheat gluten in Group II, and corn gluten in Group III. The total feed intake values (kg) of Group I, Group II and Group III were 40.75±1.08, 39.18±0.88, and 37.67±0.62, respectively, during the period between days 0-28 of fattening; 62.77±1.67, 60.14±0.96, and 57.54±1.28, respectively, during the period between days 0-42 of fattening; and 83.31±1.89, 77.79±1.43, and 75.97±1.67, respectively, during the period between days 0-56 of fattening ($p<0.05$). The live weight gain values (kg) of Group I, Group II and Group III during the period between days 0-56 of fattening were 14.82±0.84, 11.97±0.51, and 13.71±0.91, respectively ($p<0.05$). The feed conversion ratio was observed not to have a statistically significant effect on production yields ($p>0.05$). In conclusion, while the highest income from live weight gain during the period between days 0-56 of fattening was achieved with the use of soybean meal and safflower meal as dietary plant protein sources, the lowest fattening cost was achieved with the use of corn gluten.

[a] *drmazharburakcan@gmail.com* *https://orcid.org/0000-0001-5248-1369*
[b] *alperenvaralan@atauni.edu.tr* *https://orcid.org/0000-0002-0509-0514*
[c] *himik@atauni.edu.tr* *https://orcid.org/0000-0001-6933-2124*

Introduction

Proteins, as the second major building block of the human body after water, constitute almost 50% of the cell's dry weight. Proteins are known to have various functions, including, among others, the repair, growth, and maintenance of the body (Wyness, 2016; Yetim & Tekiner, 2020; Yıldırım et al., 2021). Based on assessments of their biological value, proteins found in foods of animal origin are more potent than those found in foods of plant origin. Thus, food products of animal origin are essential to adequate and balanced nutrition (Yıldırım et al., 2021). Animal proteins can be obtained through the consumption of red meat, fish, eggs, and milk and milk products. Owing to its high content of protein, which on average is 24%, red meat is considered a major dietary protein source (Wyness, 2016). According to data pertaining to the year 2019, meat consumption per capita is 100.6 kg in the United States of America (USA), and almost half of it (50.1 kg) is from poultry meat consumption, while meat consumption per capita is 65 kg in the European Union (EU-28), and 24.9 kg of it is from poultry meat consumption. When compared to the USA and EU, meat consumption per capita is reported as 36.3 kg in Türkiye, and 60% of it is from poultry meat consumption (ESK, 2019). Thus, these data show that red meat is less consumed in Türkiye. This comparison also points out a positive correlation between the level of development of countries and the animal protein consumption of their populations (Sarıözkan et al., 2007). The large difference observed in the meat and red meat consumption of Türkiye stems from the various problems of the livestock sector, including, among others, the underemphasis of small ruminant breeding. Another setback is the poor organization of the animal holdings and the limited number of producer/farmer cooperatives (Günlü & Mat, 2021).

Until the 1980s, Türkiye had a significantly large population of sheep. The sharp decline observed as of 1980 was, to a great extent, linked to the transition to a market economy and the implementation of the stability program (dated January 24, 1980) that had been initiated in the livestock sector. The reduced state aid provided to sheep

production and the increase in feed costs during this transition period eventually led to a sharp decline in the sheep population of the country. During this period, cattle production was placed at the forefront and benefited from state aid, incentives, and safeguard measures, such that farmers lost interest in sheep breeding. This trend continued until 2010. Although the sheep population displayed a gradual increase thereafter, this did not suffice to compensate for the preceding loss (Günlü & Mat, 2021). Despite the highly satisfactory fattening performance of sheep against increasing feed costs, the sustainability of sheep production can only be ensured through the increase in production yields. This would also enable the production of an adequate volume of red meat and contribute to the closing of the supply deficit. In this respect, the sheep breeding sector is highly important for red meat production (Günlü et al., 2002).

The decline in the total area and quality of grassland in Türkiye, together with the deficit in the production of roughage and the limited implementation of genetic animal improvement programs, have all contributed to the critical importance of nutrition in the sheep and goat sectors (Aksu Elmalı et al., 2010). The targeted performance values of high-producing breeds can only be achieved with the provision of high-quality feed to animals (Can et al., 2024). Thus, the protein sources incorporated into the feed ration are of particular importance. In Türkiye, the primary dietary protein sources used in animal nutrition are soybean meal, sunflower meal, cotton seed oil meal and corn gluten. The gluten protein is obtained from cereals, including barley, wheat, corn and oats, by means of the separation of starch and other components. While gluten-containing food products are widely consumed across the world, the use of corn gluten is also very common in animal nutrition. In Türkiye, corn is the third most produced cereal after wheat and barley. Not only is gluten used as a protein source in animal nutrition, but it is also used as an energy source in the livestock sector. On the other hand, the advantage of wheat is its high adaptation capacity to different climates and geographical conditions. Wheat is not only a staple food crop for humans, but it is also commonly used in animal nutrition. Wheat grains contain on average 5.4% of gluten (Can, 2023).

This study was aimed at determining the fattening performance of Morkaraman lambs fed on different dietary plant protein sources by days 28, 42 and 56 of fattening, and at identifying the most profitable feed ration in terms of sheep production economics.

Material and Method

Animal Material, Study Groups and Nutrition

The animal material of the study comprised of 24 male Morkaraman lambs of a mean age of 9 months. The body condition scores and mean live weights of the lambs were similar. The lambs were assigned to three study groups, including a control group (Group I), a group fed on wheat gluten (Group II), and a group fed on corn gluten (Group III). The animals were housed in a closed farm system, in individual stalls. The animals were housed in individual stalls in a closed farm system of a private enterprise in Bayburt province. The feed rations provided to the animals were formulated to be isonitrogenous (crude protein (CP): 17%) and isocaloric (metabolic energy (ME): 2700 kcal/kg). The protein sources incorporated into the feed rations were soybean meal and safflower meal in Group I, wheat gluten in Group II and corn gluten in Group III. After a 21-day acclimatization period, the lambs were fattened for a period of 56 days. After being transferred to the farm, the lambs were firstly treated for internal and external parasites, and then vaccinated twice against enterotoxemia with the commercial vaccine Coglavax®. The lambs were fed twice a day, at 8.00 a.m. and 4.00 p.m., with preweighed amounts of feed. Two feed troughs were placed in each stall to separately calculate the intake of concentrated feed and roughage. Table 1 presents the composition of the feed concentrates provided to the study groups.

Table 1. The composition of the feed concentrates containing different dietary protein sources, %.

Ingredients, %	Groups		
	Group I	Group II	Group III
Wheat gluten (%75 HP)		10.3	
Corn gluten (%61 HP)			14.78
Soybean meal (%45 HP)	15.93		
Safflower meal (%22 HP)	7.47		
Rice bran	10		
Barley	60	52.5	60
Wheat		30	
Corn			18.22
Molasses	3	3	3
Marble dust	2.4	1.65	2.35
Dicalcium phosphate		1.51	0.96
Soy oil	0.6	0.33	
Salt	0.3	0.31	0.3
Ammonium chloride	0.2	0.3	0.28
Vitamin-Mineral premix	0.1	0.1	0.1
Total	100	100	100
Nutrient composition			
Crude protein, %	17	17	17
Metabolisable energy, (kcal/kg)	2.700	2.700	2.700

Determination of Performance Parameters

The body weight of each lamb was measured at the beginning of the study and on days 28, 42 and 56 of fattening, in the morning, before the provision of feed to the animals. Live weight measurement was performed with the aid of a special cage equipped with a scale. Daily feed intake was calculated based on the amounts of concentrated feed and roughage remaining in the feed troughs before the morning feed replenishment. Daily live weight gain was calculated by subtracting the initial weight from the final weight for each animal and dividing by the total number of days between the two consecutive weighings. The feed conversion ratio was calculated on the basis of the amount of feed consumed for the gain of 1 kg of live weight.

Calculation of Cost and Income

The feed cost per animal was calculated by multiplying the amounts of concentrated feed and roughage consumed during the periods between days 0-28, 0-42 and 0-56 of fattening with the ruling feed prices of the year 2021. Operating costs were calculated on the basis of the costs of the feed concentrates and roughage. The costs of vaccination, medication and labor, and other costs were not taken into consideration as they did not differ between the study groups.

The income generated per animal was calculated by multiplying the total live weight gain achieved during the periods between days 0-28, 0-42 and 0-56 of fattening with the ruling live weight sales prices per kg in December 2021. The cost/income ratio was determined by dividing the sales income of the farm by the total production cost (Güneş et al., 2001).

Statistical Analyses

The study data was statistically analyzed using the SPSS 20 software package. While feed intake, feed conversion ratio and live weight gain data were subjected to one-way analysis of variance (ANOVA), the significance of the differences between the study groups was determined with Duncan's test. P values smaller than 0.05 were considered statistically significant (Tekin, 2003; Tekin, 2010).

Findings

The feed intake, live weight gain and feed conversion ratio of the animals for the different periods of fattening are presented in Table 2.

As shown in Table 2, while no statistically significant difference was determined for roughage intake, live weight gain and the feed conversion ratio during the period between days 0-28 of fattening ($p>0.05$), it was observed that both the feed concentrate intake and total feed intake of Group III were significantly lower than those of the control group ($p<0.05$). Likewise, during the period between days 0-42 of fattening, no statistically significant difference was detected for roughage intake, live weight gain and the feed conversion ratio ($p>0.05$). During this period, Groups II and III displayed similar feed concentrate intake levels, which were significantly lower those that of Group I ($p<0.05$). Furthermore, total feed intake was significantly higher in Group I in comparison to Group III ($p<0.05$). Finally, the assessment of the period between days 0-56 of fattening also revealed no statistically significant difference for roughage intake and the feed conversion ratio ($p>0.05$). During this period, Groups II and III presented with similar feed concentrate and total feed intake levels, which were significantly lower than those of Group I ($p<0.05$). On the other hand, for the entire fattening period, it was ascertained that live weight gain was significantly higher in Group I, when compared to Group II ($p<0.05$).

The results of the cost and income analysis made for the lambs fed on the different dietary protein sources for the periods between days 0-28, 0-42 and 0-56 of fattening are presented in Table 3.

As shown in Table 3, during all three fattening periods, the highest income from live weight gain was achieved in Group I. The lowest incomes from live weight gain were detected in Group III during the period between days 0-28 of fattening and in Group II during the periods between days 0-42 and 0-56 of fattening. In the present study, the mean cost/income ratio was 1.50. Based on this result, it was determined that, in view of the costs of the supply of feed concentrate and roughage alone, and by calculating the income generated through the live weight gain of the lambs, an input of 1 Turkish Lira (TL) produced an output of 1.5 TL. The cost/income ratio was lowest during the period between days 0-28 of fattening in Group II. Periodic assessment demonstrated that the mean cost/income ratios during the periods between days 0-28, 0-42 and 0-56 of fattening were 1.46, 1.51, and 1.54, respectively.

Table 2. Live weight gain, feed intake and feed conversion ratio data for the different periods of fattening.

Period (Days)	Groups	Feed Concentrate Intake (kg)	Roughage Intake (kg)	Total Feed Intake (kg)	Live Weight Gain (kg)	Feed Conversion Ratio
0-28	Group I	36.45±1.11^{a}	4.29±0.48	40.75±1.08^{a}	7.63±1.01	5.36±1.13
	Group II	34.1±1.05^{ab}	5.08±0.28	39.18±0.88^{ab}	5.62±0.55	6.98±0.78
	Group III	32.89±0.67^{b}	4.78±0.21	37.67±0.62^{b}	5.5±0.52	6.84±0.56
0-42	Group I	56.96±1.66^{a}	5.81±0.77	62.77±1.67^{a}	11.05±1.07	5.69±0.68
	Group II	52.51±1.31^{b}	7.63±0.43	60.14±0.96^{ab}	9.24±0.71	6.51±0.47
	Group III	50.22±1.11^{b}	7.32±0.40	57.54±1.28^{b}	9.65±0.85	5.99±0.48
0-56	Group I	76.85±1.89^{a}	6.46±0.86	83.31±1.89^{a}	14.82±0.84^{a}	5.62±0.33
	Group II	69.19±1.83^{b}	8.59±0.53	77.79±1.43^{b}	11.97±0.51^{b}	6.49±0.18
	Group III	67.75±1.35^{b}	8.23±0.53	75.97±1.67^{b}	13.71±0.91^{ab}	5.54±0.32

Table 3. The total cost of production and the income (TL) from live weight gain for the different periods of fattening and the different dietary plant protein sources used.

Expenditure/Income	0-28 Days			0-42 Days			0-56 Days		
	Group I	Group II	Group III	Group I	Group II	Group III	Group I	Group II	Group III
Total Cost of Feed Concentrate (TL)	1049.87	1636.86	973.64	1640.52	2520.6	1486.41	2213.28	3321.3	2005.4
Total Cost of Roughage (TL)	31.27	37.02	34.82	42.29	55.56	53.34	47.07	62.57	59.89
Total Costs (TL)	1081.14	1673.88	1008.46	1682.81	2576.16	1539.75	2260.35	3383.87	2065.29
Total Live Weight Gain (Kg)	61.04	45.01	44.03	88.43	73.95	77.26	118.6	95.8	109.73
Income From Live Weight Gain (TL)	2105.88	1552.85	1519.04	3050.84	2551.28	2665.47	4091.7	3305.1	3785.69
Cost/Income Ratio	1.95	0.93	1.51	1.81	0.99	1.73	1.81	0.98	1.83

The prices of feed concentrate used for cost calculations were 3.60 TL/Kg for Group I, 6.00 TL/Kg for Group II and 3.70 TL/Kg for Group III. The price of wheat straw used as roughage source for all groups is 7.30 TL/Kg.

Discussion and Conclusion

The rapid increase in the global population has led to an increased demand for animal products. The consumption of sheep meat (mutton) and lamb meat has a traditional place in Turkish culture. In Türkiye, the majority of the sheep population is comprised of local (indigenous) breeds, which have not been genetically improved due to their current adaptation traits. Although these local breeds are well adapted to extensive breeding, they do not produce satisfactory performance results under intensive production conditions. In recent years, the reduced size of grassland, resulting from management plans/projects and rehabilitation/improvement programs implemented for pastures has increased the importance of intensive production systems for low-producing local breeds. The priority of animal holdings is the profitability of fattening rather than the length of the fattening period. This is because high profitability enables sheep production to be performed more sustainably. In return, sustainable production enables an increase in both the small ruminant population and the production of red meat. It is projected that an increase in red meat production would reduce sales prices and increase red meat consumption per capita in Türkiye, similar to the case in developed countries.

In the present study, the differences observed in the performance parameters of Morkaraman lambs, which were fed on different dietary plant protein sources during the period between days 0-56 of fattening, were found to be statistically significant ($p<0.05$).

In a previous study on Tuj (Tushin) lambs, the mean live weight gain achieved during the period between days 0-60 of fattening was determined as 11.66 kg, and the feed conversion ratio was reported as 6.16 kg for the same period (Aksu Elmalı et al., 2010). In another study on Awassi lambs, the mean live weight gain achieved in a fattening period of 56 days was determined as 12.73 kg, and the mean feed concentrate conversion ratios ascertained for the periods between days 0-14, 14-28, 28-42 and 42-56 of fattening were 5.36 kg, 5.22 kg, 5.59 kg, and 6.53 kg, respectively. The mean roughage conversion ratios determined for the same periods in this particular study were 2.41 kg, 2.86 kg, 4.16 kg, and 4.52 kg, respectively (Kul & Akcan, 2002). In a study on Akkaraman lambs, the mean live weight gains achieved in a fattening period of 56 days in the control group and Groups 1, 2, 3 and 4 were reported as 7.95 kg, 11.14 kg, 15.42 kg, 15.30 kg, and 14.69 kg, respectively (İmik et al., 2003). Another fattening study on Morkaraman lambs reported the mean live weight achieved by day 56 as 40.86 kg and indicated the mean live weight gain achieved from day 0 up to day 56 of fattening as 15.21 kg. This study demonstrated the amount of feed required for the gain of 1 kg of live weight, in other words, the feed conversion ratio as 5.38 (Küçük et al., 2002). Another research conducted by Demir (2019) on Awassi lambs revealed that the live weight gain achieved by the end of a 56-day fattening period was 13.92 kg and the feed conversion ratio was calculated as 6.29. In a more recent study by Erensoy (2022), the mean live weight gains achieved in lambs included in three different groups by the end of 56 days of fattening were reported as 11.60 kg, 13.9 kg and 12.7 kg, and the feed conversion ratios were determined as 4.97, 4.53 and 5.18. A different study on Morkaraman lambs reported live weight gains of 15.61 kg, 14.79 kg, 19.48 kg, 15.99 kg and 18.68 kg to have been achieved in different study groups by the end of a 49-day fattening period (İmik and Günlü, 2011). Furthermore, in research investigating the impact of creep feeding and conventional feeding on growth performance in male Akkaraman lambs, the difference between the live weights measured on days 20 and 62 was reported as 5.03 kg in the animals subjected to creep feeding and 4.69 kg in those subjected to conventional feeding (Yildirim et al., 2023). The comparison of the data obtained in the present study, as shown in Table 2, with the data of previous studies demonstrated a similarity in the mean live weight gains and feed conversion ratios, which showed only numeric differences. These differences may have arisen from several factors that affect the fattening performance. Breed, sex, age, the length of the fattening period, body condition, health status and fattening season are listed among the many factors known to affect the fattening performance (Pala & Gülşen, 2021).

As presented in Table 3, according to a periodic assessment, the mean cost/income ratios determined for the periods between days 0-28, 0-42 and 0-56 of fattening were 1.46, 1.51, and 1.54, respectively. In a previous study, the mean cost/income ratios for fattening periods of 0-30, 0-60 and 0-90 days were reported as 3.48, 3.07 and 2.79,

respectively (Aksu Elmalı et al., 2010). In the present study, an increase in the length of the fattening period was observed to be associated with the irregular increase or decrease of the cost/income ratio. On the other hand, in a study conducted by Aksu Elmalı et al. (2010), an increase in the length of the fattening period was reported to be associated with a decrease in the cost/income ratio. Furthermore, the cost/income ratios reported by Aksu Elmalı et al. (2010) were higher than those reported in the present study. Thus, the results of the two studies differ from each other. This may be attributed to differences arising from the years in which the studies were conducted and various factors (i.e., breed, age, etc.) that affect fattening performance. In previous studies on lambs, the mean cost/income ratio was reported as 1.49 for the Karaman province (Cevger, 1997) and as 1.41 for the Konya province (Günlü et al., 2002). The results of the previous studies conducted in the Karaman and Konya provinces agree with the results of the present study.

The present study investigated the impact of the incorporation of alternative protein sources into the feed ration on the cost of fattening for the periods between days 0-28, 0-42 and 0-56. Based on the assessment of the study results, it was concluded that the use of corn gluten in Group III had reduced the cost of fattening. Moreover, to maximize production profitability it is suggested to employ a fattening period length of 56 days.

Apart from being used as an energy source in animal nutrition, owing to its non-degradability in the rumen, richness in bypass methionine and high level of digestibility, corn is also commonly used for the nutrition of high-producing animals to close the protein deficit. In fact, Darabighane et al. (2020) reported that the incorporation of dry corn gluten into the feed ration of lactating cows, instead of clover hay increased both dry matter intake and digestibility. Furthermore, Maklad Eman et al. (2017) reported that the replacement of corn grains and oilseed meal in the feed concentrate provided to lactating cows by 15% corn gluten increased both the volume of milk produced and the economic efficiency of the dairy farm. Moreover, in the present study, the best feed conversion ratios were achieved in the animals fed corn gluten as a dietary protein source. However, different from the previous studies referred to above, in research conducted by Taylor et al. (2017), an increased rate of corn gluten in the feed ration of cows was reported to have decreased both dry matter intake and the feed conversion ratio. In a study on broiler chickens, Giannenas et al. (2017) reported that the use of corn gluten instead of soybean meal decreased feed intake, live weight gain and the feed conversion ratio, and increased the cost of feeding. Wheat is not only a staple food product for humans but is also critical to animal nutrition. However, due to the characteristics of its gluten form, wheat has been used primarily in the bakery, confectionary and industrial food sectors. The low protein solubility of wheat gluten, despite its high protein content, limits its use in animal nutrition (Can, 2023; Fang et al., 2017). However, similar live weight gain levels have been achieved by İmik (2019) in different groups of rats fed soybean meal and wheat gluten as dietary protein sources, which is interesting.

In this study, based on cost analysis, the lowest feed concentrate costs were determined in the group fed with corn gluten at 0-28, 0-42 and 0-56 days of fattening periods. However, it was noted that, throughout the entire fattening period, feeding the lambs a dietary protein combination of soybean meal and safflower meal increased profitability, compared to the other groups, although it increased the feed cost.

Owing to its high ruminal degradability, high and balanced composition of exogenous amino acids and high protein content, soybeans meal has found common use in the nutrition of young animals and poultry (Ergin & Aydemir, 2018). However, the cultivation of soybean is rather limited in Türkiye and its supply heavily depends on imports, which leads to continuously changing prices in relation to the foreign exchange rate. On the other hand, despite being the third most produced crop in Türkiye, after wheat and barley, corn (gluten) is still imported at much lower prices than soybean meal. Wheat gluten is not preferred by animal breeders, given its adverse effects on the performance parameters of lambs and high import prices.

Given that soybeans are part of human, ruminant and poultry diets, they are an important commodity in terms of international trade, which could easily increase the production costs of the livestock sector. In this context, the availability of alternative feedstuffs for incorporation into ruminant rations is critical to reducing the feed costs of animal production. In conclusion, based on our cost-benefit analysis, while the combined use of soybean meal + safflower meal is most profitable, corn gluten could be used as an alternative protein source, depending on the foreign exchange rate and its import price.

Declarations

Ethics Committee Approval

This study was approved by the 17.12.2020 dated and 181 numbered decision of the Local Ethics Board for Animal Experiments of Atatürk University.

Author Contributions

The authors contributed equally to the development and writing of the manuscript.

Declaration of Interests

The authors have no conflict of interest to declare.

Funding

The authors thank the Scientific Research Projects Coordination Unit of Atatürk University for their financial support (Number: TDK-2021-9222). This manuscript is based on the analysis of the data presented in the doctorate thesis of the corresponding author by a different method.

References

Aksu Elmalı, D., Demir, P., & Kaya, İ. (2010). Tuj kuzularında farklı konsantre yemlerle yapılan besinin maliyet-fayda analizi. *Kafkas Üniversitesi Veteriner Fakültesi Dergisi, 16*(5), 771-775. https://doi.org/10.1016/10.9775/kvfd.2010.1250

Can, M. B. (2023). Mısır ve Buğday Glüteninin Ruminant Beslemede Kullanımı. *Journal of Animal Production, 64*(2), 93-102. https://doi.org/10.29185/hayuretim.1331751

Can, M.B., İmik, H., & Terim Kapakin K. A. (2024) Effects of Wheat and corn gluten on growth performance, histopathologic and autoimmune metabolism of entero-hepatic tissue in lambs. *Journal of the Hellenic Veterinary Medical Society* (In Press).

Cevger, Y. (1997). Karaman ili kuzu besi işletmelerinde karlılık ve verimlilik analizleri. *Ankara Üniversitesi Veteriner Fakültesi Dergisi, 44*, 277-290.

Darabighane, B., Aghjehgheshlagh, F. M., Mahdavi, A., Navidshad, B., & Bernard, J. K. (2020). Replacing alfalfa hay with dry corn gluten feed alters eating behavior, nutrient digestibility, and performance of lactating dairy cows. *Italian Journal of Animal Science, 19*(1), 1264-1274. https://doi.org/10.1080/1828051X.2020.1830722

Demir, H. (2019). *İvesi kuzu rasyonlarında farklı oranlarda pamuk tohumu kullanımının besi performansı ve besin madde sindirimi üzerine etkisinin belirlenmesi* [Doctoral thesis, Harran Üniversitesi, Fen Bilimleri Enstitüsü, Zootekni Ana Bilim Dalı].

Erensoy, K. (2022). *Kuzularda Sütten Kesim Sonrası Dönemde Farklı Kaba Yem Oranlarında Beslemenin Besi Performansına Etkileri* [Master's thesis, Bursa Uludağ Üniversitesi, Fen Bilimleri Enstitüsü, Zootekni Anabilim Dalı].

Ergin, N., & Aydemir, S.K. (2018). Soya bitkisinin hayvan beslenmesindeki yeri ve önemi. *International Journal of Eastern Mediterranean Agricultural Research, 1*(1), 143-157.

Et ve Süt Kurumu (ESK). (2019). Sektör değerlendirme raporu. Erişim adresi: https://www.esk.gov.tr/upload/Node/10255/files/Et_ve_Sut_Kurumu_2019_Sektor_Degerlendirme_Raporu.pdf. Erişim tarihi: 02.02.2024.

Fang, J., Martínez, Y., Deng, C., Zhu, D., Peng, H., Jiang, H., & Li, A. (2017). Effects of dietary enzymolysis products of wheat gluten on the growth performance, serum biochemical, immune, and antioxidant status of broilers. *Food and Agricultural Immunology, 28*(6), 1155-1167. https://doi.org/10.1080/09540105.2017.1332009

Giannenas, I., Bonos, E., Anestis, V., Filioussis, G., Papanastasiou, D. K., Bartzanas, T., Papaioannou, N., Tzora, A., & Skoufos, I. (2017). Effects of protease addition and replacement of soybean meal by corn gluten meal on the growth of broilers and on the environmental performances of a broiler production system in Greece. *PloS one, 12*(1), e0169511. https://doi.org/10.1371/journal.pone.0169511

Güneş, H., Kaygısız, F., Koçak, Ö., Pekgöz, M., & Gör, M. (2001). Siyah-Alaca ırkından erkek sığırların besi performansları üzerinde araştırmalar ve ekonomik analizler. *İstanbul Üniversitesi Veteriner Fakültesi Dergisi, 27*(1): 243-253.

Günlü, A., Çetin, O., Kırıkcı, K., & Tepeli, C. (2002). Resource usage efficiency in sheep breeding enterprises in Konya province and effects of different production strategies on profitability. *The Indian Journal of Animal Sciences, 72*(6): 495-498.

Günlü, A., & Mat, B. (2021). Türkiye ekonomisinde koyun keçi yetiştiriciliğinin yeri ve önemi. Erdem, H., Çiftci, E., Işık, M. K, & Yorgancılar, M. Ü. (Eds.), Kuzu ve Oğlak Kayıplarının Önlenmesinde Koyun Keçi Sağlığı ve Yetiştiriciliği (pp. 3-14). *Akademisyen Yayınevi*. https://doi.org/10.37609/akya.902

İmik, S. (2019). *Dişi ratların yemine katılan buğday ve mısır gluteninin ovaryum üzerine etkisinin araştırılması* [Master's thesis, Kafkas Üniversitesi, Sağlık Bilimleri Enstitüsü, Ebelik Anabilim Dalı].

İmik, H., & Günlü, A. (2011). Effects of sodium bicarbonate, polyethylene glycol and methionine added to rations with sorghum (Sorghum vulgare) in fattening lambs on growth performance, wool quality and some blood biochemical markers. *Revue de Médecine Vétérinaire, 162*(8/9), 432-439.

İmik, H., Tuncer, Ş. D., Aytaç, M., & Aylanç, A. (2003). The effect of replacing different levels of Sorghum vulgare with no bran in place of barley on fattening performance and wool quality in Akkaraman lambs. *Turkish Journal of Veterinary & Animal Sciences, 27*(3), 677-684.

Kul, S., & Akcan, A. (2002). İvesi ve ost-friz x ivesi melez (f1) kuzularda besi performansı, kesim ve karkas özellikleri. *Uludağ Üniversitesi Veteriner Fakültesi Dergisi, 22*, 1-2.

Küçük, M., Baram, D., & Yılmaz, O. (2002). Morkaraman ve Kıvırcık x Morkaraman (G1) melezi kuzularda büyüme, besi performansı, kesim ve karkas özelliklerinin araştırılması. *Turkish Journal of Veterinary & Animal Sciences, 26*, 1321-1327.

Maklad Eman, H., El-Ayek, M. Y., Abd El-Khabir, A. M., & Sharaf, K. M. I. (2017). Effect of Feeding Different Levels of Corn Gluten Feed on Milk Production and Economic Efficiency in Friesian Dairy Cows Rations. *Journal of Animal and Poultry Production, 8*(10), 419-424. https://doi.org/10.21608/jappmu.2017.46043

Pala, F., & Gülşen, N. (2021). Türkiye Yerli Koyun Irklarında Yapılan Bazı Kuzu Besi Çalışmaları. *Bahri Dağdaş Hayvancılık Araştırma Dergisi, 10*(1), 87-102.

Sarıözkan, S., Cevger, Y., Demir, P., & Aral, Y. (2007). Erciyes Üniversitesi Veteriner Fakültesi öğrencilerinin hayvansal ürün tüketim yapısı ve alışkanlıkları. *Sağlık Bilimleri Dergisi, 16*(3), 171-179.

Taylor, E. G., Lemenager, R. P., & Stewart, K. R. (2017). Using corn gluten feed in post-partum diets of young beef cows to optimize reproductive performance. *Translational Animal Science, 1*(3), 296-303. https://doi.org/10.2527/tas2017.0034

Tekin, M. E. (2003). Önemlilik testlerinde hipotezler, hata tipleri ve örnek büyüklüğü ilişkileri üzerine bir değerlendirme. *Hayvancılık Araştırma Dergisi, 13*(1-2), 81-85.

Tekin, M.E. (2010). Sağlık Bilimleri için Örneklerle Bilgisayarda istatistik. *Selçuk Üniversitesi Basımevi,* (pp. 71-88).

Wyness, L. (2016). The role of red meat in the diet: nutrition and health benefits. *Proceedings of the Nutrition Society, 75*(3), 227-232. https://doi.org/10.1017/S0029665115004267.

Yetim, H., & Tekiner, İ.H. (2020). Alternatif protein kaynaklarından yapay et üretimi kavramına eleştirel bir bakış. *Helal ve Etik Araştırmalar Dergisi, 2*(2), 85-100.

Yıldırım, S., İmik, H., & Günlü, A. (2021). Bitlis ili Mutki ilçesinde koyun keçi yetiştiren işletmelerin temel hayvan besleme bilgi düzeylerinin araştırılması. *Mehmet Akif Ersoy Üniversitesi Veteriner Fakültesi Dergisi, 6*(2), 48-56. https://doi.org/10.24880/maeuvfd.888022

Yildirim, F., Kesen, A. O., & Varalan, A. (2023). The comparative effect of creep and conventional feeding methods on growth performance and oxidative stress markers in Akkaraman lambs. *Tropical Animal Health and Production, 55*(6), 382. https://doi.org/10.1007/s11250-023-03804-z