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Research article
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Influence of various energy sources in rations on fattening performance and profitability in yearling lambs

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ABSTRACT: The aim of this study was to determine the effects of rations created with different energy sources on the fattening performance and economic profit of male yearling lamb rations. The energy sources of the rations used in the study were barley (Experiment-1), wheat (Experiment -2), and corn (Experiment -3). The animal material of the study consisted of male yearlings lambs of the Morkaraman breed, aged 7.5-8 months and with an average body weight of 44 kg.. The study consisted of 27 animals in total, 9 animals in each group, with 3 replications and 3 animals in each replication. In the study, male yearlings lambs were subjected to a 56-day fattening trial. At the end of the experiment, significant differences were found among the groups in terms of body weight, avarage daily gain, feed intake, and feed conversion ratio ($P<0.05$). The experiment-2 group had the highest body weight, avarage daily gain, and feed intake during the entire fattening period. The experiment-1 and especially experiment-2 groups performed well during the first 28 days of the fattening research. Experiment-2 performed the best in terms of feed conversion ratio, followed by experiment-1 and experiment-3. Between the 29-56th days of the fattening period, the experiment-3 groups performance improved. On the other hand, it was determined that the performance of experiment-1 and experiment-2 decreased between 29-56 days of the fattening period compared to 0-28 days. When the cost of the 1 kg ration used in the research was examined, it was determined that the lowest cost ration belonged to experiment-3, and experiment-1 and experiment-2 were the same. Parallel to the ration costs, it was determined that the lowest cost per 1 kg of body weight gain was in experiment-3, while the highest cost was in experiment-1. However, when examining both the income and profit from body weight gain, they determined that experiment-2 was significantly better than the other groups. In conclusion, the best performance and economic gain in male yearlings lambs fed with rations composed of different energy sources were obtained from wheat-based rations.

Keyword: Energy source; fattening economy; fattening performance; yearling lambs fattening

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INTRODUCTION

The world uses a variety of small ruminant fattening techniques (Yaralı and Karaca, 2011). Small ruminant fattening techniques can be categorized as suckling lamb fattening, intensive post-weaning lamb fattening, pasture lamb fattening, and yearling lamb fattening. The economic dimension of these fattening practices also varies. Research in recent years has shown that the most economical and fastest lamb fattening method is the intensive feeding method applied after weaning (Asadi vd., 2016; Azizi-Shotorkhoft vd., 2018; Arjmand vd., 2022). The correct selection of energy sources for rations in intensive fattening applications is of great importance in terms of increasing productivity and reducing costs in farming. Energy sources have a direct impact on animal growth rate, feed conversion rate, carcass quality, and the environment (Asadi vd., 2016; Azizi-Shotorkhoft vd., 2018; Arjmand vd., 2022). For example, McKeown et al. (2019) stated in their study that the use of triticale-based dried distillers grains and solubles up to 60% instead of barley did not have a negative effect on fattening performance, but there was an increase in N and P excretion into the environment. Worldwide, fattening rations use grains like barley, wheat, and corn as energy sources (Oba, 2011; Azizi-Shotorkhoft vd., 2018; Akbay, 2023). Cereals differ from each other with their different energy contents, nutrient profiles, and digestibility properties (Purwin et al., 2022; Akbay, 2023). For example, the starch of barley and wheat is degreded faster than that of corn (Purwin et al., 2022).

Barley is generally characterized as a low-cost energy source and has a higher fiber content than corn and wheat (Purwin et al., 2022). Wheat offers a more balanced nutritional profile than barley and corn and is also notable for its protein content, but its energy content is not as high as corn.

Traditional methods widely apply a feeding technique known as barley fattening. However, the correct selection of energy sources can increase efficiency in the livestock sector and contribute to reducing production costs. The literature does not find any studies comparing barley, wheat, and corn as energy sources for fattening.

In this study, it was aimed to determine the effect of intensive fattening on the performance and production cost of male Morkaraman yearlings lambs by preparing three different isocaloric and isonitrogenous rations using barley, corn, and wheat as energy sources with raw materials obtained from Iğdır and surrounding provinces.

Materials and Methods

The animal materials were composed of male Morkaraman breed lambs born in 2023 at the Animal Production Center of the Animal Science Department of Iğdır University Faculty of Agriculture. The experiment started with the creation of three distinct groups, each with three replications and similar weights. The yearlings used in the study had an average body weight of 44 kg and were 7.5–8 months old. We performed a 15-day adaptation feeding at the end of the pasture season. Next, they initiated a 56-day intensive fattening experiment. A total of 27 animals were used, 9 animals in each experimental group. In the study, the body weights (BW) of the yearlings lamb were weighed individually with a scale with 100 g sensitivity at the beginning (day 0), in the middle (day 28), and at the end of the experiment (day 56). Avarage daily gain (ADG) was determined by using the BW of the groups at the beginning, middle, and end of the experiment.

Feed raw materials used in the preparation of fattening rations were supplied by commercial companies operating in Iğdır province. The rations prepared as isocaloric and isonitrogenous were prepared taking into account the nutrient requirements specified by NRC (2007) (Table 1). Feed and water were supplied to the animals *ad libitum*. The experimental groups were fed twice a day at the same times of the day, with feed remaining in the feeders. The next day, the remaining feed in the feeders was collected and subtracted from the feed given, and daily feed intake (FI) was determined. Feed conversion ratio (FCR) was calculated using FI and ADG.

The prices of feed raw materials used in the research were recorded (Table 1). The cost of 1 kg of ration was calculated using the prices of feed raw materials. The average ration cost of each animal in each group during the fattening period was calculated by using the ration cost and the average individual FI of the experimental groups.

We calculated the cost of 1 kg of body weight gain using the feed conversion ratio and the ration cost of the groups. The income from ADG was determined by multiplying the total body weight gain at the end of the experiment by the current meat price (385 TL/kg, autumn 2024). The income from body weight gain was calculated by subtracting the average ration cost from this income. Thus, the income was determined with the cost of 1 kg of meat

Table 1. Ingredients and chemical composition of the experimental diets.

Ingredients, %	Unit price, kg/TL	Experiment-1	Experiment -2	Experiment -3
Barley	6.45	57.50	-	-
Wheat	7.50	-	57.50	-
Corn	5.20	-	-	57.50
Vegetable oil	31.50	2.30	-	-
Wheat bran	6.00	1.60	8.10	7.00
Cottonseed meal	6.45	6.00	1.80	9.20
Alfalfa	5.00	30.00	30.00	30.00
NaCl	1.00	1.00	1.00	1.00
Limestone	7.50	1.50	1.50	1.50
Mineral and vitamin premix*	35.00	1.00	1.00	1.00
Total		**100**	**100**	**100**
Nutrient composition (% of DM)				
Dry matter, %		94.28	93.69	94.12
Crude Protein, %		14.50	14.50	14.50
Metabolizable energy, kcal/kg		2713	2716	2714

*The mineral and vitamin premix contained (per kg DM premix): 500.000 IU vitamin A, 100.000 IU vitamin D3, 50 mg vitamin E, 10,50 mg vitamin B1, 1.800 mg niacin, 3,52 mg biotin, %3,5 Na, %1 Mg, %0,47 P, %33,96 Ca, 2.500 mg Mn, 30,8 mg Co, 4.400 mg Zn, 800 mg Cu, 4.250 mg Fe, 14,75 mg Se, 25.5 mg Iodine.

production, and the economic status of the yearling fed with different rations was revealed.

As a result of the study, the results of fattening performance were subjected to variance analysis with ONE-WAY-ANOVA, and the differences between the treatment groups were compared with the Duncan (SPSS, 2016) multiple comparison test.

RESULTS AND DISCUSSION

The effects of rations created using different energy sources (barley, wheat, and corn) on yearling fattening performance parameters are given in Table 2.. The significant differences were found between the experimental groups in body weight (BW), avarage daily gain (ADG), feed intake (FI), and feed conversion ratio (FCR) ($P<0.05$).

Yearlings in experiment-2 had superior BW and ADG compared to those in experiment-1 and 3. Additionally, it was determined that experiment-1 and 2 groups showed better performance in terms of BW on the first 28th day of the fattening period. In terms of ADG speed, the best performance order in the first period of the experiment (0-28 days) was found to be experiment-2>experiment-1> experiment-3.. However, between the 29-56th days of the experiment, the order changed as experiment-2= experiment-3> experiment-1. During the experiment, the highest FI was determined as the experiment-2 group, followed by the experiment-1 group and finally the experiment-3 group. In addition, although the experiment-3 group had the least FI in the total fattening period, it was determined that the experiment had a similar amount of FI with experiment-1 between days 29-56. Based on ADG and FI data during the trial period, it was determined that the experiment-2 group had the lowest FCR. There was no difference in terms of FCR in the total fattening period between the experiment-1 and experiment-3 groups. The experiment-1 and experiment-2 groups outperformed the experiment-3 group in the first 28 days of the experiment. However, the FCR parameter of the experiment-3 group improved between the 29-56 days of the experiment.

This study investigated the effects of isocaloric and isonitrogenous diets made of 3 different energy sources on the fattening performance of Morkaraman male yearlings. In the literature, it has been reported that BW was significantly affected at the end of studies conducted on Morkaraman breed lambs fed with different fattening methods and rations (Macit, 2002; Esenbuga et al., 2009; Avila-Stagno et al., 2013; Şahinler et al., 2023). For example, in a study conducted on Morkaraman yearlings, it was stated that the BW at the beginning of the fattening of ap-

Table 2. Effect of rations created with different energy sources on fattening performance.

	Experiment-1	Experiment-2	Experiment-3	SEM	Sig.
Body weight kg					
Initial	44.60	44.57	44.11	0.575	NS
Day 28	51.01^{a}	52.49^{a}	47.96^{b}	0.745	*
Day 56	55.43^{b}	58.25^{a}	53.60^{b}	0.638	**
Avarege daily gain (g/d)					
Day 0-28	227^{b}	283^{a}	137^{c}	0.022	***
Day 29-56	160^{b}	207^{a}	203^{a}	0.008	**
Day 0-56	197^{b}	247^{a}	170^{c}	0.012	***
Feed intake (kg/d)					
Day 0-28	1.62^{b}	1.77^{a}	1.32^{c}	0.069	***
Day 29-56	1.61^{b}	1.86^{a}	1.53^{b}	0.052	**
Day 0-56	1.62^{b}	1.82^{a}	1.43^{c}	0.057	***
Feed conservation ratio (g/g)					
Day 0-28	7.07^{b}	6.30^{b}	9.64^{a}	0.523	***
Day 29-56	10.26^{a}	9.03^{ab}	7.63^{b}	0.435	*
Day 0-56	8.37^{a}	7.44^{b}	8.43^{a}	0.195	*

Different letters in the shoulder label of peer data indicate significant differences ($p < 0.05$), while no letters indicate insignificant differences ($p > 0.05$), *P<0.05, **P<0.01, *** P<0.001; NS: non-significant. Experiment-1: ration created using barley as an energy source; Experiment-2: ration created using wheat as an energy source; Experiment-3: ration created using corn as an energy source.

proximately 8-month-old male yearlings for 60 days was 40.54 kg, while the BW at the end of the trial was 54.58 kg (Esenbuga et al., 2009). Avila-Stagno et al. (2013) determined in their study that the differences and contents of energy sources affect fattening performance. BW differences between experimental groups in this study have been thought to be due to energy source contents. Additionally, it is believed that the rations energy source influences the development trend in accordance with the fattening period. Because as seen in Figure 1, while the BW development trend was in experiment-1 and especially experiment-2 in the first 28 days of the trial, it was seen that the BW trend of experiment-3 improved in the 29-56 days and the other groups slowed down. In this case, it is thought that different energy sources can be selected by grouping the fattening period within itself. On the other hand, the results of this study are similar to those of the BW study conducted on Morkaraman breed lambs and yearlings in the literature (Macit, 2002; Esenbuga et al., 2009; Şahinler et al., 2023).

Different energy sources used in the diets significantly affected ADG. As seen in Figure 2 (A), in the first 28 days of the fattening period, it was found that the ADG of the animals in experiment-2 was much higher than in experiment-1 and experiment-3.. However, in the later period of the fattening (29-56 days), it was found that the ADG speed of experiment-1 and experiment-2 decreased, while it increased in experiment-3. So much so that in the first 28 days of the trial, the 146 g difference between the experiment-2 and experiment-3 groups in terms of ADG disappeared. Throughout the fattening period (0-56 days), the highest ADG was in experiment-2. Following experiment-2, it was determined that the experiment-1 and finally the experiment-3 groups had ADG. When Figure 2 (A) is examined, the change in the ADG of the animals during the trial period is clearly seen. In fattening studies conducted on Morkaraman breed lambs and yearlings, it was stated that the ADG was in the range of 145–314 g, depending on the age, gender, initial body weight of the animal, fattening model, and content of the ration (Çakır et al., 1981; Aksoy, 1996; Esenbuga et al., 2009; Şahinler et al., 2023; Kara et al., 2024). The study observed that the ADG during the trial period (0-56 d) fell within the specified range. However, it was determined that the experiment-3 group was slightly lower than this range on days 0-28 of the trial. These results indicate that fattening performance can be increased by creating rations with different

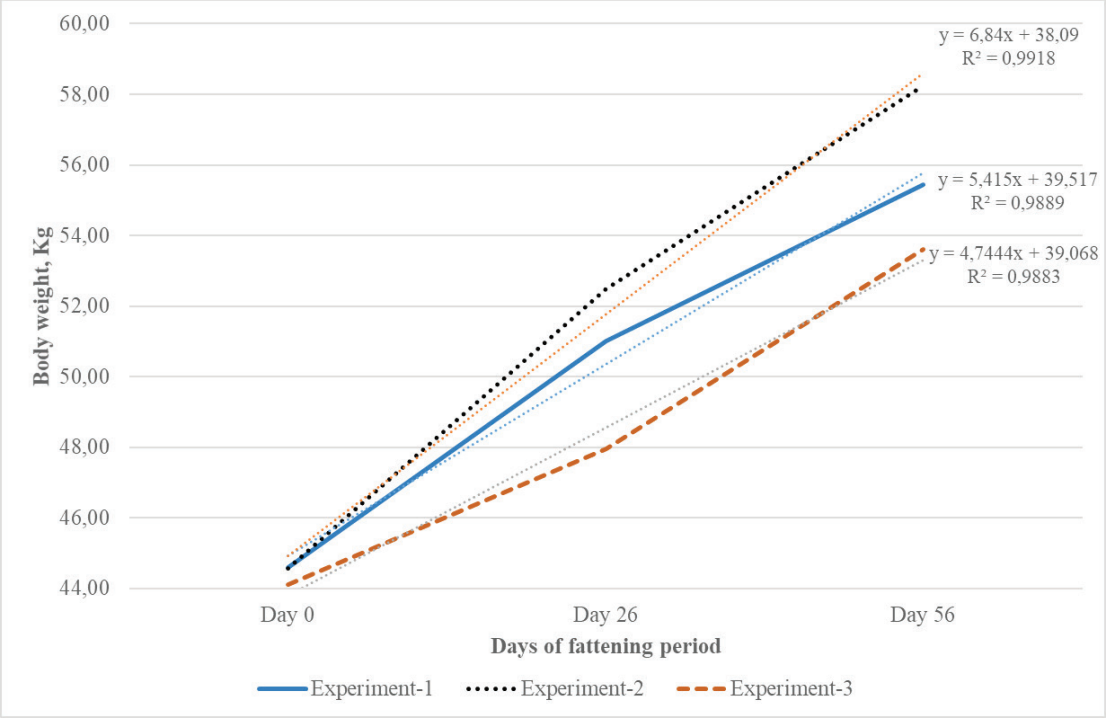


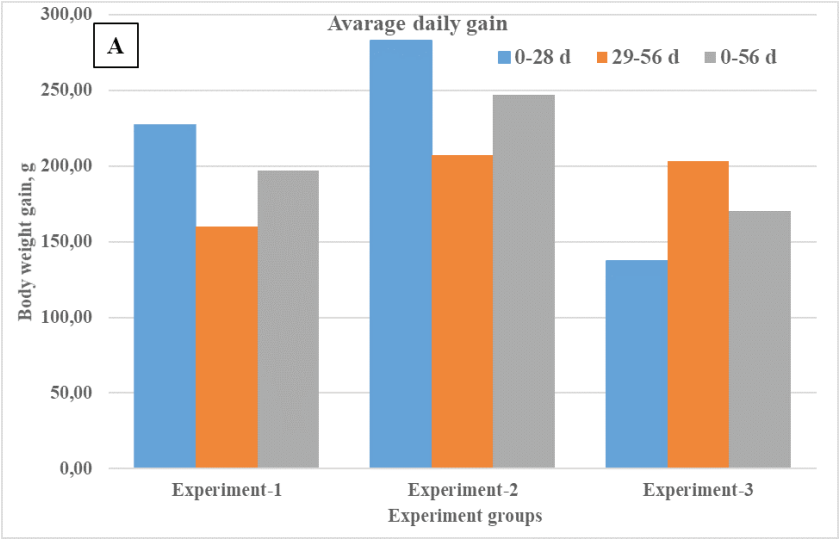
Figure 1. Body weight trend of yearlings during the trial.

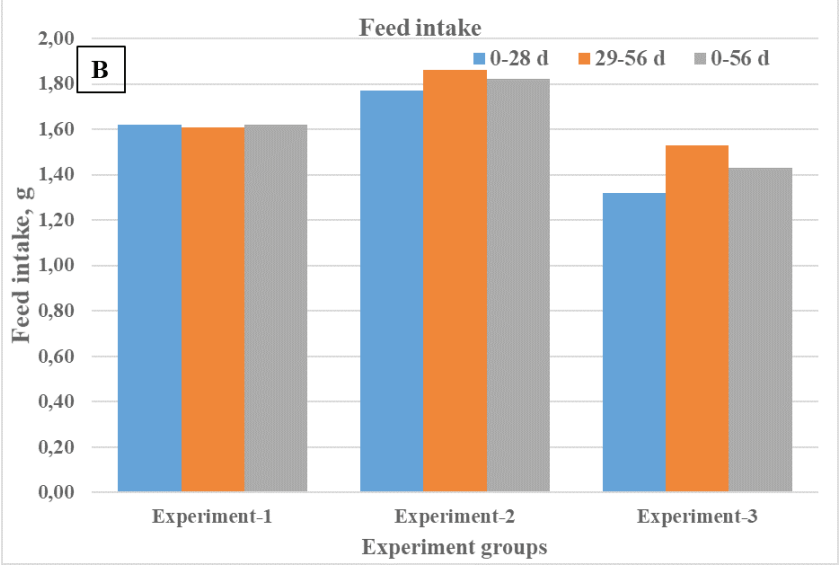
energy sources during the fattening period while also paying attention to the economy. For example, starting with rations created with barley or wheat-based energy sources at the beginning of fattening and feeding with rations using corn as an energy source during the finishing period can be done.

Similar to the ADG, there were significant changes in feed intake (FI) during the trial period (Figure 2 (B)). Namely, it was observed that the highest FI order on days 0-28 of the trial was experiment-2 > experiment-1 > experiment-3.. It was determined that the trial was ordered as experiment-2 > experiment-1= experiment-3 between days 29-56. As a matter of fact, this change in FI between days 29-56 also had an effect on avarage daily gain. In this study, it was determined that FI was 1.32-2 kg/d throughout the trial period. The FI results in this study are consistent with the results of fattening studies conducted on Morkaraman lambs and yearlings (Macit, 2002; Küçük et al., 2002).

Depending on the changes in ADG and FI, the feed conversion ratio (FCR) showed significant differences between days 0-28 and days 29-56 of the 56-day fattening period (Figure 2 (C)). It was determined that the FCR were better between the 0-28th days of the experiment in experiments-1 and experiment-2.. However, the FCR of experiment-3 improved between the 29-56th days of the trial, while it deteriorated in experiments-1 and experiment-2.. The experiment-2 group had the best FCR on average over the research period. A study on Morkaraman breed yearlings of similar age and BW reported that the FCR was 6.77 (Esenbuga et al., 2009). In this study, during the first 28 days of the trial, the results for the experiment-1 and experiment-2 groups were close to those of Esenbuga et al. (2009), while the results for experiment-3 were similar between days 29-56. It is believed that the animals BW is responsible for the deterioration of FCR in experiment-1 and experiment-2 between days 29-56 of the trial. Because Kara et al. (2024) stated that fattening performance is affected by parameters such as breed, age, gender, and body weight. It is also known that the fattening performance of animals with high BW is reduced compared to animals with low BW. In studies conducted on yearling fattening of different breeds, it is seen that FCR is in a very wide range (Gül, 2004; Abas et al., 2007; Keno et al., 2021). The significant differences in FCR results from studies in the literature may be affected by many factors, such as trial conditions, body weight, avarage daily gain rate during the trial period, and ration.

When the total performance parameters of the yearling fattening trial were examined, it was deter-





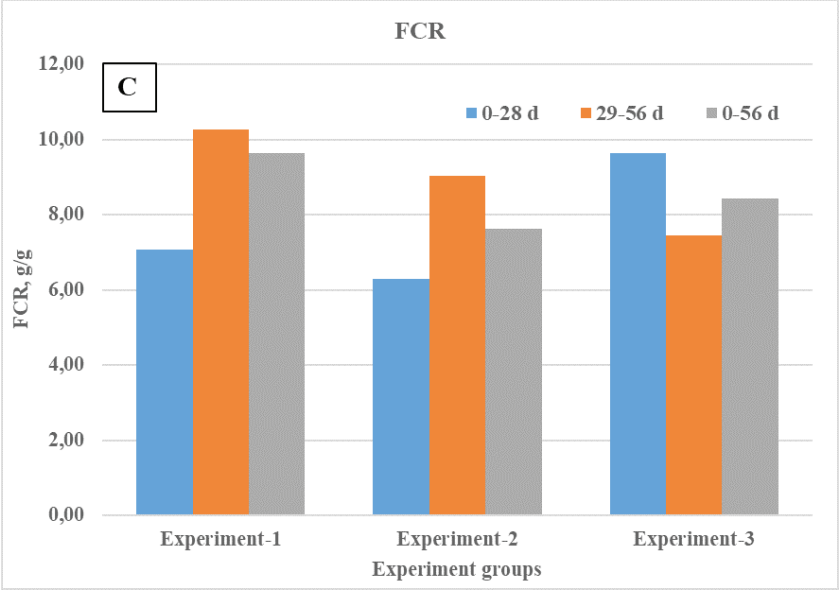


Figure 2. Effects of diets prepared with different energy sources on avarage daily gain (A), feed consumption (B), and feed conversion ratio (C) of yearlings.

mined that the animals fed with rations consisting of barley and especially wheat as energy sources showed better performance at the beginning of the fattening period. However, it was determined that this performance decreased as body weight increased.

The cost of rations created with different energy sources, the meat production cost, and the income status obtained from ADG are given in Table 3.. When Table 3 is examined, the ration cost is 6,57 TL per kg in experiment-1 and 2, and 5,28 TL in experiment-3. This difference in ration costs is due to the prices of the raw materials used. Factors such as the decline in wheat production in Türkiye and the rise in its imports in recent years have led to a significant increase in its price. This has increased the ration cost of experiment-2 considerably. On the other hand, the cost of experiment-1 is due to the prices of barley and vegetable oil. The low price of corn due to its overproduction in recent years has significantly affected the cost of experiment-3.. When the total ration cost of an animal during the fattening period is examined, it is seen that the experiment-2 group (669,61 TL) has the highest cost, followed by the experiment-1 group (596,03), and the experiment-3 group (422,82) has the lowest cost. These differences in total ration costs during the fattening period arise due to the feed intake of the animals and the prices of ration raw materials, as can be seen in Table 2.

The cost per kg body weight gain of the fattening trial varied in the fattening periods (Figure 3). In the first period of the fattening period (0–28 days), it was observed that experiment-2 had the most affordable cost (41,39 TL), followed by experiment-1 (46,45 TL) and experiment-3 (50,90 TL), respectively. However, between the 29-56th days of the experiment, it was determined that experiment-3 (40,29 TL) had the lowest ration cost, followed by experiment-2 (59,33 TL) and experiment-1 (67,41 TL). Throughout the fattening period, experiment-3 (44,51 TL) has the most suitable ration cost, while experiment-1 (54,99 TL) has the highest cost. These differences are also due to the FCR data among the groups. Despite the experiment-2 group having the highest feed intake and ration cost, the group with the highest total cost during the fattening period is experiment-1. This difference occurs because the BWG of the experiment-2 group is high, that is, the FCR is low. In fact, the net profit from BWG clearly reflects this situation. When the ration cost and the net profit data obtained are evaluated, although the ration cost is high, the low FCR value directly affects profitability. This indicates that the ration tolerates the cost arising from the raw material prices used. It was determined that experiment-2 was superior in terms of income and profit obtained from body weight gain in parallel with fattening performance. In this case, it actually shows that the traditional barley fattening habit is not always valid. Considering the prices of energy sources, it is seen that a rational approach rather than traditionalism in fattening will positively affect profitability. In addition, although the cost of body weight gain is low in fattening in experiment-3, when examined in terms of income, it is seen that experiment-2 is much more profitable than the other groups.

CONCLUSION

The economic situation and fattening performance of Morkaraman breed male yearlings fed with rations

Table 3. Ration and meat production costs and income

	Fattening periods	Experiment-1	Experiment-2	Experiment-3
Cost of 1 kg ration, TL	Day 0-56	6,57	6,57	5,28
Total ration cost for fattening period, animal/TL	Day 0-56	596,03	669,61	422,82
Feed conservation ratio, g/g	Day 0-56	8.37	7.44	8.43
	Day 0-28	46,45	41,39	50,90
Cost of 1 kg BWG, TL	Day 29-56	67,41	59,33	40,29
	Day 0-56	54,99	48,88	44,51
Avarage BWG, kg	Day 0-56	10.83	13.68	9.49
Income from BWG, TL	Day 0-56	4169,55	5266,80	3653,65
Profit from BWG, TL	Day 0-56	3573,52	4597,19	3230,83

BWG:body weight gain; TL: Türk lira

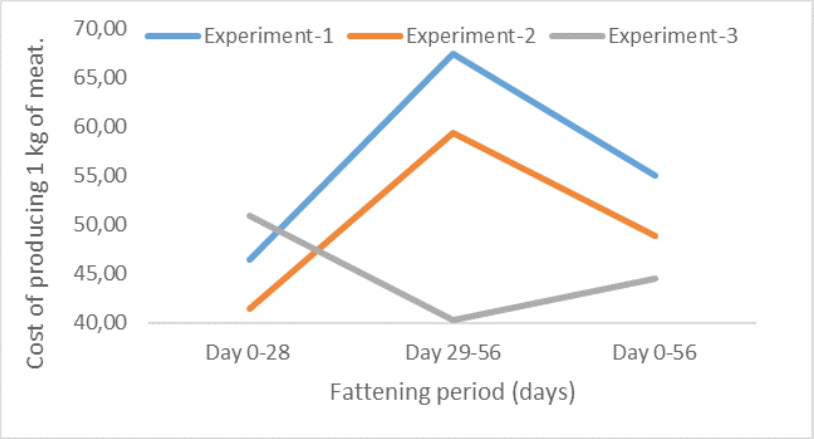


Figure 3. Cost of producing 1 kg of meat during the fattening period.

that contained different energy sources are studied. It is found that the experiment-2 group is more profitable when body weight gain is taken into account, even though the experiment-3 group has a better fattening cost. Similarly, the fattening performances showed that feeding with wheat (experiment-2) was more advantageous. In addition, considering the current prices of barley, wheat, and corn, it is thought that fattening economy and performance can be improved by creating rations with barley or wheat at the beginning of the fattening period and corn in the finishing period. The results obtained from this study need to be presented with more comprehensive parameter results, such as meat quality and blood parameters.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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