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Acomparison Study between Barley and Concentrate feeding on the growth and digestibility of Karadi male Lambs

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Abstract

Twenty six Karadi male lambs were used in this experiment with an average live body weight of 28.7± 0.553 kg. Lambs were 5 months old and assign randomly to two feeding groups of thirteen lambs each. Lambs in the first group were fed a whole barley grain based diet and the second group were fed a concentrate pellets. Both groups received *ad-libitum* of chopped barley straw. All lambs were received an equal daily allowance of concentrate pellet or barley grain (3 % of their body weights). Lambs were fed their rations for 9 weeks. At the 8th week of the feeding period, the apparent digestibility trial was conducted on four ram lambs of each group, where the total feed intake and feces was recorded. The result showed that lambs fed concentrate pellet significantly (P<0.05) had better total gain, average daily gain, daily feed intake and feed conversion ratio as compared with the lambs fed whole barley grain. Average daily nutrient intake and in vivo apparent digestibility of DM, OM, CP, EE, CF and NFE were significantly (P<0.05) higher in lambs fed concentrate pellet as compared to the barley fed group.
In conclusion, the lambs fed concentrate pellet diet had better performance, digestibility of nutrients and more economical as compare to lambs fed barley grain.

Introduction

The Karadi breed which involve 18-20% of the Iraqi sheep population are native to the northeastern mountains, villages, and rolling dry farming plains of the Kurdistan region of Iraq ***[1].*** The traditional pattern of fattening lambs in the country depends mainly on grazing natural pastures and cereal stubble. Also, occasionally fattening lambs depend on barely grain and straw in feedlots, for a period of 3-4 months. Barley is the principal feed grain used for animals in most of the countries and in large parts of Kurdistan.

The sheep production efficiency depends on the quality and supply of nutrients in the available resources. The supply of amino acids related to the protein content of the feed, transportation and absorption in alimentary tract and its degradation from plant protein and microbial protein ***[2]***. The uptake of protein related to the amount of the protein absorption and availability of limiting essential amino acids and non-protein energy-yielding substrates ***[2]***.

The preceding studies have illustrated the extent of protein loss from the rumen, effect live weight gain in ruminants. With animals grazing temperate pastures, significant losses of ingested protein may occur from the rumen. For instance, in spring those animals grazing white clover can lose approximately 30% and those on alfalfa can lose approximately 40% of ingested protein ***[3]***.

Energy supplementation may increase the efficiency of growth. The organisms responsible for fiber digestion in the rumen include bacteria, protozoa and fungi. The actual and relative biomasses of each group are a function of the availability of fermentable N, soluble sugar, starches, fiber or protein in the feed ***[4]***.

The corn and soybean meal were commonly used as the grain portion of the diet. However, according to the availability and price, other grains may replace all or some of the content of soybean meal and corn meal in a diet ***[5]***. The diet of lamb is playing important role in the fattening of growing lambs weighing 20 to 30 kg

which is 16% crude protein, whereas at 30 kg body weights and up crude protein level in the diet can be lowered as 14 percent ***[6]***.

The commercial fattening manufactured feeds are used in these operations while a barley-based diet is used in the extensive system ***[7].*** In ruminants feeding for the extensive fattening operations used barley to give satisfactory results. The average daily gain of lambs of barley feeding program was reported to be between 120-200 g, while in the intensive fattening system, it was expected to be more than 240 g/day ***[8].*** The intensive production of fattening of lambs in some part of world for, they are fed with high amount of concentrate. However, this model in feeding often affect negatively of rumen fermentation ***[9].***

The objective of this study were to investigate the outcome of the two types of feeding systems concentrate pellet or barley in regard to general performance (final weight, total gain, daily gain, feed conversion ratio), apparent digestibility of nutrients in Karadi ram lambs during the experiment.

Materials and methods

This study was carried out in the Animal Farm, Dept. of Animal Science, College of Agric. Sci. Univ. of Sulaimani, Bakrajo, Sulaimani, Kurdistan, Iraq.

Growth and digestion trial

Twenty six Karadi male lambs aged 5 months with an average initial body weight of 28.7± 0.553 kg were randomly allocated to two groups (13 lambs for each group) to receive either whole barley grain or concentrate pellet feed produced by Kosar Commerical Company, Erbil. All lambs received an equal daily allowance of concentrate diet or barley grains at a rate of 3 % of the body weight with *ad libitum* of chopped barley straw. The chemical composition of concentrate pellet diets, barley grain and barley straw is shown in Table 1. Each treatment, diet was tested for a period of 2 weeks adaptation and 9 weeks feeding period. Daily feed intake and refused were measured and sampled for 9 weeks. The sample of feed and refusal were dried at 65 °C for 48 h until constant weight, then were ground through 1 mm mash and analyzed for proximate analysis. The lambs were weighed at the beginning and weekly interval during the experimental period. Experimental treatments were tested for digestibility and voluntary feed intake, by four Karadi male lambs for each treatment. The daily feed intake of concentrate and barley straw for each treatment, diet were tested for a period of 8 weeks and 1 week of the collection period.

Daily feed intake and refused were measured and sampled during the collection period. Feces were collected using special handmade digestion sacs suited for 4 ram lambs for each group and ensured separation of urine without sticking to their movement inside the individual pens housed in. At the end of the collection period, samples of diets and feces were thoroughly mixed and one sample of each was obtained and stored in deep freeze for subsequent chemical analysis as reported by ***[10]***. The lambs' feces were mixed carefully by hand and 10% sub–sample was retained and stored at -15 ºC. After the end of the collection period, the sample of feed and refusal were dried at 65 ºC for 48 h and feces were dried at 65 ºC until constant weight. The dried samples were ground through 1 mm mash. A liquors of the samples from each day were pooled and analyzed chemically.

Table- 1: Ingredients and chemical composition of experimental diets

Ingredients (%)	Barley grain	Mixed Pellets Concentrate	Barley straw
Barley	100	40	
Wheat bran	-	25	
Yellow corn	-	18	
Soybean meal	-	12	
Limex	-	2.5	
Salt	-	2.5	
Chemical composition%			
Dry matter (DM)	89	90	94
Organic matter (OM)	97.1	93.3	87.9
Crude protein (CP)	13.5	14	4.0
Ether extract (EE)	1.9	3.2	2.62
Total Ash	2.9	6.7	12.1
Crude fiber (CF)	6.3	5.4	41
Nitrogen free extract (NFE)	75.4	70.7	40.28
Metabolizable energy ME (MJ/ kg DM) *	13.08	12.84	6.6**

*ME (MJ/ kg DM) = 0.012 CP +0.031 EE+0.005 CF +0.014 NFE ***[11]***. ** According to the ***[10].***

Chemical analysis

Proximate chemical analysis of barley grain , concentrate pellet, barley straw and feces samples in triplicate per each determination was carried out for dry matter (DM), crude protein (CP), ether extract (EE), crude fiber (CF) and ash content according to the A.O.A.C. ***[12]***. The nitrogen free extract (NFE) was calculated by subtracting the summation percentages of CP, EE, CF and ash from one hundred according to the ***[13]***. Metabolziable energy of concentrate feed and barley straw were calculated according to the ***[11]*** and ***[10],*** respectively.

Statistical analysis

The obtained data were analyzed (Adinosoft, XLSTAT, 2007) ***[14]*** for one way analysis of variance. Differences among means were carried out by using Duncan multiple range tests ***[15]***. The statistical models of this study were:

$Yij = \mu+ti+eij.$

Yij= Observed traits i^{th} animal in j^{th} treatment,

μ= Overall mean,

ti = Effect of i^{th} treatments

eij = Experimental error

Results and discussion

Table (2) showed the overall performance of lambs utilizing the two experimental diets. It is obvious that the final body weight, total weight gain, average daily gain, daily concentrate intake and improved feed conversion are significantly higher ($P< 0.05$) in lambs fed concentrate pellet compared to lambs fed whole barley grain. But, the daily barley straw intake in concentrate pellet group was significantly lower ($P< 0.05$) as compared to lambs fed whole barley grain. While, the total feed intake (g DM/day) in lambs fed both treatment were appeared non significantly ($P>0.05$). The final weight, total gain, average daily gain of lambs fed the concentrate diet were higher (40.2 Kg, 12.0 Kg and 190.48 g) as compared to whole barley grain (34.2 kg, 6.800kg and 107.94 g) respectively. The average daily gain showed in this study is lower than the values by ***[16]*** and higher than the values by ***[17]*** who observed an average daily gain of 250 and 184 g, respectively. The lower gain in lambs fed the barley-based diets explain why fattening operations in the extensive fattening systems take a long time for termination. Finishing ruminants such as fattening lambs are

fed high concentrate diets to promote higher daily gains ***[18]***. The average daily gain of lambs fed mixed pellet concentrate diet was 190 g this value is smaller than reported by ***[19]*** with lambs fed commercial diets ***[19]*** and ***[20]***. Similarly, it was found that the average daily gain was significantly higher on concentrate fed lambs compared to grazed animals supplemented with barley ***[21]*** and ***[22]***. The performance of lambs fed on farmers, conventional feed (barley+ straw) was poor and animals consumed concentrate (pellet) feeding produced significantly good growth rate. The results are well supported by the findings of Hunter ***[23]*** who experienced increased productivity with concentrate feeding, demonstrated that tropical pastures with low-quality, protein- deficient forages typical dry season adversely affect the growth rate.

The current study also showed that daily feed intake (mixed pellet concentrate) for lambs fed concentrate diets based rations was higher than that lambs fed the whole barley grain (978.7 vs. 788.4 g). This feed intake was similar to intake observed in many other fattening trials ***[19]*** and ***[20]***. While, the daily barley straw intake for lambs fed whole barley grain was higher than that lambs fed the concentrate pellet. The bulkiness of diets for lambs fed the barley-based diets may explain the depressed concentrate intake compared to an intake of lambs in the other group. It was observed from the findings of the present study that daily feed intake and feed conversion ratio were found significantly affected. Lambs consumed significantly lower amount of farmers feed (barley grain and barley straw) and gained quite low weight, this similar to the finding by ***[24]*** who reported that the low feed intake and low weight gain with pasture feeding. The feed conversion ratio was 6.33 and 10.99 in lambs fed the concentrate feed (pellets) and barley diets, respectively. It appears that the feed conversion ratio more efficient in lambs fed mixed pellet concentrate than the barley group. The feed conversion ratio obtained in this study was higher value than those found by ***[25]***. On the other hand, similar results were reported by ***[20]***.

The results reported by ***[26]*** were further confirmed the findings of the present investigation who found better weight gains and feed conversion efficiencies of the lambs fed on compound feed as compared to lambs fed on forages and grasses. It had been reported by ***[27]*** and ***[28]*** that increase in live body weight and FCR of the scientifically formulated feed were significantly superior against those recorded from conventional feed. It was further to mention that the performance of lambs fed with barley and straw (farmers‟ feed) offered by the farmers were not equally efficient, neither in the gaining weight, nor in case of the feed conversion efficiency ***[27]*** and ***[28]***. Moreover, feed lambs on farmer's feed is quite laborious and time taking, while in case of compound feed, labor, time and costs could also be minimized. Thus, it was apparently visual that compound feed was better in all lamb fattening parameters as compared to farmer's feed. Previous studies described weight gain, feed conversion ratio and net profits were considerably efficient in the lambs fed on compound feeds as compared to those fed on forages and grasses ***[5, 29 and 30]***.

Table- 2: Effect of barley or mixed pellets concentrate on average daily gain, daily feed intake and feed conversion ratio of Karadi ram lambs

Item	***Barley***	***Mixed Pellets Concentrate***
No. Lambs	*13*	*13*
Initial body weight (kg)	*27.400±0.287 a*	*28.200±0.383 a*
Final body weight (kg)	*34.200±0.422b*	*40.200±0.479a*
Total weight gain (kg)	*6.800±0.562b*	*12.00±0.417a*
Average daily gain (g/day)	*107.94±13.31 b*	*190.48± 8.89 a*
Daily concentrate intake (g DM/day)	*788.4±0.04 b*	*978.7±0.07 a*
Daily straw intake (g DM/day)	*398.5±22.92 a*	*228.3±30.89 b*
Total feed intake (g DM/day)	*1186.9±8.5 a*	*1207±4.6 a*
Feed conversion ratio (Kg feed /Kg gain)	*10.99±0.13a*	*6.33±0.06 b*
Experimental periods (day)	*63*	*63*

Means followed by different letters within each row are significant (P<0.05).

Data of daily nutrient intake of concentrate feed and barley straw are given in Table (3). Dry matter (DM), organic matter (OM), crude protein(CP), ether extract (EE), crude fiber (CF), nitrogen free extract (NFE) and metabolizable energy (ME) intake and total nutrient intake above mentioned where the significantly different between barley and mixed pellet concentrate diets except the total crude fiber intake (total CFI) was lower value as compared to the barely grain groups. Nutrient intake and total intakes of lambs fed concentrate pellet were significantly ($P<0.05$) higher than of lambs fed barley grain. In contrast , the dry matter intake of barley straw and their nutrients content such as (DM,OM,CP,EE, CF, NFE) and ME were significantly ($P<0.05$) lower in lambs fed on concentrate pellet than of lambs fed barley grain. The high intake in lambs fed on concentrate pellet may be high palatability, nutritional value, high protein, low fiber content compared to barley grain. It appears to promote that lambs fed concentrate feed (pellets) high daily nutrient intake. It seems that the concentrate pellets feed in Table (3), higher CP and ME intake by lambs fed concentrate pellets feeds. This kind of diet can depress ruminal pH ***[31]***, and a minimum level of fiber in the diet is needed to avoid digestive disorders, such as acidosis ***[32]***. In the present study, as the total mixed ration pellets, there was an increase in total nutrients; DM, OM, CP, EE, CF, NFE and ME intake. These results are in line with the findings of Papi et al. ***[33]*** who carried out an experiment with lambs heavier (from 38 to 60 kg live body weight) than those used in the present experiment (from 27 to 40 kg LBW) and reported an increase in DM intake as the forage proportion increased in the diet. Indeed, previous studies (using animals from 30 to 36 kg LBW) have also reported increased effects of high forage diets on DM intake ***[34]***. In the present study, total DM intake increased while the level of intake of the concentrated part of the total mixed ration pellets, which can be interpreted as an attempt to maximize ME intake. This fact would support the idea that animals eat food mainly to satisfy their desire for energy ***[35]***. It is noteworthy that those lambs in the barley group and concentrate pellet feed, which received barley straw ad libitum, in order to avoid digestive disorder by two group animals. These cases may be returned by different in nutritional value of two types of feeds. In similar to this results, other authors have reported decreases in average daily gain of kids and lambs as forage increased in the diet ***[35, 36, 37and 38]***, it seems in the barley + straw group had decreased growth performance. In this study, all the animals fed on concentrate pellet feed had maximized ME intakes, which allowed them to express their potential and maximize growth rates. Likewise, the higher DM intakes shown by lambs in the concentrate pellet gave raise to higher average daily gains and a shorter fattening period than the lambs fed on barley grain with barley straw, this decrease in animal performance in barley group may be lambs did not receive sufficient nutrients such as protein, carbohydrate, mineral and vitamins from barley for growth rate at short time compared to lambs fed on concentrate pellets feed. This result agrees with previous studies declared that a decrease in animal performance as forage in the diet increased ***[36]*** and ***[38]***. These differences of nutrient intakes in table (3) on account of the higher fiber and lower protein and energy intakes in barley- straw fed lambs as compared with mixed pellet concentrate-fed animals, in agreement with ***[33]*** and ***[38]***.

Table- 3: Effect of barley or mixed pellets concentrate feeding Karadi ram lambs on the nutrient intake during digestibility trail.

Item	*Barley*	*Mixed Pellets Concentrate*
DMI (concentrate g/day)	*778.0±36.1 b*	*976.0±27.2 a*
DMI (barley straw g/day)	*301.0±1.23 a*	*211.0±6.79 b*
Total DMI (g/day)	*1079.0±5.1 b*	*1178.0±7.08 a*
OMI (concentrate g/day)	*755.4±22.3 b*	*913.1±5.1 a*
OMI (barley straw g/day)	*264.6±3.08 a*	*185.5±2.15 b*
Total OMI (g/day)	*1020.0±5.7 b*	*1098.6±7.9 a*
CPI (concentrate g/day)	*105.03±0.77 b*	*156.7±2.4 a*
CPI (barley straw g/day)	*12.4±0.29 a*	*8.4±0.43 b*
Total CPI (g/day)	*117.4±2.2 b*	*165.1±2.7 a*
EEI (concentrate g/day)	*14.8±0.39 b*	*31.3±0.49 a*
EEI (g barley straw /day)	*7.89±0.16 a*	*5.5±0.10 b*
Total EEI (g/day)	*22.69±0.82 b*	*36.83±0.52 a*
CFI (concentrate g/day)	*49.01±0.32 b*	*52.7±0.81 a*
CFI (barley straw g/day)	*123.4±2.92 a*	*86.51±1.84 b*
Total CFI (g/day)	*172.4±0.81 a*	*139.2±0.52 b*
NFEI (concentrate g/day)	*586.6±2.3 b*	*672.4±1.7 a*
NFEI (barley straw g/day)	*121.2±2.7 a*	*84.9±1.2 b*
Total NFEI (g/day)	*707.8±1.3 b*	*757.3±2.8 a*
MEI (concentrate MJ/day)	*10.18±0.163 b*	*12.53±0.071 a*
MEI (barley straw MJ/day)	*1.99±0.041 a*	*1.39±0.025 b*
Total MEI (MJ/day)	*12.17±0.06 b*	*13.92±0.34 a*

Means followed by the different letters within each row are significant (P<0.05)

DMI = Dry matter Intake, OMI = Organic matter Intake, CPI = crude protein Intake, EEI = Ether extract Intake, CFI = Crude fiber Intake, NFEI= Nitrogen free extract Intake, MEI= Metabolizable energy Intake.

Date of apparent digestibility of nutrient is shown in table (4). The digestibility of all nutrients was different for the two types of feeds. It is the attempt to evaluate digestibility parameters in local Karadi male lambs consuming concentrated feed (pellets) or whole barley grain. The digestibility of DM, OM, CP, EE, CF and NFE were significantly (P<0.05) higher in lambs fed concentrate diets compared to lambs fed barley based diets. The high fiber content and low crude protein of diets containing barley may' explain the low digestibility values observed. Barley grain groups which higher straw intake in particular increase crude fiber intake in diets reduced the overall digestibility of the rations as it has a negative effect on the digestibility**.** The level of forage in the diet is widely known to affect digestibility, and as the level of concentrate in the diet increases, so increase DM and OM digestibility ***[39]*** and ***[40]***. However, the effect of the forage to concentrate ratio on digestibility of other components is still controversial, with some researchers suggesting that CP digestibility might be not affected ***[41]*** or even increased ***[42]***, while fiber digestibility is usually reduced ***[43]***. The results of the present study show differences in fiber or CP digestibility due to the level of forage in the diet, while DM digestibility significantly decreased with increased barley straw intake by lambs fed on barley grain groups. This decrease in DM digestibility has been previously observed in other experiments where a source of fiber was added to a high-concentrate diet, because of the low digestibility of the fibrous part of the diet, which would accordingly reduce DM digestibility ***[44]***. The result of this study was similar to the researchers ***[20]*** who reported that the (dry matter, crude protein, crude fiber) digestibility were significantly higher in lamb fed to the concentrate diets compared to lambs fed to the barley based diet.

Table- 4: Effect of barley or mixed pellets concentrate Karadi ram lambs on the in vivo digestibility of the nutrient (%)

Item%	*Barley*	*Mixed Pellets Concentrate*
DMD	*76.7± 0.204 b*	*79.8±0.279 a*
OMD	*79.1±1.7 b*	*82.4±2.08 a*
CPD	*69.9±0.322 b*	*75.3±0.269 a*
EED	*80.4±1.05 b*	*86.3±2.8 a*
CFD	*54.4±0.457 b*	*62.3±0.473 a*
NFED	*86.8±0.377 b*	*90.1±0.279 a*

Means followed by the same letter within a row are not significant (P<0.05).

DMD = Dry matter digestibility, OMD = Organic matter digestibility, CPD = crude protein digestibility, EED = Ether extract digestibility, CFD = Crude fiber digestibility, NFED = Nitrogen free extract digestibility.

The cost per kg gain and economical efficiency are indicated in Table (5). The feed costs of kg gains in mixed pellet concentrate groups was in 2595 Iraqi Dinar (I.D.) lower than in barley grain (4244.5 I.D.) The higher cost of gain observed in lambs fed the barley diet was due to two reasons, 1st the lower average daily gain, 2nd the more feed cost / kg gain, I.D. The price of barley straw intakes is higher than that of lambs fed mixed pellet concentrate. Lambs fed on mixed pellet concentrate showed the highest economic efficiency, being 2.31compared with the barley group which 1.41 (Table 5).

Both of concentrate feed could be successfully used for growing or fattening male lambs. Therefore, mixed pellet concentrate help incoming animals on to full feed quicker with an improvement in rate of gain and/or feed conversion, consequently reduction in overall feed cost per kilogram gain as compared to barley grain.

However, the prices of kg concentrate, daily weight gain, concentrate intake daily/ head, I.D., total cost of total daily feed intake, lamb, I.D. were higher in lambs fed mixed pellet concentrate compared to barley grain. But, the feed costs of kg gains in mixed pellet concentrate group was in lower than in barley grain group. This result about profitability similar with the results of authors ***[20]*** who indicated that the lambs fed concentrate feed more profitable than lambs fed barley grain. The results reported by ***[45]*** suggested that the fattening lambs through roughages and forages may not be profitable, but considerably higher returns have been achieved when fattening lambs were fed on scientifically formulated feed.

Generally, improvements in gain, nutrient intakes, feed conversion and feed digestibility, more economic showed in lambs fed mixed pellet concentrate compared to lambs fed barley grain.

Table- 5: Effect of barley or mixed pellets concentrate on profitability.

Item	*Barley*	*Mixed Pellets Concentrate*
Average daily weight gain, g/ lamb	*107.94±13.31 b*	*190.48± 8.89 a*
Price of kg concentrate, I.D.	*400*	*500*
#Average concentrate intake daily as kg DM/ lamb	*0.7884±0.04 b*	*0.9787±0.07 a*
Average concentrate intake daily as kg fed / lamb	*0.886*	*1.087*
Price of concentrate intake daily/ head, I.D.	*354.4*	*434.8*
#Average barley straw intake daily as kg DM /lamb	*0.3985±0.04 a*	*0.2283±0.07 b*
Average barley straw intake daily as kg fed / lamb	*0.415*	*0.238*
Price of barley straw intake daily / lamb, I.D.	*103.75*	*59.5*
[1]Total cost of total daily feed intake, lamb, I.D.	*458.15*	*494.3*
[2]Price of daily weight gain, I.D	*647.64*	*1142.9*
Feed cost / kg gain, I.D.	*4244.5*	*2595.02*
[3]Economical efficiency	*1.41*	*2.31*

DM in barley grain, mixed pellets concentrate and barley straw were 89, 90 and 96%, respectively.

[1]Price of one ton from mixed pellet concentrate and barley is 700000 and 400000 I.D., respectively. [2] The price of one kg live body weight is 6000 Iraqi Dinar (I.D). Price of one ton from barley straw is 25000 I.D. [3]Economical efficiency= Price of daily weight gain / total cost of daily feed intake.
Means followed by the same letter within a row are not significant (P<0.05).

Conclusion

It was concluded that lambs fed concentrate pellets showed better growth performance at shorter time in the present study as well as better digestibility and profitability as compared to the lambs fed barley grain.

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