

## Effects of feeding with broiler litter in pellet-form diet on Qizil fattening lambs' performance, nutrient digestibility, blood metabolites and husbandry economics

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Article Info	Abstract
<b>Article history:</b> Received: 16 July 2017 Accepted: 21 February 2018 Available online: 15 September 2018	<p>The aim of this study was to evaluate the feeding of Qizil fattening lambs with different levels of broiler litter (BL) on their weight gain, dry matter intake (DMI), nutrient digestibility, selected blood metabolites and husbandry economics. During an eight-weeks experimental period, 28 male lambs (an average of <math>42.21 \pm 5.63</math> kg and ages of 7-8 months) were allocated randomly to one of four dietary treatments, including; control diet with no litter (NL, n = 7), diet containing 5% BL (LL, n = 7), diet with 10% BL (ML, n = 7) and diet containing 15.00% BL (HL, n = 7) as dry matter (DM) basis. The lambs were kept in individual pens and had free access to feed and water (<i>ad libitum</i>) throughout the study. In this research, DMI and feed conversion ratio were not influenced significantly by the dietary treatments, while average daily gain (ADG) was found to be significant. The lambs which consumed LL diet (5.00% BL) had the greatest ADG. The DM digestibility significantly influenced by dietary treatments, as the HL diet (15.00% BL) had the least DM digestibility. There were also significant differences in the crude protein and acid detergent fiber digestibility among the treatments. Blood urea nitrogen and glucose levels were significantly affected by the treatments. Low litter treatment had the least FCR and the highest economical advantage. In conclusion, feeding male Qizil lambs with BL can reduce production cost without any negative effects on performance.</p>
<b>Key words:</b> Broiler litter Economics Growth performance Qizil breed	

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### اثرات تغذیه با بستر پلت شده جوجه های گوشتی بر عملکرد، قابلیت هضم مواد مغذی، متابولیت های خونی و اقتصاد پرورش بره های پرواری نژاد قزل

#### چکیده

هدف از این مطالعه بررسی تغذیه سطوح مختلف بستر جوجه های گوشتی بر روی افزایش وزن، ماده خشک مصرفی، قابلیت هضم مواد مغذی، برخی از متابولیت های خونی و اقتصاد پرورش بره های پرواری نژاد قزل بود. در طول ۸ هفته دوره آزمایشی، ۲۸ بره نر (با متوسط وزن  $42.21 \pm 5.63$  کیلوگرم و سن ۷ تا ۸ ماه) به طور تصادفی به یکی از ۴ تیمار آزمایشی اختصاص داده شدند. تیمارها شامل جیره شاهد بدون بستر (هفت رأس)، جیره با ۵ درصد بستر (هفت رأس)، جیره با ۱۰ درصد بستر (هفت رأس) و جیره با ۱۵ درصد بستر (هفت رأس) بر اساس ماده خشک بودند. بره ها در تمام طول مدت آزمایش در جایگاه های انفرادی نگه داری شدند و دسترسی آزاد به آب و غذا داشتند. ماده خشک مصرفی و نسبت تبدیل خوراک به طور معنی داری تحت تأثیر تیمارهای آزمایشی قرار نگرفتند، ولی افزایش در میانگین میزان وزن گیری روزانه بطور معنی داری مشاهده شد. بره هایی که جیره با ۵ درصد بستر را مصرف کرده بودند بیشترین میانگین افزایش وزن روزانه را داشتند. قابلیت هضم ماده خشک به طور معنی داری تحت تأثیر تیمارها قرار داشت به طوری که جیره با ۱۵/۰۰ درصد بستر کمترین قابلیت هضم ماده خشک را داشت. همچنین بین تیمارهای آزمایشی تفاوت معنی داری در قابلیت هضم پروتئین خام و فیبر نامحلول در شونده اسیدی وجود داشت. نیتروژن اوره ای خون و گلوکز به طور معنی داری تحت تأثیر تیمارها قرار گرفتند. تیمار دارای ۵/۰۰ درصد بستر حداقل نسبت تبدیل خوراک و بیشترین سود اقتصادی را داشت. در نتیجه تغذیه بستر جوجه های گوشتی به بره های نر پرواری نژاد قزل می تواند هزینه تولید را بدون اثر منفی بر روی عملکرد کاهش دهد.

واژه های کلیدی: اقتصاد، بستر جوجه های گوشتی، عملکرد رشد، نژاد قزل

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## Introduction

Generally, the use of agricultural by-products and waste materials follows three main objectives in animal nutrition, 1) Economical advantages for producers 2) Reducing environmental pollution and 3) Sparing the lands for other business activities instead of animal feed production.<sup>1</sup> In developing countries, the main limiting factor in animal production is inadequate availability of feedstuffs to meet nutrient requirements.<sup>2</sup> In recent years, the agricultural by-products and the wastes of poultry industry have increased in Iran. Therefore, by identifying proper processing methods and nutritive value of these materials, they can be used as animal feed.<sup>3</sup>

Qizil sheep is one of the most popular breeds in north-west of Iran especially in West-Azərbayjan province. Their population has been announced to be approximately two million heads. This breed is popular because of its high capacity for twining, fattening and resistance against diseases.<sup>4</sup> Feeding sheep with poultry litter means that poultry wastes can be managed efficiently, besides, it can provide a low cost protein source for animals.<sup>5</sup> These materials can reduce feeding costs up to 20.00 – 40.00%.<sup>6</sup> Broiler litter contains, 25.00 – 50.00% crude protein (CP), 55.00 – 60.00% total digestible nutrients (TDN) as dry matter (DM) basis and it is also rich in essential minerals that can be utilized by animals. Therefore, broiler litter has similar or higher nutritive value than good quality forage.<sup>7</sup> Ruminants have so many different microbial species in their gastro-intestinal tract that enable them to use by-products and waste materials, so they can utilize the end products of these materials to meet maintenance and growth requirements.<sup>8</sup> The broiler litter (BL) provides large quantity of non-protein nitrogen (NPN) such as uric acid, porins and allantoin for ruminants because uric acid comprises the main part of excreted nitrogen. It degrades more slowly to ammonia by rumen microorganisms than other NPN sources such as urea, so it can be utilized more efficiently by rumen microbes.<sup>9</sup> The objective of this study was to determine optimal level of BL in the diet and its effects on Qizil lambs' performance and economics.

## Materials and Methods

**Litter collection and processing.** Litter was obtained from a commercial broiler operation in Miandoab, Iran. Litter was spread on a smooth area to dry (72 hr), and then it was stacked for two days to remove pathogens and improve its palatability<sup>10</sup> (deep stacking and sundry method). After that, litter was sieved, ground and then mixed with other diet ingredients in a manufactory to make pellet form. Diet ingredients were heated at 100 °C for 5 min during the pelleting process. At the end of the processing, the moisture content of the pellets was adjusted and prepared to offer the lambs.

**Treatments and animal study.** The present study was conducted in Qizil Sheep Research and Breeding Center of Miandoab, Iran. In this study, 28 male Qizil lambs (an average weight of  $44.21 \pm 5.63$  kg and 7 to 8 months old) were randomly assigned to one of four dietary treatments in completely randomized design experiment. Treatment groups including: control diet with no litter (NL, n = 7), low litter diet containing 5% BL (LL, n = 7), moderate litter diet with 10% BL (ML, n = 7) and high litter diet containing 15.00% BL (HL, n = 7) as dry matter basis. Diets were iso-caloric and iso-nitrogenous, which contained 14.00% CP and 2.52 Mcal metabolizable energy (ME) per kg dry matter (DM). Diets were formulated according to the nutrient requirements of small ruminants.<sup>11</sup> The ingredients and chemical composition of the experimental diets have been shown in Table 1. Diets were offered twice a day at 08:00 am and 16:00 pm, and residuals were collected and weighed daily. The lambs had free access to feed and clean water (*ad libitum*) throughout the experiment. The experimental diets were fed for two weeks for adaptation. Before the beginning of the experiment, the lambs were vaccinated against enterotoxemia. In addition, 1 mL per 5 kg Flunil® suspension (Levamisole + Triclabendazole; Damloran Pharmaceutical Co., Tehran, Iran) was given to each lamb as a parasiticide. Feed and water bunks were washed and disinfected weekly. The lambs were housed individually in concreted floor pens (1.20 × 1.50 m) with wood shavings, and pens were cleaned weekly. The lambs were weighed weekly during the experimental period and finally were weighed at the end of the study. Chewing activity was measured through observation for every 5 min during 24-hr period. All treatments were measured for chewing activity on 15 and 30 day and was calculated from the total feeding and ruminating time.<sup>12</sup> Rumen pH was measured by oral stomach tube 3 hr after morning feeding.

**Palatability test.** The stir method was used to determine diet palatability. Twenty five percent of the diets were offered separately to each lamb for 1 hr, and then they starved for 4 hr. After this time, the lambs were fed alfalfa hay (100 g) for 5 min and the hay residuals were collected and weighed. After 20 min starvation, the lambs were fed corn silage (100 g) for 5 min and then the residuals were collected and weighed. This way was also continued for concentrates. Palatability can be calculated by the following formula:

$$X = \frac{w1-w2}{T}$$

where,  $X$  = the amount of consumed feed per min;  $w1$  = offered feed weight (100 gr from each feed);  $w2$  = residual weight after 5 min feeding; and  $T$  = the time spent on consuming each feed (per min).<sup>13</sup>

**Table 1.** Ingredients and chemical composition of diets fed to Qizil lambs.

Ingredients	Dry matter of diets (%) <sup>a</sup>			
	NL	LL	ML	HL
Alfalfa hay	30.00	30.00	30.00	30.00
Corn Silage	20.00	20.00	20.00	19.86
Barley grain	20.00	20.00	20.00	18.00
Soybean meal	8.50	7.50	6.30	5.70
Broiler litter	0.00	5.00	10.00	15.00
Wheat bran	14.80	11.00	7.00	4.20
Meat meal	1.00	1.00	1.00	1.00
Molasses	3.00	3.00	3.00	3.00
Fat	0.20	0.50	1.00	1.74
Minerals and vitamins <sup>b</sup>	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50
Limestone	0.50	0.40	0.10	0.00
DCP	0.50	0.10	0.10	0.00
<b>Chemical composition</b>				
Dry matter (DM)	76.61	76.87	77.24	76.76
Metabolizable energy (Mcal kg <sup>-1</sup> DM)	2.52	2.52	2.52	2.52
Crude protein (CP)	14.00	14.00	14.00	14.00
Calcium	0.81	0.81	0.81	0.81
Phosphorous	0.50	0.46	0.50	0.50
Neutral detergent fiber (NDF %)	38.10	36.10	34.10	32.20
Acid detergent fiber (ADF)	20.90	21.00	21.10	21.20
Organic matter (OM)	72.75	75.56	73.89	74.72
Ash	27.25	24.44	26.11	25.28

<sup>a</sup> Diets were broiler litter (BL) included in the diets at 0 (NL), 5.00 (LL), 10.00 (ML) and 15.00 (HL) percent of dietary dry matter.

<sup>b</sup> composition per 1 kg contained (Vit A 500000 IU, Vit D3, 100000 IU, Vit E 100 mg, Ca 190 g, P 90 g, Mg 19 g, Na 50 g, Mn 2000 mg, Fe 3000 mg, Cu 300 mg, Zn 3000 mg, Co 100 mg, Se 1 mg, I 100 mg, antioxidant 3000 mg).

**Sampling and analytical method.** Feed samples were taken (100 g) daily before morning feeding (07:30) and at the end of study (60 day), the collected samples were mixed together to take one sample for DM, OM, CP, EE, NDF and acid detergent fiber (ADF) analysis. Blood samples were collected from jugular vein with vacuumed tubes (7 mL) on days 15, 30 and 60. Blood samples were centrifuged at 3000 g for 15 min and then the serum was partitioned into aliquots and stored at - 20 °C until analysis for glucose, blood urea nitrogen (BUN), total protein, cholesterol and triglyceride. Manure samples were collected and weighed daily before morning feeding and stored at - 20 °C until analysis for DM, OM, CP, EE, NDF and ADF. The samples of diets and feces were oven-dried at 60 °C to reach a constant weight, and then ground to pass a 1 mm sieve.<sup>14</sup> The DM, OM, CP and EE were analyzed using standard methods as described.<sup>15</sup> NDF and ADF were measured according to Van Soest *et al.*<sup>16</sup> Apparent digestibility of DM and other nutrients were calculated by measuring acid insoluble ash (AIA). The following equation was used to calculate each nutrient digestibility:<sup>17</sup>

$$X = \frac{\text{Marker in feed (\%)}}{\text{Marker in manure (\%)}} \times \frac{\text{Nutrient in manure (\%)}}{\text{Nutrient in feed (\%)}}$$

where, X is apparent digestibility of each nutrient.

**Statistical analyses.** The experiment followed a completely randomized design. Data were analyzed using GLM procedures in SAS (version 8.1; SAS Institute, Cary, USA). Initial body weight was considered as covariate. Differences were considered significant at  $p < 0.05$  and means were assessed by Duncan multiple range test.

## Results

**Dry matter intake, growth performance and digestibility.** The effects of BL inclusion in sheep diet on DMI, diet palatability and growth performance are presented in Table 2. DMI was increased numerically with increasing the level of BL in the diets, although there was not a significant difference among treatments. The results of this study indicate that adding BL in the diet did not decrease DMI of Qizil lambs. There was a significant difference among treatments on palatability ( $p < 0.01$ ), as ML treatment had the greatest (87.18 g consumed feed per min) and the control diet had the least palatability (64.63 g consumed feed per min). The results of the present study indicated that the palatability of the diets did not decrease by including BL in the diets. Final weights and FCR were not affected significantly by the treatments. However, average daily gain (ADG) and feed efficiency tended to be significant ( $p = 0.06$  and  $p = 0.07$  respectively). The LL treatment had greater ADG and FE rather than others (333 and 0.138 g per day, respectively). Dry matter digestibility was significantly affected by dietary treatments ( $p < 0.05$ ). High litter diet had the least DM digestibility among the treatments (65.82%). Protein digestibility were significantly different among the treatments ( $p < 0.05$ ). The results of the current study showed that the digestibility of diet CP can be reduced with increasing BL level in the diet (Table 2). The effect of dietary treatments on ADF digestibility was significant ( $p < 0.05$ ). The highest level of BL in the diet had the least ADF digestibility (38.11%) while, moderate level (ML) of BL in the diet had the highest digestibility (47.31%). The OM, EE and NDF digestibility were not affected significantly by dietary treatments, however, according to Table 3, NDF digestibility was decreased numerically with increasing BL level in the diets.

**Chewing activity and rumen pH.** Total chewing activity (min per day) was measured and the results were significantly different among the treatments ( $p < 0.05$ ). The results showed that sheep received LL diet showed the greatest chewing activity (817.86 min per day). Total ruminating time (min per day) was also significantly different among the treatment groups ( $p < 0.05$ ). However, total eating time was not affected by dietary treatments. The results of the present study indicated that BL inclusion in the sheep diet significantly increased the rumen pH ( $p < 0.01$ ). Rumen pH was higher in lambs consuming BL diet than those consuming control diet. The highest rumen pH value belonged to LL diet (Table 3).

**Table 2.** Dry matter intake, growth performance and nutrient digestibility of Qizil lambs fed diets containing broiler litter.

Parameters	Dry matter of diets (%) <sup>1</sup>					p-value
	NL	LL	ML	HL	SEM	
Initial body weight (kg)	44.88	43.48	44.24	47.00	2.280	0.7279
Final body weight (kg)	55.25	57.49	55.85	59.36	2.550	0.6717
Dry matter intake (g per day)	2328	2445	2357	2517	113.570	0.6369
Average daily gain (ADG)	246	333	276	294	21.750	0.0635
Feed conversion ratio (g)	9.92	7.50	8.69	8.95	0.780	0.2109
Feed efficiency	0.10	0.13	0.11	0.12	0.008	0.0736
Palatability (g consumed feed min <sup>-1</sup> )	64.45 <sup>b</sup>	65.64 <sup>b</sup>	87.18 <sup>a</sup>	80.09	4.140 <sup>a</sup>	0.0013
<b>Digestibility (%)</b>						
Dry matter	70.43 <sup>a</sup>	69.64 <sup>a</sup>	70.92 <sup>a</sup>	65.82 <sup>b</sup>	0.890	0.0020
Organic matter	72.74	77.55	73.88	74.71	1.320	0.4937
Crude protein	78.40 <sup>a</sup>	75.20 <sup>ab</sup>	77.08 <sup>a</sup>	72.74 <sup>b</sup>	1.180	0.0141
Ether extract	76.19	73.50	78.03	72.56	2.420	0.3821
Neutral detergent fiber	65.10	63.81	62.21	61.21	1.230	0.1489
Acid detergent fiber	47.15 <sup>a</sup>	43.20 <sup>ab</sup>	47.31 <sup>a</sup>	38.11 <sup>b</sup>	1.930	0.0079

<sup>1</sup> control diet with no broiler litter (NL, n = 7), low (5.00%) broiler litter (LL, n = 7), moderate (10.00%) broiler litter (ML, n = 7) and high (15.00%) broiler litter (HL, n = 7) as dry matter basis.

Different superscripts in each row indicates significant differences ( $p < 0.05$ ).

**Table 3.** Chewing activity and rumen pH of Qizil lambs fed diets containing broiler litter.

Parameters	Dry matter of diets (%) <sup>1</sup>					p-value
	NL	LL	ML	HL	SEM	
Total eating time (min per day)	288.57	309.29	284.29	280.00	14.95	0.53
Total ruminating time (min per day)	453.57 <sup>ab</sup>	508.57 <sup>a</sup>	427.14 <sup>b</sup>	495.71 <sup>a</sup>	19.27	0.02
Total chewing activity (min per day)	742.14 <sup>ab</sup>	817.86 <sup>a</sup>	711.40 <sup>b</sup>	775.71 <sup>ab</sup>	25.63	0.04
Rumen pH	6.00 <sup>c</sup>	6.75 <sup>a</sup>	6.40 <sup>b</sup>	6.60 <sup>ab</sup>	0.08	<0.01

<sup>1</sup> control diet with no broiler litter (NL, n = 7), low (5.00%) broiler litter (LL, n = 7), moderate (10.00%) broiler litter (ML, n = 7) and high (15.00%) broiler litter (HL, n = 7) as dry matter basis.

Different superscripts in each row indicates significant differences ( $p < 0.05$ ).

**Blood metabolites.** There was a significant difference in blood glucose among the treatment groups ( $p < 0.05$ ). Control diet with no broiler litter group had the highest glucose level whereas, HL diet had the least blood glucose level (74.00 vs 64.85 mg dL<sup>-1</sup> respectively). Blood urea nitrogen was also affected by dietary treatments ( $p < 0.05$ ) with the highest for control diet in comparison to the other treatments. Blood cholesterol, total protein and triglyceride were not affected by experimental treatments (Table 4).

**Economics.** In the economical assessment, income to cost and the costs per unit production were calculated. The most income was earned by LL diet. Average cost of production unit (live weight) was reduced by replacing soybean meal (high cost protein source in Iran) by BL (low cost protein source in Iran) in diets.

## Discussion

Based on the results, adding BL in the diet did not decrease DMI which was in consistence with the results of Obeidat *et al.* reported that increasing BL level in the diet did not reduce DMI.<sup>18</sup> Knowlton *et al.* also indicated that BL containing diets did not reduce DM and water intake in Holstein and Jersey cows.<sup>19</sup> No decrease in DMI in BL fed lambs may be related to appropriate processing method of litter. The litter processing had an important role in removing pathogens and palatability of diets, so lambs can consume it properly.<sup>20</sup> The palatability test indicated that the palatability of the diets was increased by increasing the BL level in the diets. In agreement with the results of this study, Mavimbela *et al.*, found that BL containing diets have appropriate palatability and did not decrease DMI.<sup>21</sup>

**Table 4.** Blood metabolites of Qizil lambs fed diets containing broiler litter.

Blood metabolites	Dry matter of diets (%) <sup>1</sup>					p-value
	NL	LL	ML	HL	SEM	
Glucose (mg dL <sup>-1</sup> )	74.00	63.42	55.71	64.85	4.82	0.0913
Cholesterol (mg dL <sup>-1</sup> )	85.57	86.28	75.57	95.85	5.76	0.1315
Triglyceride (mg dL <sup>-1</sup> )	53.14	58.00	47.14	52.29	7.82	0.8084
Total protein (g dL <sup>-1</sup> )	11.62	10.77	10.37	11.17	0.56	0.4446
BUN (mg dL <sup>-1</sup> )	31.42 <sup>a</sup>	25.71 <sup>b</sup>	19.14 <sup>c</sup>	23.71 <sup>b</sup>	1.11	0.0001

<sup>1</sup> control diet with no broiler litter (NL, n = 7), low (5.00%) broiler litter (LL, n = 7), moderate (10.00%) broiler litter (ML, n = 7) and high (15.00%) broiler litter (HL, n = 7) as dry matter basis.

Different superscripts in each row indicates significant differences ( $p < 0.05$ ).

No differences were observed in ADG and final weight among the treatments. It was shown that including BL in Holstein steers diet did not affect weight gain.<sup>22</sup> In lambs which were fed different levels of BL in their diet, Obeidat *et al.* found that there was no significant difference in ADG among treatments.<sup>18</sup> In this study, ADG tended to be significantly different among different treatments, in which ADG was greater for the lambs consuming LL diet than those consumed other diets. Control diet had the least ADG. High ADG in BL fed lambs compared to NL fed group may be related to numerically higher DMI and relatively similar DM digestibility in LL and ML treatments. Although, HL fed lambs had lower DM digestibility, higher BUN level in NL fed lambs indicated that more protein has lost as ammonia, so nitrogen retention can be decreased in these lambs that can affect ADG.<sup>23</sup> On the other hand, LL fed lambs had greater rumen pH value than those fed other diets, thus better FCR and weight gain observed in LL diet group can be an indication of optimal rumen fermentation in the lambs of this treatment group. The LL treatment group had the least FCR among the treatments while BL level in their diet was increased. These results are in consistent with the previous study by Talib and Ahmed.<sup>24</sup> In the current study, it was demonstrated that the digestibility of DM decreases while BL level in the diet increases. High litter treatment had the least DM digestibility. Elemam *et al.* observed that DM digestibility decreases by increasing BL level in the diet.<sup>23</sup> Similar results were reported by Obeidat *et al.*<sup>18</sup> In this experiment, increasing BL level in the diets had a significant effect on CP digestibility, which was in agreement with Negesse *et al.* results, indicated that CP digestibility was influenced by increasing BL level in the diet.<sup>25</sup> Reduced CP digestibility in BL containing diets was also reported by Talib and Ahmad.<sup>24</sup> The observed decreased CP digestibility may be due to the occurrence of Maillard reaction which can reduce nutrient digestibility particularly diet CP.<sup>26</sup> Heat production through litter processing can initiate such reactions, for this reason it can decrease CP digestibility in BL containing diets. Chaudhry *et al.* reported that the produced heat over 60 °C during poultry litter processing causes Maillard reaction.<sup>27</sup>

Acid detergent fiber (ADF) digestibility was significantly affected by dietary treatments. In consistent with the previous study by Talib and Ahmad, NDF and ADF digestibility were reduced in the dietary treatments in comparison with the control group.<sup>24</sup> They assumed that decreased NDF and ADF digestibility were related to the reduced rumen pH in BL containing diets. However, in the current study rumen pH increased with including BL in the diet. Elemam *et al.* also indicated that the crude fiber digestibility was reduced in lambs fed 300 g kg<sup>-1</sup> BL.<sup>23</sup> Decreased ADF digestibility in current study may be related to the presence of indigestible wood shavings in the litter that are full of lignin.<sup>18</sup> In addition, higher

numerically DMI in BL fed lambs can cause increase dilution rate and reduce fiber digestibility.<sup>28</sup> In the current study it was showed that the lambs fed control diet had lower rumen pH than those fed BL containing diets which was in agreement with the previous work by Elemam *et al.*<sup>23</sup> Total chewing activity observations indicated that there were significant differences among the treatment groups, as the lambs fed LL diet had the greatest chewing activity. It has been shown that there is a positive relationship between rumen pH and chewing activity.<sup>29</sup> This can explain why rumen pH was higher in LL fed lambs. Blood urea nitrogen was decreased in lambs fed BL containing diets than those fed control diet. Nadeem *et al.* conducted an experiment and reported that feeding BL didn't have any effect on goats' BUN,<sup>2</sup> which was not in agreement with the results of the present study. Decreased level of BUN in BL fed lambs may be related to the low degradability of nitrogenous compounds in these diets, probably because of Maillard reaction occurrence. It has been reported that the high rate of protein degradation causes high NH<sub>3</sub> concentration in rumen,<sup>30</sup> and additional NH<sub>3</sub> passes across rumen epithelium and then excrete as urea.<sup>31</sup> Other blood metabolites, including glucose, triglyceride, cholesterol and total protein were not affected by the dietary treatments.

The BL containing diets not only did not have any negative effects on lambs weight gain, but also decreased production costs. Recently, the cost of usual protein sources such as soybean meal has been increased in Iran. According to the results of this study, replacing soybean meal by BL decreases cost per kg of feed. LL fed lambs had the greatest ADG and the best FCR among all the other treatments, hence LL treatment had the greatest net income. In consistent with the present study, Paul *et al.* indicated that the use of 0.00, 15.00 and 30.00% poultry litter in the diet had no effect on ADG and FCR of Holstein steers.<sup>32</sup> In addition, the cost per kg of live weight gain was the least in that study. In another study, Elemam *et al.* reported that cow performance and economic efficiency were improved with consuming diets containing broiler litter.<sup>23</sup>

In conclusion, the results of this study revealed that Qizil fattening lambs can consume broiler litter containing diets properly without any negative effect on their performance. Furthermore, feed cost, one of the most important factors of sheep rearing, can be decreased through replacing expensive protein supplements such as soybean meal by low cost litter. Appropriate litter processing is necessary to produce a safe diet for both animal and human.

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### Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

### References

1. El-Sabban FF, Bratzler Jw, long TA, et al. Value of processed poultry waste as a feed for ruminants. *J Anim Sci* 1970; 31: 107-111.
2. Nadeem MA, Ali A, Azim A, et al. Effect of feeding broiler litter on growth and nutrient utilization by Barbari goat. *Asian-Australas J Anim Sci* 1993; 6:73-77.
3. Boda K. Non-conventional Feedstuffs in the nutrition of farm animals. New York, USA: Elsevier 1999; 13-15.
4. Eliasi G. Evaluating beta- lactoglobulin gene polymorphism in the five sheep breeds through PCR-RELP. MSc Thesis. Agricultural Faculty of Tabriz University, Tabriz: 2002.
5. Daniel J, Olson KC. Feeding poultry litter to beef cattle, MU Guide. MU Extension, University of Missouri-Columbia, 2005: G2077.
6. Goetsch AL, Aiken GE. Broiler litter in ruminant diets implications for use as a low-cost by-product feedstuff for goats. In: Merkel RC, Adebe G, Goetach AL (Eds). *The opportunity and challenged of enhancing goat production in East Africa*. Langston, OK: Langston University Press 2000; 58-69.
7. Fontenot JP, Hancock JW. Utilization of poultry litter as feed for beef cattle. Department of Animal and Poultry Sciences Virginia Polytechnic Institute and State University Blacksburg, Virginia, USA: 2001.
8. Areghore EM. Chemical composition and nutritive value of some tropical by products feedstuffs for small ruminant's *in vivo* and *in vitro* digestibility. *Anim Feed Sci Technol* 2000; 85:99-109.
9. Jordon DJ, Klopfenstein TJ, Adams DC. Dried poultry waste for cows grazing low-quality winter forage. *J Anim Sci* 2002; 80(3):818-824.
10. Animut G, Merkel RC, Abede G, et al. Effects of level of broiler litter in diets containing wheat straw on performance of Alpine doelings. *Small Ruminant Res* 2002; 44: 125-142.
11. NRC. Nutrient requirements of small ruminants: Sheep, goats, cervide, and new world camelids. National Academy of Science. Washington, USA. 2007;1-384.
12. Johansson MS. Chewing behaviour of growing cattle. Swedish University of Agricultural Sciences. Department of Animal Environment and Health Section of Production Systems. Skara, Sweden; 2011. Student report 279.
13. Church DC. Taste, appetite and regulation of energy balance and control of food intake. I. Appetite, taste and palatability. In: Church DC (Ed). *Digestive physiology and nutrition of ruminants*. Oregon, USA: Oxford Press 1979; 281-290.
14. Pond WG, Church DC, Pond KR, et al. Basic animal nutrition and feeding. 5<sup>th</sup> ed. New York, USA: Wiley 2005; 23-25.
15. AOAC: Official methods of analysis. 15<sup>th</sup> ed. Washington, USA: Association of Official Analytical Chemists 1990.
16. Van Soest PJ, Robertson JB, Lewis BA. Methods for dietary fiber, neutral detergent fiber, and non-starch polysaccharides in relation to animal nutrition. *J Dairy Sci* 1991; 74(10):3583-3597.
17. Van Keulen J, Young BA. Evaluation of acid-insoluble ash as a natural marker in ruminant digestibility studies. *J Anim Sci* 1977; 44, 282-287.
18. Obeidat BS, Awawdeh MS, Abdullah AY, et al. Effect of feeding broiler litter on performance of Awassi lambs fed finishing diets. *Anim. Feed Sci Technol* 2011; 165, 15-22.
19. Knowlton KF, Wilkerson VA, Casper DP, et al. Manure nutrient excretion by Jersey and Holstein cows. *J Dairy Sci* 2010;93(1):407-412.
20. Fontenot JP. Feeding poultry wastes to cattle. Department of Animal and Poultry Sciences Virginia Polytechnic Institute and State University Blacksburg, Virginia, USA: 1996; 38.
21. Mavimbela DT, van Ryssena JBJ, Last R. The effect of high broiler litter diets as survival ration on the health of sheep. *J S Afr Vet Assoc* 1997; 68 (4):121-124.
22. Cullison AE. Use of poultry manures in steer finishing rations. *J Anim Sci* 1976; 42(1):219-228.
23. Elemam MB, Fadelelseed AM, Salih AM. Growth performance, digestibility, N-balance, and rumen fermentation of lambs fed different levels of deep-stack broiler litter. *Res J Anim Vet Sci* 2009; 4: 9-16.
24. Talib NH, Ahmed FA. Digestibility, degradability and dry matter intake of deep-stacked poultry litter by sheep and goats. *J Anim Vet Adv* 2008; 7(11): 1474-1479.
25. Negesse T, Patra AK, Dawson LJ, et al. Performance of Spanish and Boer × Spanish doelings consuming diets with different levels of broiler litter. *Small Rumin* 2007; 69:187-197.
26. Van Soest PJ, Mason VC. The influence of the Maillard reaction upon the nutritive value of fibrous feeds. *Anim Feed Sci Technol* 1991; 32(1-3): 45-53.
27. Chaudhry SM, Naseer Z. Silages of citrus pulp-poultry litter-corn forage for sheep. *Pak J Agri Sci* 2006; 43: 173-179.
28. Corrêa DS, Magalhães RT, Siqueira DCB. Ruminal dry matter and fiber fraction degradability from two stylos cultivars. *Arq Bras Med Vet Zootec* 2014; 66: 1155-1162.
29. Mertens DR. Creating a system for meeting the fiber requirements of dairy cows. *J Dairy Sci* 1997; 80:1463-1481.

30. National Research Council (NRC). Nutrient requirements of dairy cattle. Washington DC, USA: The National Academies Press 2001; 72-74.
31. D'Mello JPF. Amino acids in animal nutrition. Edinburgh, UK: CABI Publishing 2003; 265-291.
32. Paul BN, Gubta BS, Srivastava JP. Influence of feeding unconventional cakes and poultry manure mixture on growth and feed efficiency in crossbred calves. *Ind J Anim Nutr* 1993; 10: 169-171.