Study Of The Effect Of Different Ratios of Forage To Concentrate On Performance And Carcass Traits Of Zel Fattening Lambs

Seyed Mohsen Mousavi Kashani
Qaemshahr Branch, Islamic Azad University

Shahabodin Gharahveysi (S.gharavysi@gmail.com)
Islamic Azad University, Qaemshahr Branch https://orcid.org/0000-0002-1069-0215

Kaveh Jafari Khorshidi
Qaemshahr Branch, Islamic Azad University

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Abstract

Fattening refers to the proper management and feeding of livestock to achieve maximum weight gain at a minimum cost over a specified period of time. This study aimed to determine the most effective ratio of forage to concentrate on feed intake, performance, and carcasses of male Zel fattening lambs. The present study was performed using 20 lambs of 16-week-old for 90 days in a completely randomized design with four treatments and five replications at the Islamic Azad University of Qaemshahr. Experimental treatments included different ratios of forage to concentrate (80:20, 70:30, 60:40, and 50:50). Traits were measured during the fattening period. The collected data were analyzed by LSmeans procedure and regression in SAS software. Effect of different ratios of forage to concentrate was significant on all performance traits ($p < 0.01$), slaughter weight ($p < 0.05$), weight gain during rearing ($p < 0.05$), daily weight gain ($p < 0.05$), feed intake ($p < 0.01$), feed conversion ratio ($p < 0.01$), the weight of digestive system contents ($p < 0.05$), hot and cold carcass weight ($p < 0.05$), carcass percentage ($p < 0.05$) and thickness Backfat ($p < 0.05$). The linear change in the mentioned traits is due to the increase of the concentrate to forage ratio ($p < 0.01$). As the percentage of concentrate in the ration increases, feed intake increases. The concentrate is palatable and contains more energy and nutrients than forage. Therefore, lambs that consumed more concentrate had higher body weight and slaughter weight. Based on the results for optimal performance in fattening lambs, a ration with the ratio of forage to concentrate equal (50:50) is recommended.

Introduction

One of the main strategies for producing animal protein is fattening. Fattening refers to the proper management and feeding of livestock to achieve maximum weight gain at a minimum cost over a specified period of time. On the other hand, the purpose of being weight gain is to provide the animal protein needed for human societies (Hosseini et al. 2019). Fattening using pastures is cheaper than intensive fattening, but will take longer. Also, the amount of overweight in this method is much less than the intensive method. Because some of the energy and nutrients that need to be stored in fattening animals are wasted on maintenance and walking. This method is not suitable for a country like Iran. Because the pastures of the country are not in a good condition. The number of grazing livestock is more than the capacity of pastures. Due to the decrease in rainfall and the increase in the number of livestock, the condition of the pastures worsens every year. Feeding lambs in pastures or with forage, although it may produce carcasses with a higher ratio of lean meat, will reduce the growth rate and produce lighter carcasses. In contrast, lambs fattening with concentrate-based rations increases the growth rate and production of heavier carcasses (Murphy et al. 1994). For lamb fattening in the intensive method, a feed consisting of forage and concentrate is used. Forage is fibrous in nature. Because of this, they cannot provide enough energy and protein to feed lambs. Therefore, this deficiency can be met by dense food in terms of energy and protein (concentrate). The right combination of forage and concentrate can create the best and most desirable performance in lamb fattening. The results indicate that the addition of concentrate to forage-based rations in ruminants by increasing the heat produced by visceral organs and reducing the energy of fecal dry matter and urinary nitrogen increases the production efficiency of these animals (Shi et al. 2018). When rations consisting of grains and forage are consumed, the efficiency of utilizing nutrients for the production of animal tissues usually increases (Nie et al. 2020). The appropriate ratio of forage to concentrate in the ration of fattening lambs is important. Traits related to lamb fattening in the intensive method depend on the ration's energy and protein levels (Borton et al. 2005; Nie et al. 2020).

Zel sheep is the only without tail fat breed in Iran. Instead of a tail fat, it has a narrow tail consisting of 7 tail nuts with a length of 10 to 15 cm. Lack of tail fat in Zel sheep has caused fat accumulation and storage in the tail fat is not done and stored between tissues. This has increased the quality and marketability of Zel lamb meat (Hosseini et al. 2019).

This study aimed to determine the best forage to concentrate ratio on feed intake, performance, and carcasses of male Zel fattening lambs.

Materials And Methods

Animals and treatments

The present study was performed using 20 male Zel lambs in the Islamic Azad University of Qaemshahr. The mean weight of lambs with a mean age of 16 weeks was 27.8±2.1. Experimental treatments included rations with different ratios of forage to concentrate (80:20, 70:30, 60:40, and 50:50). Metabolizable energy and crude protein of rations were 2.10, 2.15, 2.40, and 2.85 mcal/kg of dry matter and14.0, 14.3, 15.2, and 16.3%, respectively (table 1). Published tables and references were used to determine the chemical composition of the feed materials used and the metabolizable energy of the rations (AFRC 1998; Nik-Khah and Amanlou 2001). Rations were formulated based on the tables of nutritional needs and requirements of animals and were presented in table 1 (Nik-Khah and Amanlou 2001).

A box was designed and considered for each lamb. Experimental feeds were randomly assigned to lambs. Water and feed were provided for each box. Thus, feed consumption was measured individually. The duration of the experiment was 90 days. Lambs were weighed every week after 10 hours of abstinence and at 6 a.m. The lambs were fed three times a day at 6, 14, and 20 o'clock to the point of appetite. Healthy water was constantly available to the lambs.

Traits measurement

At the end of the rearing period, three lambs from each treatment were randomly selected and slaughtered. All body parts and internal organs of each animal were separated and weighed. The carcasses were kept in the refrigerator for 24 hours at 4°C. Each carcass was then divided into two equal parts. The final weight at the end of the experimental period was considered as the slaughter weight. The right half of the carcass was divided into pieces including neck, shoulder, brisket, flank, Rack-Loin, and legs. Then, they were weighed. Lean meat tissues, subcutaneous fat, intramuscular and bone fat were separated and weighed (Hosseini et al. 2019). To measure the cross-sectional area of the rack-Loin muscle or eye muscle, the area between the ribs 12 and 13 of the left carcass was cut, and its area was calculated using a Planimeter. The subcutaneous fat thickness of the left half carcass was measured on the transverse diameter of the eye muscle as the backfat thickness (Borton et al. 2005; Fimbres et al. 2002; Ramos et al. 2020).

Table 1. Experimental rations used and their compounds (%)

	Experimental	Treatment	(Forage to	concentrate ratio)
Ration components	80:20	70:30	60:40	50:50
Soybean meal	3	5	7	10
Corn	3	6	9	12
Barely	2	4	7	10
Wheat bran	2	5	7	8
Alfalfa	80	70	60	50
Molasses sugarcane	3.5	3.5	3.5	3.5
Dicalcium phosphate	3	3	3	3
Supplement[1]	0.5	0.5	0.5	0.5
Salt	0.5	0.5	0.5	0.5
Bicarbonate sodium	0.5	0.5	0.5	0.5
Calcium carbonate	2	2	2	2
Chemical	*compounds*			
Metabolizable energy(Mcal/Kg)	2.10	2.15	2.40	2.85
Crude protein(%)	14.0	14.3	15.2	16.3
Calcium(gr/Kgr)	10.1	10.4	10.7	10.9
Phosphorus(gr/Kgr)	6.0	6.1	6.2	6.3

1. Each kilogram of supplement includes 2400 international units of vitamin A, 2000 international units of vitamin D3, 1900 international units of vitamin E, 1.15 grams of manganese, 1.19 grams of zinc, 51.2 grams of magnesium, 0.52 grams of Iron, 3 g of sulfur, 0.52 g of copper, 14 mg of cobalt, 26 mg of iodine, and 10 mg of selenium.

Statistical analysis

For the present study, a completely randomized experimental design with four treatments and five replications was used. The collected data for the studied traits were recorded in the computer. LSmeans procedure and regression in SAS software (2000) were used for statistical analysis of data. The statistical model used was as follows:

$y_{ij} = \mu + T_i + e_{ij}$

That; y_{ij}, the amount of each observation; μ, the mean effect; T_i, the treatment effect, and e_{ij} is the residual effect.

Result

Performance traits

As shown in table 2, the effect of different ratios of forage to concentrate was significant on all performance traits ($p<0.01$). Treatment containing the equal ratio of forage to concentrate caused a significant change in performance traits ($p<0.01$). Traits of slaughter weight ($p<0.05$), weight gain in fattening period ($p<0.05$), daily weight gain ($p<0.05$), feed intake ($p<0.01$) and feed conversion ratio ($p<0.01$) were increased linearly with increasing concentrate to forage ratio (table 2). This means that as the amount of concentrate in the ration increases, these traits increase with a constant linear coefficient. It should be noted that no significant nonlinear relationship was observed ($p>0.05$).

Table2. The effect of different forage to concentrate ratios in feed on performance traits of Zel fattening lambs

Treatment(forage to concentrate ratio)	Initial weight(kg)	Slaughter weight(kg)	Weight gain in fattening(kg)	Daily weight gain(g/d)	Feed consumption(g/d)	Feed conversion ratio[1]
80:20	27.8	50.6[a]	22.8[a]	253[a]	2109[a]	8.34[a]
70:30	27.6	52.8[a]	25.2[a]	280[a]	2196[a]	7.84[a]
60:40	27.9	54.3[a]	26.4[a]	293[a]	2201[a]	7.51[a]
50:50	27.7	58.9[b]	31.2[b]	347[b]	2280[b]	6.57[b]
P.Value[2]	0.46	0.01	0.01	0.01	0.01	0.01
SEM[3]	0.89	0.91	0.78	9.12	82.8	0.19
Linear[4]	0.89	0.03	0.03	0.03	0.00	0.00
Nonlinear	0.96	0.10	0.13	0.21	0.08	0.27

1- Feed conversion ratio is feed consumption divided by daily weight gain. 2- Probability value. 3- Standard error of mean. 4- P.value values of regression coefficients are presented. Common letters in each column indicate no statistically significant difference ($p>0.05$).

Traits related to carcass quality

Studying the effect of different ratios of forage to concentrate on carcass quality traits (table 3), it was observed that the difference between the mean weight of digestive system contents, hot and cold carcass weight, carcass percentage, and backfat thickness was significant ($p<0.05$).

Traits of the weight of digestive system contents ($p<0.01$), hot and cold carcass weight ($P<0.05$), carcass percentage ($p<0.05$), and backfat thickness ($p<0.05$) with increasing concentrate to forage ratio Increased linearly (Table 3). It should be noted that no significant nonlinear relationship was observed ($p>0.05$).

Table3. The effect of different forage to concentrate ratios in feed on the carcass quality of Zel fattening lambs

Treatment(forage to concentrate ratio)	Weight of digestive system contents (kg)	Weight of empty digestive system (kg)	Hot carcass weight (kg)	Cold carcass weight (kg)	Carcasses percentage (%)	Back fat thickness (mm)	Eye muscle area (cm2)
80:20	5.8[a]	4.2	29.8[a]	29.0[a]	57.3[a]	5.9a	16.9
70:30	4.1[b]	4.1	32.7[b]	30.9[b]	58.5[ab]	8.6b	17.2
60:40	4.0[b]	3.8	33.1[b]	31.8[b]	58.6[ab]	8.5b	17.0
50:50	3.8[b]	3.9	33.5[b]	32.0[b]	54.3[b]	8.1b	17.2
P.Value[1]	0.03	0.09	0.04	0.04	0.04	0.04	0.19
SEM[2]	0.30	0.18	0.69	0.91	0.83	0.40	0.33
Linear[3]	0.00	0.06	0.03	0.03	0.03	0.04	0.19
Nonlinear	0.06	0.49	0.19	0.46	0.03	0.09	0.27

1- Probability Value. 2- Standard error of mean. 3- P.value values of regression coefficients are presented. Common letters in each column indicate no statistically significant difference (p>0.05).

Traits of fat, meat and carcass bone

As can be seen in table 4, the effect of different ratios of forage to concentrate was not significant on all traits related to fat, meat, and carcass bone (p>0.05). Also, the results of regression analysis presented in table 4 show that there is no linear and non-linear relationship between changes in these traits and increasing the percentage of concentrate in the ration (p>0.05).

Table4. The effect of different ratios of forage to concentrate in feed on fat, meat and carcass bones of fattening lambs (kg)

Treatment(forage to concentrate ratio)	Lean meat	Bone	Subcutaneous fat	Intramuscular fat	Total carcass fat	The ratio of lean meat to carcass fat
80:20	7.5	2.1	1.8	0.8	2.6	2.9
70:30	7.9	2.4	2.0	1.0	3.0	2.6
60:40	8.2	2.6	2.4	1.0	3.4	2.4
50:50	8.5	2.5	2.6	1.2	3.8	2.2
P.Value[1]	0.07	0.19	0.27	0.21	0.10	0.09
SEM[2]	0.27	0.10	0.10	0.07	0.20	0.18
Linear[3]	0.41	0.76	0.82	0.90	0.84	0.23
Nonlinear	0.64	0.85	0.02	0.58	0.31	0.37

1- Probability Value. 2- Standard error of mean. 3- P.value values of regression coefficients are presented. Common letters in each column indicate no statistically significant difference (p>0.05).

Carcass components traits

Studying the effect of different ratios of forage to concentrate on the traits of carcass components (table 5), it is observed that the difference between the mean weight of traits of carcass components was not significant (p>0.05). Based on the results of Table 4, it is observed that there is no linear and non-linear relationship between changes in carcass component traits and increasing the percentage of concentrate in the ration (p>0.05).

Table 5. The effect of different ratios of forage to concentrate in feed on carcass components of fattening lambs of Zel (kg)

Treatment(forage to concentrate ratio)	Right side carcass	Neck	Shoulder	Brisket	Flank	Rack-loin	Legs
80:20	14.9	1.4	2.5	1.4	1.7	2.3	4.0
70:30	18.7	1.3	2.4	1.3	1.6	2.2	4.3
60:40	16.0	1.3	2.3	1.1	1.6	2.1	4.4
50:50	16.2	1.2	2.3	1.1	1.5	2.0	4.1
P.Value[1]	0.06	0.20	0.19	0.25	0.27	0.18	0.21
SEM[2]	0.82	0.09	0.10	0.06	0.11	0.09	0.08
Linear[3]	0.50	0.34	0.90	0.16	0.04	0.42	0.28
Nonlinear	0.31	0.52	0.83	0.49	0.36	0.62	0.67

1- Probability Value. 2- Standard error of mean. 3- P.value values of regression coefficients are presented. Common letters in each column indicate no statistically significant difference (p>0.05).

Traits of internal organs of the body

Based on the results of table 6, it can be seen that the effect of different ratios of forage to concentrate was not significant on the traits of internal organs of fattening lambs (p>0.05). On the other hand, there is no linear and non-linear relationship between changes in these traits and increasing the percentage of concentrate in the ration (p>0.05).

Table6. The effect of different ratios of forage to concentrate in feed on internal organs of fattening lambs Zel (kg)

Treatment(forage to concentrate ratio)	Feet	Liver	Lungs	Heart	Spleen	kidneys	Fat of internal organs[1]
80:20	1.0	1.0	0.6	0.2	0.1	0.2	1.2
70:30	1.1	1.0	0.6	0.2	0.1	0.2	1.3
60:40	1.1	1.1	0.6	0.2	0.1	0.2	1.5
50:50	1.1	1.1	0.6	0.2	0.2	0.1	1.6
P.Value[2]	0.41	0.56	0.68	0.71	0.31	0.38	0.21
SEM[3]	0.06	0.02	0.08	0.01	0.01	0.01	0.08
Linear[4]	0.01	0.02	0.49	0.09	0.46	0.08	0.08
Nonlinear	0.01	0.76	0.90	0.31	0.18	0.39	0.02

1- The total fat of the kidneys, pelvis, and internal organs of the digestive tract. 2-Probability Value. 3- Standard error of mean. 4- P.value values of regression coefficients are presented. Common letters in each column indicate no statistically significant difference (p>0.05).

Discussion

Performance traits

The change significantly in the treatment containing the equal ratio of forage to concentrate (P <0.01) be due to the presence of dense substances containing energy and protein in the feed. Therefore, livestock showed better performance by consuming more concentrate. These results are consistent with the results of other researchers in this field (Glimp et al. 1989; Hatfield et al. 1997; Mahgoub et al. 2000).

The better response of livestock to a higher growth rate can be related to the increase in energy and protein concentration of the experimental rations. A number of researchers have reported that rations containing 70% concentrate stimulate the proper response of lambs and fattening calves to growth performance (Langlie 2020; Fimbres et al. 2002; Glimp et al. 1989; Mahgoub et al. 2000). They also reported that the effects of a high percentage of concentrate in the ration can be seen in the dry matter consumed by lambs (Hatfield et al. 1997; McLeod and Baldwin 2000), goats (Lu and Potchoiba 1990), and fattening calves (Lardy et al. 2004). The results of these studies are consistent with the results of the present study. The animal consumes the feed to provide the energy it needs. Once the energy needs are met, the appetite for food decreases. The highest and lowest performance was related to the lambs of the last and first treatment, respectively (table 2). Improving the conversion ratio of rations by increasing the concentrate ratio can be due to the increase in energy and protein in the ration, which led to a better response of livestock.

Traits related to carcass quality

With increasing the percentage of concentrate in the feed of fattening lambs and consequently increasing the feed consumption, the mentioned traits were affected and changes were observed. Concentrate increases the palatability of the ration and on the other hand, the amount of energy and other nutrients in the concentrate is more than forage. Therefore, it seems natural that the traits presented in table 3 improve. Compared to concentrate,

forager, in addition to being bulkier, also have the ability to absorb more water, which will increase the volume and, consequently, the weight of these substances in the gastrointestinal tract.

As the percentage of concentrate in the feed increased, the percentage of carcasses decreased linearly. It can be said that more contents of the digestive tract have negative effects on carcass performance. This means that more contents of the animal's digestive tract at the time of slaughter will reduce its carcass percentage. The results of the present experiment are consistent with the findings of other researchers in this field (Borton et al. 2005; Mahgoub et al. 2000; McClure et al. 1995; Singh et al. 2004).

Traits of fat, meat and carcass bone

Considering that in the present study, changing the ratios of forage to concentrate had no effect on traits of fat, meat and carcass bone, these results are consistent with the reports of other researchers (Borton et al. 2005; Ramos et al. 2020; McClure et al. 1995; Singh et al. 2004). According to the reports of other researchers and the results of the present study, it can be said that in rations containing high forage, less fat is stored subcutaneously in the carcass.

Carcass components traits

There are few studies on the effects of the percentage of dietary concentrate on carcass components (Moron-Fuenmayor and Clavero 1999; Preziuso et al. 1999). Legs, rack-loin, and shoulder weights have been reported to be heavier in lambs fed by forage-concentrated ration than in lambs fed by forage ration (Moron-Fuenmayor and Clavero 1999). This indicates the positive role of concentrate in fattening.

Traits of internal organs of the body

According to the current study results, it can be mentioned that the increase in the amount of concentrate consumption, which is due to the increase in the percentage of concentrate in the feed, has not affected the internal organs of the body. The results of the present study are consistent with the limited number of published reports in this field (Ramos et al. 2020; Moron-Fuenmayor and Clavero 1999; Singh et al. 2004).

Conclusion

As the percentage of concentrate in the ration, feed intake increases. The concentrate is palatable and contains more energy and nutrients than forage. Therefore, it is natural for lambs that consume more concentrate to have more body weight and slaughter weight. Due to the fact that the Zel breed is without tail fat, fat storage is done between the muscles and inside the abdominal area. Based on the results of the present study, for optimal performance in fattening lambs, a ration with an equal ratio of forage to concentrate (50:50) can be suggested.

Declarations

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Author contribution

All the authors contributed to the study conception and design. Data collection was done by Seyed Mohsen Mousavi Kashani. Data analysis and manuscript preparation were performed by Shahabodin Gharahveysi and Kaveh Jafari Khorshidi. All the authors edited, read, and approved the final manuscript.

Data availability

All data generated and analyzed during this study are included in this published article. Declarations The study was conducted at a commercial animal farm (Qaemshahr, Mazandaran province, north of Iran). All lambs' care and use procedures were approved by the Department of Animal Science, Islamic Azad University (Qaemshahr branch, Qaemshahr, Iran).

Consent to participate

Not applicable.

Consent for publication

All the authors give consent for publication.

Conflict of interest

The authors declare no competing interests

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