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Effects of feeding pomegranate peel silage on feed intake and growth performance of Turkey bred sheep

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A B S T R A C T

The experiment was conducted to determine the effects of feeding pomegranate peel silage with beet top silage, wheat straw, alfalfa hay, barley, cotton seed cake and mineral plus on feed intake and growth performance of Turkey bred sheep in research farm of Agriculture Faculty, Kabul University. Twelve, two and half years old turkey bred sheep with (57.240 ± 5.28) kg average initial body weight were used in a completely randomized design (CRD). Animals were caged individually in 3 groups and 4 replications. Groups included in this experiment were, first group (Control) or T1 pomegranate peel silage (PPS) 0%, second group or T2 (5% PPS) or 106 g and third group or T3 (10% PPS) or 211 g. In addition, animals were fed with 633 g barley, 633 g alfalfa hay, 211 g cotton seed cake, 106 g beet top silage, 4 g mineral plus with the same amount and wheat straw for control group or T1, T2 and T3, 528 g, 422 g and 317 g in dry matter (DM) basis, respectively once in a day at around 8 am. According to statistical analysis, there was a highly significant difference between groups in feed intake and significant difference in growth performance of sheep. According to L.S.D test, it was shown that the second group (T2) was better in feed intake and growth performance compared to other groups. The FCR of T1, T2 and T3 were 12.43, 7.88 and 15.13, respectively and the FCE were 8.05, 12.69 and 6.61 in control group, T2 and T3, respectively. Results of this study suggest that feeding (5%) pomegranate peel silage with wheat straw, alfalfa hay, cotton seed cake, barley, beet top silage and mineral plus affects the feed intake and growth performance of Tukey sheep.

Keywords: Turkey Sheep, Pomegranate peel silage, Beet top silage.

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Introduction

Pomegranate (*Punica grantum* L.*)* belongs to *Punicaceae* family and it is one of the oldest known edible fruits (Seeram *et al.*, 2006). The edible part of the pomegranate (aril) is about 55 to 60% of total fruit weight and consists of about 75 to 85% juice and 15 to 25% seeds (Abbasi *et al.*, 2008). Due to the potential benefits of pomegranate fruits on human health (Lansky and Newman, 2007), and the development of industrial technologies to obtain more appealing products (e.g. ready-to-eat arils or ready-made juices and extracts; Shabtay *et al.*, 2008), there has been a great increase in the demand and production of those fruits. Consequently, the agro-industries yield large amounts of residual biomasses, the pomegranate by-products (seeds, peels and pulp). At present, the disposal of these processing wastes represents a cost, which makes imperative to find alternatives. In this regard, their use in ruminant feeding would contribute to reduce the amount of cereals fed to the animals, reducing not only the feeding cost of ruminant production but also reduce the food competition (Salami *et al.*, 2019).

Pomegranate peel attracts attention due to its apparent wound healing properties (Chidambara *et al.*, 2004), immune modulatory activity (Gracious *et al.*, 2001), antibacterial activity (Navarro *et al.*, 1996) anti-atherosclerotic and anti-oxidative capacities (Tzulker *et al.*, 2007). Anti-oxidative activity has often been associated with a decreased risk of various diseases (Whitley *et al.*, 2003). In a previous study it was found that Pomegranate peel had the highest antioxidant activity among the peel, pulp and seed fractions of 28 kinds of fruits commonly consumed in China as determined by FRAP (Ferric reducing antioxidant power) assay (Li *et al.*, 2006). Edible parts of pomegranate fruit

(about 50% of total fruit weight) comprise 80% juice and 20% seeds. Fresh juice contains 85% water, 10% total sugars and 1.5% pectin, ascorbic acid and polyphenolic flavonoids. Dried pomegranate seeds contain the steroid estrogen estrone (Heftaman and Bennett, 1996; Moneam *et al*., 1988).

The pomegranate tree (*Punica grantum* L.*)* is important in tropical, subtropical, and Mediterranean regions (Al-Rawahi *et al*., 2013). Pomegranate is one of the most popular fruits in Afghanistan and the world. Kandahari pomegranate has the best quality and it is the most popular variety between 48 varieties available in Afghanistan. Production of pomegranate in Afghanistan was 181765 tons with total harvesting area of 15621 acres in 2018 (CSO, 2019).

By 2050, the world will need to feed an additional 2 billion people and require 70% more meat and milk. The increasing future demand for livestock products, driven by increases in income, population, and urbanization will impose a huge demand on feed resources. A huge quantity of fruit and vegetable wastes and by-products from the fruit and vegetable processing industry are available throughout the world that encourages to using it as a new source feeds in animal ration formulation.

In a previous study, Shabtay *et al.* (2008) demonstrated that dietary supplementation with fresh pomegranate peels promoted a significant increase in feed intake, with a positive tendency toward increased BW gain in bull calves. They suggested that the antioxidant and immunomodulatory properties of pomegranate peels might improve immune function, which could benefit calf health. On the other hand, Oliveira *et al.* (2010) found that feeding a pomegranate extract to young calves for the first 70 days of life suppressed the intake of grain and the digestibility of fat and protein, likely because of the high tannin content.

N2O is a dangerous greenhouse gas and expected to increase by 35-60% by 2030 with an increase in demand for meat and dairy products (IPCC, 2007). PP containing tannins may improve N utilization efficiency and thereby decrease the N content of manure, which, in turn, may affect N2O emissions because less N is available to the denitrifying bacteria that use the manure as substrate. The addition of saponins from PP can thus modify the C and N contents of sheep manure. Sheep (*Ovis aries* L.) produce 8 kg of enteric methane (CH4) gas per animal per year (Broucek, 2014) and by using PP in animals ration the amount of CH4 may reduce.

Dried pomegranate contains 90.15 % dry matter and 9.85 % moisture; it contains 96.57% organic matter and 3.43% ash. Also 6.52% protein, 3.46% Ether extract, 10.50% crude fiber, 76.09% NFE, 29.36% NDF, 19.22% ADF, 3.90% ADL, 10.14% hemicellulose, 15.32% cellulose available in pomegranate peel composition and 4287 kcal kg^{-1} dry matter for gross energy (Table 1).

Table 1. Chemical composition of dried pomegranate peel.

Chemical composition	(%)
Dry Matter	90.15
Organic matter	96.57
Ash	3.43
Protein	6.52
Ether extract	3.46
Crude fiber	10.50
NFE	76.09
NDF	29.36
ADF	19.22
ADL	3.90
Hemicellulose	10.14
Cellulose	15.32
Gross energy (Kcal kg^{-1} DM)	4287

Amino acid composition of dried pomegranate peels (mg $100g^{-1}$ DM) that illustrated in (Table 2) cleared that dried pomegranate peel (DPP) protein contained a much higher content of essential amino acids (arginin, histidine, leucine, lysine, phenylalanine, and valine). The corresponding values were 8.23, 7.56, 7.16, 7.23, 7.14, and 5.33 (g $100g^{-1}$ CP) for the same amino acids, respectively. On the other hand, both isoleucine and methionine recorded the moderate values (3.51 and 3.02 g $100g^{-1}$ CP, respectively); meanwhile, threonine showed the lowest value (2.12 g $100g^{-1}$ CP). Essential amino acids recorded (51.30 g $100g^{-1}$ CP) of total amino acid in DPP, while non-essential amino acids (alanine, aspartic, cystine, glutamic, glycine, proaline, serine, and tyrosine) recorded (48.37 g $100g^{-1}$ CP).

Table 2. Amino acids content of dried pomegranate peels.

Amino acid composition of dried pomegranate peels (mg 100g^{-1} DM)	
Essential amino acids	
Arginine	8.23
Histidine	7.56
Isoleucine	3.51
Leucine	7.16
Lysine	7.23
Methionine	3.02
Phenylalanine	7.14
Threonine	2.12
Valine	5.33
Subtotal	51.30
Nonessential amino acids	
Alanine	5.05
Aspartic	8.11
Cystine	1.02
Glutamic	13.52
Glycine	12.41
Proline	3.22
Serine	3.02
Tyrosine	2.02
Subtotal	48.37
Not determined	0.33

Minerals in DPP were found to be Ca, P, K, Na, and Mg at levels of 342, 120, 150, 68, and 56 mg 100g^{-1} DM, respectively. In addition, the DPP contained a considerable amount of Zn, Mn, Cu, Fe, and Se at levels of 1.08, 0.86, 0.65, 6.11, and 1.07 mg 100g^{-1} DM, respectively.

Vitamins determined in DPP that composed of vitamin B1 (Thiamine), vitamin B2 (Riboflavin), vitamin C (L-Ascorbic acid), vitamin E (α-Tochoferol), and vitamin A (Retinol). The corresponding values of vitamins determined above were 0.141, 0.09, 13.26, 4.13, and 0.181 mg 100g^{-1} DM of DPP (Table 3).

Table 3. Mineral and Vitamin content of dried pomegranate peel.

Mineral Content of Dried Pomegranate Peel (mg 100g^{-1} DM)	
Macro-elements	
Calcium (Ca)	342
Phosphorus (P)	120
Potassium (K)	150
Sodium (Na)	68
Magnesium (Mg)	56
Micro-elements	
Zinc (Zn)	1.08
Manganese (Mn)	0.86
Cupper (Cu)	0.65
Iron (Fe)	6.11
Selenium (Se)	1.07
Vitamin content of dried pomegranate peel (mg 100g^{-1} DM)	
B1 (Thiamine)	0.141
B2 (Riboflavin)	0.090
C (L-Ascorbic acid)	13.260
E (α-Tocopherol)	4.130
A (Retinol)	0.181

Materials and Methods

This experiment was carried out on November and December months of 2019 for 21 days at the research and experimental farm of Agriculture Faculty, Kabul University, Kabul, Afghanistan, which lies on 34°31'4.5687 latitude (N) and 69°8'18.2174 longitude (W). Twelve female Turkey bred sheep, aged two and half years old with an average live body weight of 57.240 ± 5.28 kg were divided in a completely randomized design (CRD) into three groups (Table 4), this experiment was done to know the effects of pomegranate peel silage along with beet top silage, wheat straw, alfalfa hay, barley, cotton seed cake and mineral plus, on feed intake and growth performance of turkey bred sheep.

Table 4. Experimental groups.

Groups		Concentrate	Forage
1.	Control	45 (%)	25 (%) wheat straw + 30 (%) alfalfa hay
2.	5% PPS	45 (%)	20 (%) wheat straw + 30 (%) alfalfa hay + 5 (%) PPS
3.	10% PPS	45 (%)	15 (%) wheat straw + 30 (%) alfalfa hay + 10 (%) PPS

The experimental diets (Table 5) calculated to cover the requirements of total digestible nutrients (TDN), protein, calcium and phosphorus for 60 kg Sheep according to NRC (1998).

Wheat straw, alfalfa hay, Barley and cotton seed cake and Mineral plus bought from the related markets of the city, beet tops, after harvesting they cut into small pieces, sun-dried and then it was treated with urea to make silage, after 30 days the silage were ready to use. The pomegranate peels were collected from the juice shops, the peels were sun-dried and then cut into small pieces then treated with urea to make silage and was ready to use after 30 days. PPS were used in diets with different levels, 0%, 5% or 106 g and 10% or 211 g. Animals were fed 633 g barley, 106 g BTS, 4 g mineral plus, 211 g cotton seed cake, 633 g alfalfa hay with the same amount and wheat straw for control group (T1), T2 and T3, 528 g, 422 g and 317 g in DM basis, respectively once in a day at around 8 am. Fresh water and salt were available all times for animals.

Table 5. Amounts of diets used in the turkey sheep diet during the experiment (%).

Feed Ingredient	Control (T1)	T2	T3
Barley	30.00	30.00	30.00
Beet top silage	5.00	5.00	5.00
Mineral plus	0.19	0.19	0.19
Cotton seed cake	10.00	10.00	10.00
Alfalfa hay	30.00	30.00	30.00
Wheat straw	25.00	20.00	15.00
PPS	0.00	5.00	10.00
Total	100.00	100.00	100.00
Chemical composition (%)			
Dry Matter	84.74	84.03	85.00
TDN	96.00	91.89	93.85
Protein	22.82	22.63	22.89
Calcium	0.88	0.86	0.88
Phosphorus	0.43	0.42	0.43
Energy : protein	4.21	4.06	4.10

Fig. 1. The process of making silage from pomegranate peels and beet tops.

Daily amount of experimental ration weighed before feeding and feed residues were weighed the following morning before feeding the diet. Body weight changes were weekly recorded before they fed diet.

Collected data of feed intake and live body weight, were subjected to statistical analysis as one-way ANOVA procedure and the groups comparison done with Least Significance Differences (L.S.D) test using MS. Excel.

Average daily gain (ADG) were found by dividing the total weight gain to days of experiment. FCR were calculated by dividing the total feed intake on total weight gain and FCE calculated by dividing total weight gain on total feed intake and multiply by 100.

Economic evaluation was done using the relationship between feed costs (local market price of ingredients) and sheep live body weight gain. Economic evaluation was calculated as follow: The cost for 1-kg gain=total cost {Afghani (AF)} of feed intake/total gain (kilogram).

Results and Discussion

There was a highly significant difference between groups in feed intake and significant difference in weight gain of turkey sheep, according to L.S.D test it was shown that T2 (5% PPS) was better in both feed intake and growth performance compared to other groups. In table 6 it is shown that feed intake of control group, 5% PPS and 10% PPS were 36.008, 39.667 and 38.005 kg, respectively and the weight gain was 3.863, 5.034 and 2.513 kg, respectively.

Table 6. Effects of dietary supplementation with PPS on feed intake and weight gain of turkey bred sheep.

Groups	Parameter	Means	Standard deviation	P-value
Control	Feed Intake (Kg)	36.008^{a}	0.81	0.003035
5% PPS		39.667^{ab}	0.46	
10% PPS		38.005^{c}	1.38	
Control	Weight Gain (Kg)	3.863^{a}	0.69	0.048267
5% PPS		5.034^{b}	3.81	
10% PPS		2.513^{c}	0.50	

Tannins are considered to have both adverse and beneficial effects in ruminants (Makkar *et al.*, 2003). High concentration of tannin may reduce feed intake, digestibility of protein and carbohydrates, and animal performance through their negative effect on palatability and digestion (Reed, 1995).

Pomegranate peel is rich in tannins, which were previously shown to have both adverse and beneficial effects in ruminants (Makkar, 2003). Moderate concentrations of condensed tannins (2 to 4% of DM) in the diet of sheep improve production efficiency in ruminants without increasing feed intake, as manifested by increases in wool growth, BW gain, milk yield, and ovulation rate (Aerts *et al.*, 1999). The findings of this study were in agreement with this statement because when 10% PPS used the feed intake and weight gain was low, due to its high Tannin content.

Also the current study is in harmony with Saeed *et al.* (2017) showed in their study that higher dry matter intake (DMI), organic matter intake (OMI) and nitrogen intake (NI) of wheat straw by lambs fed T2 as compared T1 may due to improve rumen condition as a result of anti-oxidative property of pomegranate peel (PP) (16) (17) demonstrated that addition of PP significantly enhance feed Intake. Those workers suggested that anti-oxidative and immunomodulatory properties of PP might improve immune function, which could benefit calf health.

Result of feed intake that illustrated in table 7 recorded that when 5% PPS and 10% PPS used in rations of experimental animals, the feed consumption increased but the increase was higher when 5% PPS used compared to 10% PPS group. These results in disagreement with those reported by Sadq *et al.* (2016) who showed that final body weight was significantly ($P<0.05$) higher in Karadi lambs fed 1% or 2% pomegranate peel as compared with lambs fed 4%. In addition, incorporation DPP at level of 1 or 2% significantly ($P<0.05$) decreased dry matter intake.

Result of weight gain that illustrated in table 7 showed that using 5% PPS group, gained higher body weight in comparison to 10% PPS group. The result of this study is in agreement with Abarghuei *et al.* (2013), who stated that the tendency to similar live weight gain in all groups can be attributed to an internal mechanism related to lambs, but the inclusion of PP as half of the forage had a clear negative effect on the lambs. Abarghuei *et al.* (2013) suggest that PP contains high concentrations of saponin, which reduces protein digestibility due to negative effects on digestion, and decreases feed consumption by reducing the palatability. However, result of the current study is in disagreement with Kotsampasi *et al.* (2014) who stated that the addition of PP to the total mixed ratio (TMR) at concentrations of 0, 120, and 240 g kg^{-1} did not significantly affect live weight, live weight gain, DM consumption, and feed utilization.

Table 7. Feed intake and growth performance of experimental animals.

Items	Control		5% PPS		10% PPS	
Live Body weight (kg)						
No. of Animals	4		4		4	
Initial weight (kg)	58.973 ± 3.210		59.101 ± 6.880		53.645 ± 2.580	
0-7	57.433	1.642	54.872	1.822	54.015	1.575
8-14	59.533	2.100	55.691	0.819	53.714	-0.301
15-21	60.126	0.593	57.051	1.360	54.595	0.881
22-28	61.870 ± 3.620		64.135 ± 3.640		56.158 ± 2.970	
Final weight (kg)						
Total body weight gain (Kg)	2.898 ± 0.690		5.034 ± 3.810		2.513 ± 0.500	
Experiment Duration (days)	21		21		21	
Average Daily Gain (ADG, g day^{-1})	138.00 ± 0.030		239.700 ± 0.180		119.600 ± 0.030	
Feed Intake						
Feed consumption (Kg day^{-1} as fed)	1.905		2.099		2.011	
Feed consumption (Kg DM^{-1} basis)	1.715		1.889		1.810	
Feed Conversion Ratio (FCR)	12.430		7.880		15.130	
Feed Conversion Efficiency (FCE)	8.050		12.690		6.610	

Data of economic evaluation (Table 8) shows that using PPS at different levels reduces the cost of ration but the cost was very low when 5% PPS used in ration compared to 10% PPS. The cost of one Kg weight gain in control group, 5% PPS and 10% PPS were 329, 193 and 396 Afghani (AFN), respectively. The result of this study was in agreement with Omer *et al.* (2019) who stated in their study that dried pomegranate peel can be used safely in sheep feeding at level of 1% because this level realized the best growth performance and depressed the price of ration cost and recorded the best relative economic efficiency (Omer *et al.*, 2019).

In addition, these results were in agreement with those found by Denek and Can (2006); Omer and Abdel-Magid Soha (2015) who noted that the use of agro-industrial by-products in sheep rations has been successfully adopted as a strategy to reduce feeding costs and also to cope with the need to recycle waste material.

Table 8. Economic evaluation of the experiment.

Item	Control	5% PPS	10% PPS
Daily Feed Intake (fresh, Kg)	2.354	2.779	2.889
Price of 1 Kg of Feed Ration	19.330	16.640	16.440
Daily feeding cost ($)	45.500	46.300	47.500
Average Daily Gain (kg)	0.138	0.240	0.120
Feed Cost AFN / Kg of gain	329	193	396

Conclusion

From the data illustrated in the current study we found that supplementation of 5% PPS with wheat straw, alfalfa hay, barley, cotton seed cake, beet top silage and mineral plus had a significant effect on the feed intake and growth performance of turkey bred sheep. In addition, adding 10% PPS in the experimental animal ration was low compared to the second group, which may be due to the high amount of tannin available in pomegranate peel and the amount of urea used in PPS, which may change the taste of the diet. From the findings of this study it is recommended to use 5% PPS in ration of turkey bred sheep.

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