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Growth Performance and Carcass Traits of Zel Breed Lambs Fed Different Ratios of Forage and Concentrate

Research Article

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ABSTRACT

The research aimed to determine the most effective ratio of forage to concentrate on feed intake, body weight, and carcass traits of male Zel fattening lambs. The current study was performed using 20 lambs of 16-week-old for 90 days in a completely randomized design with four treatments and five replications. Experimental treatments were 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 and regression procedure in SAS software. Effect of different ratios of forage to concentrate was significant on the feed intake, body weight 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 back fat thickness ($P<0.05$). The linear change in the mentioned traits was due to the increase of the concentrate to forage ratio ($P<0.01$). As the percentage of concentrate in the ration increases, feed intake was increased. The concentrate is palatable and contains more energy and nutrients than forage. Therefore, lambs that consumed more concentrate had higher body and slaughter weight. Based on the results for optimal performance in fattening lambs, a ration with ratio of forage to concentrate equal (50:50) is recommended.

KEY WORDS lambs, carcass, fattening, feed intake, performance, weight.

INTRODUCTION

The lambs from the Zel breed 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. A lack of tail fat in the Zel sheep is caused fat accumulation and storage between tissues. This has increased the quality and marketability of Zel lamb meat (Hosseini *et al.* 2019). Animal protein production is dependent on animal fattening. Fattening is the good management and feeding of animals to get the maximum weight gain at a minimum cost over a determined period of time (Hosseini *et al.* 2019). One of the cheaper methods of fattening is using pastures. Of course, in this method, some of the feed energy is spent on walking the animal. This method is not suitable for countries that do not have pastures or, have poor pastures. Fattening lambs in pastures or by intensive method only 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. they cannot provide enough energy and protein to feed lambs for fattening in a short period. Therefore, in order to reach the desired weight in a short period of time, a concentration feed in terms of energy and protein (concentrate) can

be used. The right combination of forage and concentrate can create the best and most desirable performance in lamb fattening. In a study conducted by Shi *et al*. (2018), it has been reported that the addition of concentrate to forage-based rations in ruminants by increasing the heat produced by visceral organs and reduces the energy of fecal dry matter and urinary nitrogen increases the production efficiency. When rations consisting of concentrate 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). This study aimed to determine the best forage to concentrate ratio on feed intake, body weight, and carcasses traits of male Zel fattening lambs. The research hypothesis is that by increasing the amount of concentrate, feed consumption will increase and growth rate will increase.

MATERIALS AND METHODS

Lambs and treatments

The present study was performed using 20 male Zel breed 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 kg. Experimental treatments were 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 2.55 mcal/kg of dry matter and 14.0, 14.3, 15.2, and 16.3%, respectively (Table 1). Neutral detergent fiber (NDF) of rations were 32.7, 32.2, 30.7, and 28.9% respectively. Acid detergent fiber (ADF) of rations 24.8, 22.7, 20.6, and 18.5%, 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, 1993). Rations were formulated based on the tables of nutritional needs and requirements of animals and were presented in Table 1 (AFRC, 1993).

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 intake was measured individually. The duration of the experiment was 90 days. Lambs were weighed every week after 10 hours of feed's abstinence at 6 am. 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. Each animal's body parts and internal organs 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 back fat thickness (Fimbres *et al*. 2002; Borton *et al*. 2005; Ramos *et al*. 2020).

Statistical analysis

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

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

Where:
Y_{ij}: amount of each observation.
μ: mean effect.
T_i: treatment effect.
e_{ij}: residual effect.

RESULTS AND DISCUSSION

As shown in Table 2, the effect of different ratios of forage to concentrate was significant on the feed intake and body weight traits ($P<0.01$). Treatment containing an equal ratio of forage to concentrate caused a significant change in these traits ($P<0.01$). With increasing concentrate to forage ratio, 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 a constant linear coefficient). It should be noted that no significant nonlinear relationship was observed ($P>0.05$). 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, lambs 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).

Table 1 Experimental rations used and their compounds (%)

Ration components	Treatments		Forage to concentrate ratio	
	80:20	70:30	60:40	50:50
Soybean meal	3	5	7	10
Corn	3	6	9	12
Barley	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 estimated				
Metabolizable energy (kcal/kg)	2.10	2.15	2.40	2.55
Crude protein (%)	14.0	14.3	15.2	16.3
Calcium (g/kg)	10.1	10.4	10.7	10.9
Phosphorus (g/kg)	6.0	6.1	6.2	6.3
Neutral detergent fiber (NDF, %)	32.7	32.2	30.7	28.9
Acid detergent fiber (ADF, %)	24.8	22.7	20.6	18.5

[1] Each kilogram of supplement includes: vitamin A: 2400 IU; vitamin D_3: 2000 IU; vitamin E: 1900 IU; Mn: 1.15 g; Zn: 1.19 g; Mg: 51.2 g; Fe: 0.52 g; S: 3 g; Cu: 0.52 g; Co: 14 mg; I: 26 mg and Se: 10 mg.

Table 2 The effect of different forage to concentrate ratios (F/C ratio) on the feed intake, body weight traits of Zel fattening lambs

Forage:concentrate ratios	Initial weight (kg)	Slaughter weight (kg)	Weight gain (kg)	Daily weight gain (g/d)	Feed intake (g/d)	Feed conversion ratio
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	0.46	0.01	0.01	0.01	0.01	0.01
SEM	0.89	0.91	0.78	9.12	82.8	0.19
Linear	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

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

The better response of lambs 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 (Glimp *et al.* 1989; Mahgoub *et al.* 2000; Fimbres *et al.* 2002; Langlie, 2020). 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 lambs.

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 back fat 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 back fat thickness (P<0.05) with increasing concentrate to forage ratio were increased linearly (Table 3).

It should be noted that no significant nonlinear relationship was observed (P>0.05). 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. The concentrate increases the palatability of the ration. 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.

Table 3 The effect of different forage to concentrate ratios on the carcass quality of Zel fattening lambs

Forage: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 (cm^2)
80:20	5.8[a]	4.2	29.8[a]	29.0[a]	57.3[a]	5.9[a]	16.9
70:30	4.1[b]	4.1	32.7[b]	30.9[b]	58.5[ab]	8.6[b]	17.2
60:40	4.0[b]	3.8	33.1[b]	31.8[b]	58.6[ab]	8.5[b]	17.0
50:50	3.8[b]	3.9	33.5[b]	32.0[b]	54.3[b]	8.1[b]	17.2
P-value	0.03	0.09	0.04	0.04	0.04	0.04	0.19
SEM	0.30	0.18	0.69	0.91	0.83	0.40	0.33
Linear	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

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 4 The effect of different ratios of forage to concentrate on the fat, meat and carcass bones of fattening lambs (kg)

Forage:concentrate ratio	Lean meat	Bone	Subcutaneous fat	Intramuscular fat	Total carcass fat	Lean meat/carcass fat ratio
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	0.07	0.19	0.27	0.21	0.10	0.09
SEM	0.27	0.10	0.10	0.07	0.20	0.18
Linear	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

SEM: standard error of the means.

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

Forage: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	0.06	0.20	0.19	0.25	0.27	0.18	0.21
SEM	0.82	0.09	0.10	0.06	0.11	0.09	0.08
Linear	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

SEM: standard error of the means.

Table 6 The effect of different ratios of forage to concentrate on the internal organs of fattening lambs Zel (kg)

Forage: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	0.41	0.56	0.68	0.71	0.31	0.38	0.21
SEM	0.06	0.02	0.08	0.01	0.01	0.01	0.08
Linear	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.
SEM: standard error of the means.

Compared to concentrate, forage, 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 carcass weight 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 (McClure *et al.* 1995; Mahgoub *et al.* 2000; Singh *et al.* 2004; Borton *et al.* 2005).

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). 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 (McClure *et al.* 1995; Singh *et al.* 2004; Borton *et al.* 2005; Ramos *et al.* 2020). 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.

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). 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.

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). 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 (Moron-Fuenmayor and Clavero, 1999; Singh *et al.* 2004; Ramos *et al.* 2020).

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. The results of the present study confirm the experimental hypothesis. This means that with increasing the ratio of concentrate in the ration, feed intake and weight gain increased. 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.

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