Journal of Research in Ecology

An International Scientific Research Journal

Original research

The effects of replacing barley grain with different levels of dried citrus pulp on performance of Zel male fattening lambs

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ABSTRACT:

This study aimed to investigate the effects of replacing barley grain with different levels of dried citrus pulp on the performance of Zel male fattening lambs. The treatments were: Treatment 1 (control): 0% dried citrus pulp + 50% barley grain (Treatment 0%), Treatment 2: 15% dried citrus pulp + 35% barley grain (Treatment 30%), Treatment 3: 30% dried citrus pulp + 20% barley grain (Treatment 60%), Treatment 4: 40% dried citrus pulp + 10% barley grain (Treatment 80%), Treatment 5: 50% dried citrus pulp + 0% barley grain (Treatment 100%). Maximum and minimum contents of protein were related to treatment 1 (17.3) and treatment 5 (16.2). No significant difference was observed between the experimental treatments in terms of crude fat ($P<0.0001$). No significant difference was observed between the experimental treatments in terms of average NDF ($P<0.0001$). Adding citrus pulp to the rations of fattening lambs had no significant effect on the intake of daily dry matter. In the whole fattening period, daily weight gain in Treatment 4 was more than ones in other experimental treatments but it was not statistically significant. Treatment 4 had more proper conversion factor compared to other treatment in the whole fattening period and significant differences were observed between 45, 60 and 75 feedlot.

Keywords:
Citrus pulp, barley grain, Zel male lambs

Article Citation:
Amin Valizadeh, Pouria Ehsani and Sadegh Karimzadeh
The effects of replacing barley grain with different levels of dried citrus pulp on performance of Zel male fattening lambs
Journal of Research in Ecology (2017) 5(1): 531-540

Dates:
Received: 17 Jan 2017 **Accepted:** 04 Feb 2017 **Published:** 04 April 2017

Web Address:
http://ecologyresearch.info/documents/EC0267.pdf

INTRODUCTION

In Iran, after apple, *Citrus* is in the second place of production and they are used in processing industry in addition to be used freshly. In Iran, *Citrus* waste including collection, transportation, storage and conversion of wastes were annually about 900 thousand tons (Nazem *et al.*, 2008).

The use of agricultural byproducts in feeding ruminant animals allowed that the materials which are not applied in human nutrition, are used in order to produce valuable animal products, such as meat and milk (McDonald *et al.,* 1995).

Citrus fruits belong to Rutaceae family and Aurantioideae subfamily and divided into three types *viz., Citrus,* Fortunella *(Kumquat)* and *Poncirus trifoliata.* There are numerous cultivars of them in Iran, including the varieties of oranges, tangerines, grapefruit, bitter orange, lemon and lime. *Citrus sinensis* Osbeck and other numerous cultivars are found in Iran. *Citrus* pulp contains low crude protein (about 7 percent), high digestible fiber (about 20 percent neutral detergent fiber in terms of dry matter), moderate metabolizable energy and high content of total digestibility nutrient (74 to 83%) (Bampidis and Robinson, 2006). This product has a high pectin, which is used by the rumen microflora and improves the digestion of dietary fiber (Urdaneta *et al*., 1996).

Citrus pulp as concentrate feed material contains relatively high energy and the metabolizable energies of dry and wet pulps are 10.3 and 2.4 MJ per Kg of dry matter and the cereals used for ruminants are replaced with it (Arthington *et al.,* 2002; Bueno *et al.,* 2002); but, it has less adverse impact compared to starch rich foods (Leiva *et al.,* 2000). Nutritional value of citrus pulp is high due to high amounts of soluble carbohydrates which are accessible to the growth of microorganisms in the rumen (Bampidis and Robinson, 2006; Caparra *et al.,* 2007), but its digestible protein and nitrogen has low values (Fegeros *et al.,* 1995). It is similar sugar beet pulp in terms of nutritional value, because of high digestible fibers, and the same characteristics of woody forage (Ghedalia *et al.,* 1989). *Citrus* pulp is used in animal nutrition because of its beneficial effect on ruminal fermentation, digestion of fiber, and microbial protein production (Gado *et al.,* 2009). Its beneficial effects on cattle (Gado *et al.,* 2009) and small ruminants (Fegeros *et al.,* 1995) have been shown. Using *citrus* pulp in the rations of ruminants are suitable due to high capacity fermentation (Grasser *et al.,* 1995).

Citrus pulp stimulates rumen fermentation and significantly increase woody forage intake (Ayona and Orskov, 1985; Abedini *et al.,* 2012). 30 to 40% of concentrated rations of fattening lambs can be replaced with *citrus* pulp without any effects on growth and carcass quality (Bhattacharya and Harb, 1973; Caparra *et al.,* 2007) and even with positive effects on the feed productivity and daily weight gain (Rodrigues *et al.,* 2008).

Researches has shown that these products have suitable potential in feeding livestock but the possibility of optimal use of the feed sources and optimal production of livestock products require adequate information about the nutritional value and possible restrictions on the use of this material.

MATERIALS AND METHODS

In the present study, *Citrus* waste of Kowsar juice factory, located in Ramsar City was used and then the pulps were moved to Mr. Tonekaboni's farm, located in Bandpei Town, Babolsar City, to perform the research. Feed analysis and the experiments related to the design were conducted in the Animal Nutrition Laboratory of Animal Science Research Institute, Iran.

The experimental treatments were: Treatment 1 (control): 0% dried citrus pulp + 50% barley grain (Treatment 0%), Treatment 2: 15% dried citrus pulp + 35% barley grain (Treatment 30%), Treatment 3: 30% dried citrus pulp + 20% barley grain (Treatment 60%), Treatment 4: 40% dried citrus pulp + 10% barley grain (Treatment 80%), Treatment 5: 50% dried citrus pulp + 0% barley grain (Treatment 100%).

Chemical properties

The content of dry matter and chemical compounds of total mixed rations according to the following methods, in the Animal Nutrition Laboratory, Animal Science Faculty were determined.

Percentages of dry matter, crude protein, crude fat, ash were determined in accordance with AOAC method (AOAC, 2002). Neutral and acid detergent fiber were determined by the method developed by Scerra *et al.* (2001). The amounts of non-fiber carbohydrate of food, rations, rumen contents and face were determined using following equation (NRC, 2001):

Non-fiber carbohydrate (%) = 100- (ash (%) + crude fat (%) + neutral detergent fiber (%) + crude protein (%))

Physical properties of total mixed rations

To determine the particle size distribution of the ration, dry sieving method and Penn state particle separator (Kononoff *et al.*, 2002) were used. Penn state particle separator includes three sieves with different pore diameters of 19, 8 and 1.18 mm. To measure the particle size, firstly the sieves are placed above each other in descending order and then, they were shaken on a flat surface with a length of 17 cm for five times and a severity of 1.1 Hz and then, rotated as a quarter and this process was done for eight times. After shaking, the matter left on the sieve was weighed.

Physical effective factor of rations were measured based on the dry matter left on the three mentioned sieves (Kononoff *et al.*, 2002). Physical effective fiber was calculated by multiplying physical effective factor by NFD of the particles left on the three sieves (Kononoff *et al.*, 2002).

Fattening period

In the present study, 16 Zel lambs with the average weight of 25±0.5 Kg were used. The lambs were placed in solitary places with a bucket of clean water and separate manger. After 15 days of adaptation with place, environment and ration, they were fattened for 90 days. The used animals were randomly grouped into four experimental treatments and four replicates per treatment so that environmental conditions such as light, temperature, etc. would be the same for all treatments. The places were cleaned daily. General conditions, including manger, watering place, ventilation, space and other environmental factors were similar as much as possible. During adaptation period, enterotoxaemia and anti-parasite vaccines (twice at an interval of 14 days) were administered. During this period, feed and water were given to animals separately. The animals had free access to water and minerals were available as block. Drinking water was changed daily and every day, fresh water was accessed freely to the animals. Water bucket also be thoroughly washed daily.

Feed items used in the rations were barley grain, dried citrus pulp, molasses, wheat straw, urea, cottonseed meal, wheat bran, vitamin supplements and mineral, salt (Table 1). Feed was totally mixed and then, given to the animals twice a day and at an interval of 12 hours (7 am and 7 pm). The rations were adjusted using SRNS V.1.9.4208 software (2013). Every morning, the remaining feed of previous day was collected and weighed, so the daily feed intake and percentage of remained feed of each manger were determined. Feed items and chemical compounds of total mixed grains used in this study are listed in Table 1. Geometric mean sizes of alfalfa, feed and feeder were measured based on the method recommended by Pennsylvania University. Effectiveness coefficient was calculated based on the ratio of dry matter remained in sieves 2 and 3 to the total sieved dry matter based on the old Penn state particle separator (Lammers *et al.,* 1996) and the new Penn state particle separator (Mertens, 1997; Kononoff *et al.,* 2002).

Geometric mean and standard deviation of feed particle were calculated by following equation provided

Table 1. Feed items and chemical compounds of total mixed rations used in present study

	Experimental Treatments				
	Treatment 1 (0%)	**Treatment 2 (30%)**	**Treatment 3 (60%)**	**Treatment 4 (80%)**	**Treatment 5 (100%)**
Barley grain	50.0±5.0	35±4	20±2	10±1	0
Dried citrus pulp[1,2]	0	15±2	30±4	40±6	50±9
Molasses	3.7±0.9	0.9±3.7	0.9±3.7	0.9±3.7	0.9±3.7
Urea	1.3±0.2	1.6±0.2	1.7±0.2	2±0.2	2.3±0.3
Wheat straw[3]	32±4	31.7±3.2	31±4	31±4	31±4
Cottonseed meal	7±1	7.0±1.0	7.0±1.0	7±1	7±1
Wheat bran	5±0.9	0.9±5	0.9±5	0.9±5	0.9±5
Vitamin supplements and minerals[5,6]	0.3±0.09	0.09±0.3	0.09±0.3	0.09±0.3	0.09±0.3
Salt non-fiber carbohydrate	0.7±0.15	0.7±0.15	0.7±0.15	0.7±0.15	0.7±0.15
Chemical compounds (%)	**Treatment 1**	**Treatment 2**	**Treatment 3**	**Treatment 4**	**Treatment 5**
Dry matter	49.9±5	56.74±5	56.5±4.5	55.51±4	55.51±4
Crude protein	17.3±2	16.8±2.1	16.6±1.6	16.3±2	16.2±2
Neutral detergent fiber	39.0±4.1	39±4.1	39±4.1	40±4.2	40±4.3
Acid detergent fiber	24±3.1	24±3.1	24±3.1	24±3.1	24±3.1
Crude fat	7.6±1.5	6.6±1.5	7.3±1.5	6.6±1.5	6.3±1.6
Non-fiber carbohydrate	30±3.1	31±3.1	30±3.2	31±3.1	31±3.1
Metabolizable energy	2.5±0.10	2.5±0.10	2.5±0.10	2.5±0.10	2.5±0.10
Particles left on the sieve with the pore diameter of 19mm	11.5±1.9	10±1.9	10±1.9	10±1.8	9.5±1.8
Particles left on the sieve with the pore diameter of 8mm	13.5±1.2	13±1.2	13±1.2	13±1.2	12.5±1.2
Particles left on the sieve with the pore diameter of 1.18mm	66±6	67±6	67±6	67±6	67±6
Particles left on the end plate[4]	9±1.1	10±1.2	10±1.2	10±1.2	11±1.2
Geometric mean (mm)	4.81±1	4.56±1.1	4.56±1.1	4.56±1.1	4.42±1
Standard deviation of geometric mean	2.49±0.2	2.45±0.2	2.45±0.2	2.45±0.2	2.46±0.2
peNSF>8	1.23±0.1				
peNDF>1.18	18.21±2.2				

[1]Total mixed rations containing dried citrus pulp with the length of geometric mean (mm); [2]Total mixed rations containing dried citrus pulp with the length of geometric mean (mm); [3]Particles left on the sieves with the pore diameters of 19 and 8 mm, from PSPS (Lammers *et al.,*1996)

peNDF>1.18 (%) = (DM%>19mm × NDF%>19mm) + (DM%>8mm×NDF%>8mm) + (DM%>1.18mm× NDF% >1.18mm)

[4] Particles left on the sieve with the pore diameters of 1.18 mm, from PSPS (Mertens, 1997; Kononoff *et al*., 2002)

peNDF>8 (%) = (DM%>19mm × NDF%>19mm) + (DM%>8mm × NDF%>8mm)

[5] Anionic and cationic difference; [6]According to NRC estimate (2001)

by American Society of Association Executives:

$$d_{gw} = \log^{-1} \left| \frac{\Sigma \, (W_i \log \bar{d}_i)}{\Sigma \, W_i} \right|$$

$$S_{gw} = \log^{-1} \left| \frac{\Sigma \, W_i \, (\log \bar{d}_i - \log d_{gw})}{\Sigma \, W_i} \right|^{1/2}$$

where 'd_{gw}' is geometric mean, 's_{gw}' is standard deviation of feed particles, 'd_i' is pore diameter of particle separator (mm) and 'W_i' is the cumulative percentage of matter on each sieve. Physical effective factor of forage and total mixed rations were calculated by three different methods, including pefm (physical effective factor based on the dry matter left on the sieve with the pore diameter of 1.8 mm) (Mertens, 1997), physical effective factor based on the sum of dry matter left on the two sieves with the pore diameters of 1.8 mm and 19 mm, pef >8 (Lammers *et al.,* 1996) and physical effective factor based on the sum of dry matter left on the three sieves with the pore diameters of 1.8 mm, 8 and 19 mm, pef >1.18. The lambs were weighed two times in adaptation period (beginning and end of the period) and during fattening period (every 15 days) after taking them away from water and feed for 12 days. In this way, feed intake didn't influence on weighing. Totally, six weighing periods took place in treatments and fattening period and their daily weight gain was recorded for statistical analysis.

Daily weight gain

Daily weight gain = (Final weight - Primary weight)/the number of the days of fattening

Feed conversion ratio

Feed conversion ratio = Feed intake / live weight gain

Statistical analysis of data

Statistical analysis of data was performed based on completely randomized design with three treatments and four replications. The data were analyzed by GLM approach in SAS software (2002) and the means were compared at significance level of 5% by Duncan's method. Statistical model of the design is as follows:

$$X_{ij} = \mu + T_i + \varepsilon_{ij}$$

where, 'X_{ij}' is the value of each observation of replication 'j' and treatment 'i', 'μ' mean of observations, 'T_i' effect of treatment and 'ε_{ij}' error.

RESULTS AND DISCUSSION

Chemical compounds Treatments

There was no significant difference between treatments in terms of dry matter content (P>0.0001). The highest protein content was related to Treatment 1 (17.3 %) and the lowest one was related to Treatment 5 (16.2 %). Variations in the amount of protein can be due

Table 2. The particle size distribution of experimental rations separated by Penn State particle separator

Items	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5	Mean standard error	Sig.
Particles left on the sieve							
19 mm (%)	11.5±1.1	10±1.1	10±1.1	10±1.1	9.5±1.1	0.00	0.00
8 mm (%)	13.5±1.3	13±1.2	13±1.2	13±1.2	12.5±1.3	0.004	<0.0001
1.18 mm (%)	66±4.4	67±4.4	67±4.4	67±4.4	67±4.4	0.004	<0.0001
End plate (%)	9±1	10±1	10±1	10±1	9.5±1	0.004	<0.0001
Geometric mean (mm)	4.81±0.8	4.56±0.8	4.56±0.83	4.56±0.82	4.42±0.81	0.004	<0.0001
Standard deviation of geometric mean	2.44±0.5	2.45±0.5	2.45±0.5	2.45±0.5	2.46±0.5	0.004	<0.0001

In each column, there is a significant difference between the numbers with dissimilar letters (p<0.05).

to the type of orange, soil nutrients and orange processing methods (Table 2).

There was no significant difference between treatments in terms of crude fat content (P>0.0001). The highest percentage of fat was found in Treatment 1 (7.6%) and the lowest one was found in to Treatment 4 (6.3%). There was no significant difference between treatments in terms of average NDF (Table 2).

The effects of experimental treatments on dry matter intake

Adding citrus pulp to the rations of fattening lambs had no significant effects on daily dry matter intake (Table 3). It seems that adding byproducts of *Citrus* to the rations of ruminants didn't influence the feed intake. Lanza *et al*. (2000) reported that replacing a part or total of corn or barley grain with dried orange pulp or dried lemon pulp in the concentrate fed to dairy cattle didn't affect the feed intake. The average feed intake in Awassi lambs fed by the rations containing dried citrus pulp which were used in 33, 66 and 100% replacement of corn grain, didn't change but it decreased at higher percentage of replacement. It seems that one of the reasons for reduced dry matter intake with the increased amount of pulp in the rations is reduced palatability. No significant difference was observed between experimental treatments in terms of dry matter intake. This result is consistent with the results of the studies by Bueno *et al*. (2002) and Caparra *et al.* (2007).

Macedo *et al.* (2007) achieved the maximum level of dry matter intake, organic materials and protein with 50% wet orange pulp. Eliora (1991) stated that the volume of digestion in the rumen - reticulum determines the feed intake restriction which was explained in one of Mertens's (1992) mechanisms controlling food intake. Mertens (1992) showed that increase in NDF of rations resulted in reduction in optimal feed intake. In the treatments with 75% wet orange pulp, the fibers don't limit the feed intake because, according to Mertens's (1992), with the consumption of NDF, less than 1.2% of body weight, feed intake is controlled by physiological factors and not by rumen repletion. Increased dry matter intake in the rations with wet orange pulp is due to the better ruminal fermentation caused by the presence of pectin. So, the rapid and pervasive analysis of wet orange pulp cell wall due to less repletion results in increased dry matter intake which can be clearly observed in treatment1. Increased consumption of crude protein, crude fat and nitrogen free extract with the increase in the percentage of wet orange pulp depends on two factors:

- Increased dry matter intake which results in the increased consumption of all nutrients.
- Wet orange pulp provided more crude protein, crude fat and nitrogen free extract compared to corn so that increase in the percentage of wet orange pulp results in the increase in these nutrients (Macedo *et al*., 2007).

Burns (2008) stated that the structure of fiber source used in ruminant nutrition widely affects rumen

Table 3. Dry matter intake in sheep fed with dried orange pulp on the days of weighing (Kg of dry matter)

Day of weighing	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5	Mean standard deviation	Sig.
15th day	0.849a±0.01	0.809a±0.02	0.653a±0.011	0.923a±0.02	0.875a±0.011	0.017	0.0116
30th day	0.983a±0.01	0.930a±0.01	0.932a±0.02	0.956a±0.03	0.982a±0.02	0.024	0.5978
45th day	1.061a±0.03	1.071b±0.04	1.521a±0.03	1.144a±0.09	1.112a±0.08	0.032	0.4420
60th day	1.124a±0.06	1.135a±0.04	1.651a±0.03	1.232a±0.01	1.173a±0.03	0.063	0.7947
75th day	1.353a±0.04	1.361a±0.04	1.973a±0.02	1.418a±0.04	1.314a±0.05	0.068	0.9194
90th day	1.581a±0.05	1.591a±0.07	1.694a±0.07	1.532a±0.03	1.507a±0.07	0.073	0.7944
Whole period	1.158a±0.04	1.254a±0.04	1.404a±0.02	1.200a±0.03	1.161a±0.04	0.036	0.8664

In each column, there is a significant difference between the numbers with dissimilar letters (p<0.05).

digestion so that the use of lignin rich fiber sources such as dry fodder (99 g per Kg of dry matter) in the rations of lambs negatively affected the decomposition of feed in rumen, the pass rate in the digestive organs and dry matter intake.

Macedo *et al*. (2007) showed that increase in wet orange pulp resulted in more dry matter intake and protein, more efficient microbial production, better protein digestibility and more absorption of nitrogen.

The effects of experimental treatments on body weight gain

In the whole fattening period, daily weight gain in treatment4 was more than one in other experimental treatments but it was not statistically significant (Table 4). There were no significant differences between the experimental treatments in terms of body weight in different days of fattening and daily weight gain and this result is consistent with the results of the study by Lanza *et al*. (2000).

Castro and Zanetti (1998) showed that citrus pulp can be used in the starter feed of calves in order to replace NDF rich feed such as Bermuda dry forage with it without any effects on daily weight gain, dry matter intake and food conversion ratio. Cruz *et al*. (2009) found that

Table 4. Daily weight gain in sheep fed with dried orange pulp (Kg)

Studied characteristics	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5	Mean standard error	Sig.
Initial weight at the beginning of adaptation period	25.1^{a}±2.2	24.63^{a}±2.2	25.12^{a}±2.2	23.76^{a}±2.2	24.71^{a}±2.2	1.221	0.6301
Initial weight at the beginning of fattening period	25.43^{a}±2.2	25.23^{a}±2.2	26.34^{a}±2.2	25.24^{a}±2.2	25.33^{a}±2.2	1.011	0.3518
Weight on 15^{th} day	29.24^{a}±2.1	28.63^{a}±2.1	30.43^{a}±2.2	28.73^{a}±2.1	28.54^{a}±2.1	1.004	0.5112
Weight on 30^{th} day	32.14^{a}±2.4	32.65^{a}±2.2	33.64^{a}±3.1	32.64^{a}±3.1	32.29^{a}±2.2	1.023	0.5775
Weight on 45^{th} day	34.74^{a}±2.6	36.22^{a}±2.1	37.21^{a}±2.1	35.74^{a}±2.4	34.53^{a}±2.9	1.065	0.6445
Weight on 60^{th} day	38.03^{a}±3.1	39.23^{a}±3.1	38.78^{a}±3.5	39.63^{a}±3.9	38.18^{a}±3.5	1.087	0.6765
Weight on 75^{th} day	41.54^{a}±3.9	42.43^{a}±3.9	43.62^{a}±3.1	43.51^{a}±3.9	41.33^{a}±3.6	1.233	0.6234
Weight on 90^{th} day	43.69^{a}±3.1	45.47^{a}±3.3	46.38^{a}±3.5	46.67^{a}±3.6	44.43^{a}±3.3	1.014	0.5097
Weight gain on 15 feedlot	0.245^{a}±0.01	0.220^{a}±0.01	0.285^{a}±0.01	0.234^{a}±0.02	0.201^{a}±0.01	0.022	0.5855
Weight gain on 30 feedlot	0.219^{a}±0.01	0.251^{a}±0.01	0.246^{a}±0.01	0.255^{a}±0.01	0.215^{a}±0.01	0.020	0.4287
Weight gain on 45 feedlot	0.206^{a}±0.01	0.240^{a}±0.01	0.235^{a}±0.01	0.233^{a}±0.01	0.204^{a}±0.03	0.016	0.1550
Weight gain on 60 feedlot	0.205^{ab}±0.01	0.231^{ab}±0.01	0.208^{b}±0.01	0.241^{a}±0.01	0.208^{a}b±0.02	0.016	0.1066
Weight gain on 75 feedlot	0.214^{a}±0.01	0.235^{a}±0.01	0.231^{a}±0.02	0.243^{a}±0.01	0.212^{a}±0.02	0.018	0.4265
Weight gain on 90 feedlot	0.204^{a}±0.01	0.224^{a}±0.01	0.235^{a}±0.03	0.238^{a}±0.01	0.208^{a}±0.03	0.016	0.2490
Total weight gain	0.216^{a}±0.01	0.233^{a}±0.01	0.212^{a}±0.03	0.244^{a}±0.01	0.210^{a}±0.01	0.013	0.1947

In each column, there is a significant difference between the numbers with dissimilar letters ($p<0.05$).

Table 5. Food conversion ratio in lambs fed by dried orange pulp (Kg of feed per Kg of weight gain)

Studied characteristics	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5	Mean standard error	Sig.
15 feedlot	$3.46^{a}\pm0.5$	$3.68^{a}\pm0.5$	$2.29^{a}\pm0.5$	$3.94^{a}\pm0.5$	$4.35^{a}\pm0.5$	0.456	0.6524
30 feedlot	$4.48^{a}\pm0.4$	$3.71^{a}\pm0.5$	$3.78^{a}\pm0.5$	$3.74^{a}\pm0.6$	$4.56^{a}\pm0.6$	0.391	0.4299
45 feedlot	$5.15^{a}\pm0.7$	$4.46^{a}\pm0.9$	$6.67^{b}\pm0.6$	$4.9^{a}\pm0.5$	$5.45^{a}\pm0.5$	0.249	0.3143
60 feedlot	$5.40^{a}\pm0.6$	$4.91^{a}\pm0.7$	$7.93^{b}\pm0.9$	$5.11^{a}\pm0.9$	$5.63^{a}\pm0.5$	0.260	0.0211
75 feedlot	$6.32^{a}\pm0.5$	$5.79^{a}\pm0.4$	$8.54^{b}\pm0.4$	$5.83^{a}\pm0.8$	$6.2^{a}\pm0.7$	0.368	0.4065
90 feedlot	$7.75^{ab}\pm0.4$	$7.01^{a}\pm0.4$	$7.21^{a}\pm0.6$	$6.43^{a}\pm0.6$	$7.24^{ab}\pm0.7$	0.226	0.0695
Total feedlot	$5.36^{ab}\pm0.5$	$5.38^{ab}\pm0.5$	$6.62^{b}\pm0.6$	$4.91^{a}\pm0.5$	$5.52^{ab}\pm0.7$	0.216	0.1129

In each column, there is a significant difference between the numbers with dissimilar letters ($p<0.05$).

increasing the percentage of wet orange pulp in the rations of fattening lambs increases the final weight, total weight gain, daily weight gain and daily feed intake and maximum of them were obtained in the 75% replacement.

Pereira and Javier (2004) found that in 50% replacement of fiber sources with wet orange pulp in fattening lambs, weight gain were increased. Their result is not consistent with the result of the present study and the reason for this may be the different type of orange pulp and using similar level of pulp among the treatment. But the results of present study are consistent with the study by Scerra *et al.* (2001), according to their study, replacement of forage and 30% concentrate with orange pulp in the rations of lambs had no effect on their live weight gain.

The effects of experimental treatments on food conversion ration

Treatment 4 had more proper conversion factor compared to other treatment in the whole fattening period and significant differences were observed between 45th, 60th and 75th day of fattening periods (Table 5).

Abedini *et al.* (2012) reported that replacing with 33% of citrus pulp had the maximum daily weigh gain and the best food conversion ratio than the levels of 66% and 100%. 30 to 40% of concentrated rations of fattening lambs can be replaced with citrus pulp without any effects on growth and carcass quality (Bhattacharya and Harb 1973; Caparra *et al.,* 2007) and even with positive effects on the feed productivity and daily weight gain (Rodrigues *et al*., 2008).

The lambs that used the rations containing orange pulp had better food conversion ration than control treatment (0% orange pulp) that the higher lignin content in control treatment than experimental rations was expressed as its reason (about 10% vs. 3%) (Cruz *et al.,* 2009). Adverse effects of lignin on feed consumption, growth of animal and food conversion ratio were shown well by Bampidis and Rabinson (2006) and Burns (2008) and they concluded that food conversion ratio was improved in lambs that uses wet orange pulp as fiber source but Pereira and Javier (2004) have observed no significant effect at the levels of 0% to 25% (4.45 and 4.24 respectively).

CONCLUSION

According to the results of present study, using *citrus* pulp is a good feed to be used in fattening lambs and to reduce its costs. Also, waste disposal problem is partly solved in the factories. Using 40% dried orange pulp in the rations improves feed consumption, daily weight gain, food conversion ratio and totally, the performance of fattening lambs compared to other treatments and without any adverse effects on the performance of fattening lambs.

REFERENCES

Abedini A, Ghorchi T and Zerehdaran S. (2012). The effects of replacing barley grains with different levels of citrus pulp in the rations of Taleshi male lambs. *Journal of Animal Production Research,* 2(1): 41-51.

[AOAC] Association of Official Analytical Chemists. (2002). Official Method of Analysis. 17th ed. AOAC, Arlington, VA. 120-155p.

Bampidis VA and Robinson PH. (2006). Citrus by-products as ruminant feeds: A review. *Animal Feed Science and Technology*, 128(3-4): 175–217.

Barrios-Urdaneta A, Fondevila M, Peiro JM and Castrillo C. (1996). Effect of feeding level and substitution of barley grain by citrus pulp in ammonia-treated straw diets on digestibility and microbial synthesis efficiency in sheep. *Annales de Zootechnie.* 45, suppl, 297 .

Ben-Ghedalia D, Edith Yosef, Miron J and Est Y. (1989). The effects of starch- and pectin-rich diets on quantitative aspects of digestion in sheep. *Animal Feed Science and Technology*, 24(3-4): 289–298.

Bhattacharya AN and Harb M. (1973). Dried citrus pulp as a grain replacement for Awasi lambs. *Journal of Animal Science,* 36: 1175-1180.

Bueno MS, Ferrari E Jr, Bianchini D, Leinz FF and Rodrigues CFC. (2002). Effect of replacing corn with dehydrated citrus pulp in diets of growing kids. *Small Ruminant Research*, 46(2-3): 179–185.

Burns JC. (2008). Utilization of pasture and forages by ruminants: A historical perspective. *Journal of Animal Science,* 86(12): 3647–3663.

Caparra P, Foti F, Scerra M, Sinatra MC and Scerra V. (2007). Solar-dried citrus pulp as an alternative energy source in lamb diets: Effects on growth and carcass and meat quality. *Small Ruminant Research*, 68(3):303-311.

De Castro AKM and Zanetti MA. (1998). Study of fiber inclusion in the diet of Holstein calves. *Revista Brasileira de Zootecnia,* 27:1193–1198.

Eliora Z. (1991). Microbial Surface Components and Toxins in Relation to Pathogenesis, Boston, MA: Springer US, 20p.

Fegeros K, Zervas G, Stamouli S and Apostolaki E. (1995). Nutritive value of dried citrus pulp and its effect on milk yield and milk composition of lactating ewes. *Journal of Diary Science,* 78(5):1116–1121.

Gado M, Salem AZM, Robinson PH and Hassan M. (2009). Influence of exogenous enzymes on nutrient digestibility, extent of ruminal fermentation as well as milk production and composition in dairy cows. *Animal Feed Science and Technology*, 154(1):36–46.

Grasser LA, Fadel JG, Garnett I and De Peters EJ. (1995). Quantity and economic importance of nine selected by-products used in California dairy rations. *Journal of Dairy Science,* 78(4):962–971.

John Arthington D, William Kunkle E, and Amy Martin M. (2002). Citrus pulp for cattle. *Veterinary Clinics: Animal Practice*, 18(2): 317-326.

Jose Pereira C and González Javier. (2004). Rumen degradability of dehydrated beet pulp and dehydrated citrus pulp. *Animal Research*, 53(2): 99-110.

Kononoff PJ, Lehman HA and Heinrichs AJ. (2002). A comparison of methods used to measure eating and ruminating activity in confined dairy cattle. *Journal of Dairy Science,* 85:1801-1803.

Lammers BP, Buckmaster DR and Heinrichs AJ. (1996). A simple method for the analysis of particle sizes of forage and total mixed rations. *Journal of Dairy Science,* 79(5):922–928.

Leiva E, Hall MB and Van Horn HH. (2000). Performance of dairy cattle fed citrus pulp or corn products as sources of neutral detergent-soluble carbohydrates. *Journal of Diary Science,* 83(12): 2866–2875.

Macedo CAB, Mizubuti IY, Pereira ES, Ribeiro ELA, Ramos BMO, Mori RM, Pinto AP, Moreira FB and Bonin MN. (2007). Apparent digestibility and nitrogen use of diets with different levels of fresh orange pulp. *Archivos de Zooecnia*, 56 (216): 907-917.

Macías-Cruz U, Quintero-Elisea A, Avendaño-Reyes LA, Correa-Calderón FD, Álvarez-Valenzuela SA, Soto-Navarro FA, Lucero-Magaña and González-Reyna A. (2009). Buffel grass (*Cenchrus ciliaria* L.) substitution for orange pulp on intake, digestibility, and performance of hair sheep lambs. *Tropical Animal Health and Production*, 42(2): 223– 232.

Massimiliano Lanza, Priolo, Alessandro L, Biondi, Bella M and Ben Salem H. (2000). Replacement of cerial grains by orange pulp and carob pulp in faba bean-based diets fed to lambs: effects on growth performance and meat quality. *Animal Research, EDP Sciences*, 50 (1): 21-30.

McDonald P, Edwards RA, Greenhalgh JFD and Morgan CA. (1995). Animal Nutrition. Addison Wesley Longman, Inc., U.K., ISE reprint, 1999. 607 p.

Mertens DR. (1992). Non structural and structural carbohydrates. Large dairy herd management. *American Dairy Science Association*, 25:219.

Mertens DR. (1997). Creating a system for meeting the fiber requirements of dairy cows. *Journal of Dairy Science,* 80(7):1463-1481.

National Research Council (NRC). (2001). Nutrient Requirements of Dairy Cattle. National Academic Press. Washington DC.

Nazem K, Rozbahan Y and Shoja'a sadati A. (2008). The nutritional value of citrus PULP (lemon and orange) processed by *Neurospora sitophila*. *Journal of Science and Technology of Agriculture and Natural Resources,* 12(43b):495-505.

Rodrigues GH, Susin I, Pires AV, Mendes CQ, Araujo RC, Packer U, Ribeiro MF and Gerage LV. (2008). Replacement of corn by citrus pulp in high grain diets fed to feedlot lambs. Ciência *Rural, Santa Maria*, 38 (3): 789-794.

SAS. (2002). User's Guide: Statistics. Version 8.2nd Ed. SAS Inst. Inc., Cary, NC.

Scerra V, Caparra P, Foti F, Lanza M, Priolo A. (2001). Citrus pulp and wheat straw silage as an ingredient in lamb diets: effects on growth and carcass and meat quality. *Small Ruminant Research*, 40(1): 51-56.

Silva Ayona T and Orskov ER. (1985). Fiber degradation in the rumen of animals receiving hay and untreated or ammonia treated straw. *Journal of Animal Feed Science and Technology,* 19(3): 277-287.