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Research article

Effect of addition of different levels of pomegranate peel powder to concentrate diet on productive performance of Awassi lambs

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Abstract

This study was conducted to investigate the effect of the addition of pomegranate peel powder to the concentrate diet at a level of zero (T1), 1.5 (T2) and 3% (T3) on productive performance of Awassi lambs. Concentrate was offered to lambs at a rate of 2.5% of live body weight and ground wheat straw on the adilbitum basis. Results revealed that there was a significant (P<0.05) increase in straw dry matter, organic matter and nitrogen intakes by lambs fed the low level of pomegranate peel powder (T2), whereas, lower values were recorded by lambs fed the high level (T3). With similar trend of change, total dry matter intake were 1056.03, 954.61 and 841.48 g/day, and 975.35, 896.24 and 793.92 g/day of total organic matter intake, and 8.49, 7.73 and 6.70 g/day of total nitrogen intake for treatments 2, 1 and 3 respectively. Although there was no significant effect in growth parameters, lambs fed T2 gained better final weight, total and daily gains, 34.20, 8.15 and 145.53 g/day respectively, however, lambs fed T3 recorded 31.52, 5.72 and 101.34 g/day for these parameters respectively. Lambs fed T1 and T2 achieved better values of feed conversion ratio as compared with lambs in T3. Lower digestion coefficients were recorded by lambs fed T2 as compared with lambs fed T1 and T3 with slight difference in dry matter digestibility (58.39%) and organic matter digestibility (59.68%), and relatively high differences in crude protein digestibility (51.78%) and nitrogen free extract digestibility (63.85%). Lambs fed T2 were prior in ether extract digestibility in comparison with lambs fed T3, where digestion coefficients were 59.92% and 55.09% respectively vs. 60.17% for control treatment. Crude fiber digestion coefficients were closed among the three treatments.

Keywords: Pomegranate peel, wheat straw, Awassi lambs, Performance

Introduction

Natural increase in population undoubtedly associates with increase demand for animal products. This case prompts serious search for alternative feeds and improves utilization of the available sources in order to diminish the expected gap between ruminant requirements and currently used diets, taking in consideration that depending on concentrates should be reduced. (1) Confirmed the importance of lowering cereals ratio in ruminant diets due to its high prices and human need. Hence improve ruminant productivity requires increase utilization of available feeds by some additives (2). However, healthy diets with high nutritive value are very important to produce quality and economic animal products (3). From other hand, improve utilization efficiency of dietary protein is conclusive to improve animal performance. (4) Referred to importance of post ruminal degradability of dietary protein. Protection dietary protein from ruminal degradation may reduce loss of via rumen wall as

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ammonia produced as end product of amino acid metabolism (5).Pomegranate characterized with high tannin content, especially the peel in which, tannin content is about 25-28% (6). Treatment of protein supplements with tannin was examined as a protection method from ruminal degradability (7). Accordingly, tannin may help to improve ruminant productivity by increasing flow of true protein from the rumen and enhance feed digestibility due to protected effect of ruminal degradability of dietary protein (8). The peel also contains phenolic compounds, and then it possesses higher biological activity, antioxidant and antimicrobial growth characteristics as compared with juice and seeds (9, 10, 11). The objective of this study is to investigate the effect of addition of PP powder (PPP) to concentrate at different levels on performance of Awassi lambs, taking advantage of expected decrease of ruminal degradability of dietary protein and increase its arrival to absorption area in duodenum with opportunity of enhancing utilization of roughage due to improve rumen ecology.

Materials and Methods

Ethical approval

The Animal Ethical Committee of Veterinary Medicine College, University of Al-Qadisiyah, Iraq, has approved the present study under permission No: 407

Experimental diets:

This study was carried out at a private farm in Al-Nile sub district to investigate the effect of addition of different levels of pomegranate peel powder (PPP) to concentrate diet on performance of Awassi lambs. Experimental diets comprised concentrate and roughage diets. Concentrates were prepared by grind their ingredients including wheat bran, barley, yellow corn and soybean meal. These ingredients were mixed locally with addition of PPP at 0, 1.5 and 3% as control, low and high PPP level treatments respectively. Levels of ingredients were estimated to secure the standard ratio of rumen degradable nitrogen (RDN) to metabolizable energy (ME) of about 1.34 g RDN/MJ of ME. Concentrate diets were offered to lambs at 2.5% of body weight. Allowances of concentrate diets offered for each lambs were adjusted weekly according to changes in their body weights. Roughage was ground wheat straw and offered on *adilbitum* basis. Tables (1) and (2) show levels of concentrate ingredients and chemical composition of these ingredients, PPP, concentrate diets and wheat straw.

Table (1). Components of concentrate diets (%)

Concentrate diets	Barley	Wheat bran	Yellow corn	Soybean meal	PPP	Salt	Pro feed
0%	40	36	20.6	1.4	0	1	1
1.5%	40	36	19.1	1.4	1.5	1	1
3%	40	36	17.6	1.4	3	1	1

Table (2). Chemical composition of concentrate ingredients, PPP, concentrates diets and wheat straw

Diets and ingredients	DM (%)	% of DM				
		Ash	CP	EE	CF	NFE
Barley	90.25	3.40	9.96	3.86	5.75	77.03
Wheat bran	88.13	7.06	13.90	4.86	18.56	55.62
Yellow corn	91.37	6.69	8.13	5.12	4.81	75.25
Soybean meal	89.01	7.24	45.69	2.17	6.26	38.64
PPP	94.78	4.71	4.40	2.76	10.38	77.75
T1	88.44	3.93	6.61	5.75	11.96	71.75
T2	88.24	6.32	6.57	6.04	13.22	67.85
T3	88.24	3.49	6.32	3.16	11.02	76.01
Wheat straw	91.19	9.88	2.41	4.16	42.45	41.10

DM: dry matter. CP: crude protein, EE: ether extract, CF: crude fiber, NFE: nitrogen free extract, PPP: pomegranate peel powder, T1, T2, T3: treatments (concentrates) containing 0, 1.5 and 3% of PPP respectively.

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Experimental animals:

Twelve Awassi lambs used in this study were bought from local markets with average body weight of 25.85± 0.45 kg and aged 4-6 months. Lambs were transferred to place of the study and viewed to veterinary tests to ensure its safety and presence of disease. Lambs were injected against external parasites and drenched against intestine and liver worms. Single case was treated against diarrhea. Sodium bicarbonate was used at rate of 0.25% to treat acidosis of single case observed in T3 in which PPP was added at 3%.Lambs were weighed using digital balance and randomly distributed into treatments with 4 lambs per each. Lambs were housed individually and were gradually adapted to consume concentrate diets before the start of the study; preliminary period. Concentrate diets were offered twice a day, morning meal at 8 AM and evening meal at 4 PM., Lambs were weighed at the end of each week to determine changes in body weight.

Voluntary intake of diets, body weight gain and conversion efficiency:

At the end of preliminary period, all lambs were adapted to experimental diets and individual pens, then study was began actually and extended to 8 weeks during which, daily intake of diets was recorded by the difference between offered and refused of both concentrates and straw. Total gain (TG) was determined on basis of difference between initial and final weight of lamb. Average daily gain (ADG) was estimated by dividing average TG on period of study Feed conversion efficiency (FCR) was estimated by dividing average total daily intake of diets on ADG.

Digestibility coefficients:

Digestion study was carried out at the end of feeding trial to determine digestibility coefficients. Diet (concentrates and straw) consumed and feces excreted by each lambs were precisely determined. Feces were collected for 6 days using digestion sacs, which were suitably designed to avoid contamination with urine, and maintaining animal movement (12). Samples of concentrate, straw and feces were taken during collection period (digestion trial) and kept in freezer at -20 ºC. Frozen samples were then thawed and samples of concentrate, straw and feces were used for chemical analysis. Digestibility coefficients were estimated as a percentage of digested parts, which presents the difference between the consumed and excreted parts.

Chemical analysis:

Chemical analysis was conducted in duplicate manner using methods of AOAC (13). Dry matter (DM) content of concentrate and straw was determined by drying samples in oven at 105 ºC for 24 hours (h), whereas feces samples were dried at 60 ºC for 72 h. Dried samples were left to cool in desiccator, grind and kept in plastic containers. Ash content was determined by ashing samples in furnace at 500 ºC for 4 h. Ether extract (total fat, EE) content was determined by extraction with hexane in Soxhulate apparatus. Samples were folded up with filter paper before extraction and dried after that at 60 ºC for 30 min. Crude protein (CP) content was determined using S4 Kjeltec System. Samples were digested for 1 h with 10 ml of concentrated H_2SO_4 in digestion unit in presence of $NaSO_4$ and $CuSO_4.5H_2O$ and Seas catalysts and boiling stone supplied by German Behr Company to homogenize boiling. Ammonia, which liberated during digestion with acid, was distilled in distillation unit with addition of 25 ml of distilled water and 35 ml of 30% NaOH solution. Condensed ammonia was collected in conical flask containing 30 ml of 3% H_3BO_3 and few drops of indicator (bromocresol green and methyl red). In the final step, collected solution was titrated against 0.05 M H_2SO_4. Crude fiber (CF) content was determined using DOSI-Fiber Extractor manufactured by Spanish Selecta Company. In this apparatus soluble nutrients present in samples were dissolved and extracted with 0.128 M H_2SO_4 and 0.223 M KOH for 1 h per each with addition of few

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drops of octanol to avoid foam. Nitrogen free extract was determined by difference.

Statistical analysis:

Data of study was collected and analyzed according to randomized complete design (CRD) to investigate effect of addition of different levels of PPP, 0, 1.5 and 3%. Statistical analysis system SAS (14) was used to analyze data and Duncan (15) multiple ranges was used to test differences among means**.**

Results

1-Daily intake of nutrients:

Table (3) shows effect of PPP on average intake of nutrients. Statistical analysis revealed that addition of low level of PPP (T2) increased (P<0.05) intake of dry matter (DMI), organic matter (OMI) and nitrogen (NI) of wheat straw as compared with control diet in which concentrate was offered free of PPP.

Table 3- Effect of level of pomegranate peel on average intake of nutrients (g ±SE)

Treatments (level of pomegranate peel powder, PPP)	T1 0% PPP	T2 1.5% PPP	T3 3% PPP	Significant effect
Intake of straw DM	350.16^{ab} 11.35±	391.15^{a} 31.91±	287.92^{b} 25.57±	*
Intake of straw OM	315.56^{ab} 10.23±	352.49^{a} 28.76±	259.47^{b} 23.04±	*
Intake of straw N	1.347^{ab} 0.043±	1.505^{a} 0.122±	1.108^{b} 0.098 ±	*
Intake of concentrate DM	604.45 34.72±	664.89 33.81±	553.82 47.98±	NS
Intake of concentrate OM	580.69 33.35±	622.87 31.68±	534.49 46.30±	NS
Intake of concentrate N	6.388^{ab} 0.369±	6.987^{a} 0.355±	5.598^{b} 0.484±	*
Intake of total DM	954.61^{ab} 24.57±	1056.03^{a} 60.88 ±	841.48^{b} 70.64±	*
Intake of total OM	896.24^{ab} 24.17±	975.35^{a} 55.98±	793.96^{b} 66.50±	*
Intake of total N	7.736^{ab} 0.326±	8.493^{a} 0.451±	6.706^{b} 0.560±	*
Intake of total digestible DM	569.07 13.38±	618.65 47.52±	512.69 54.17±	NS
Intake of total digestible OM	555.15 12.35±	586.43 45.65±	502.48 50.79 ±	NS
Intake of total digestible N	4.250 0.044±	4.406 0.289±	3.696 0.448±	NS

Means having different letters at the same row are significantly different at (P<0.05), PPP: pomegranate peel powder, DM=dry matter, OM=organic matter, N=nitrogen NS= non-significant.

Average intakes were 391.14, 352.49 and 1.505 g vs. 350.16, 315.56 and 1.347 g of these nutrients respectively. In spite of positive effect of addition of low level of PPP, addition of high level of PP (T3) in the current study led to mathematical decrease to 287.92, 259.47 and 1.108 in DMI, OMI and NI respectively. Results also revealed that intake of total DM (TDMI), OM (TOMI) and N (TNI) adopted similar significant (P<0.05) trend as intake of these nutrients in straw. However, significant effect of PPP levels on

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intake of concentrates was limited to NI only. Where, lambs fed concentrate diet containing low level of PPP consumed higher (P<0.05) N as compared with lambs fed concentrate diet free of PPP and that containing high level of PPP. TNI values were 6.98, 6.38 and 5.59 g/day respectively. Results of the current study also showed that higher insignificant intake of digestible DM (TDMI) was achieved by lambs fed concentrate diet containing low level of PPP in comparison with lambs fed other levels.

2-Weight gain and feed conversion ratio:

Table (4) shows effect of level of PPP on average weight gain and feed conversion ratio. Statistical analysis revealed no significant effect of level of PPP on weight gain. However, lambs fed concentrate diet containing 1.5% PPP attained higher final weight (FW), average total (TG) and daily gain (ADG) (34.20, 8.15 and 145.53) as compared with 32.60, 6.87 and 122.76 attained by lambs fed the control diet in which no PPP was added and 31.52 kg, 5.72 kg and 101.34 g/day attained by lambs fed concentrate diet containing 3% PPP.

Table 4- Effect of level of pomegranate peel on weight gain and feed conversion ratio (Units shown ±SE)

Treatments (level of pomegranate peel powder, PPP)		T1 0% PPP	T2 1.5% PPP	T3 3% PPP	Significant effect
Initial weight (kg)		25.72 2.07±	26.05 0.49±	25.80 1.07±	NS
Final weight (kg)		32.60 0.58±	34.20 2.40±	31.52 1.26±	NS
Total weight gain (kg)		6.87 ±1.48	8.15 2.44±	5.72 1.29±	NS
Daily weight gain (g/day)		122.76 26.57±	145.53 43.67±	101.34 23.90±	NS
Feed conversion ratio	g DM/g weight gain	7.71 1.19±	7.25 1.56±	8.30 1.80±	NS
	g OM/g weight gain	7.30 1.22±	6.70 1.36±	7.83 1.65±	NS
	g N/g weight gain	0.063 0.01±	0.058 0.02±	0.066 0.02±	NS
	g DDM/g weight gain	4.63 1.09±	4.25 1.41±	5.05 1.43±	NS

PPP: pomegranate peel powder, DM=dry matter, OM=organic matter, N=nitrogen DDM=digestible DM, NS= non-significant.

Results of this study revealed that feed conversion ratio (FCR) was not affected by PPP levels regardless to expression way. However, there was no significant differences among level of PPP in this study; lambs fed low level of PPP (T2) consumed its diet more efficiently than lambs fed high level of PPP (T3).

3-Digestibility of nutrients:

Table (5) shows effect of level of PPP on digestibility of nutrients of diet used in the study. Results showed that digestibility of nutrients were not a significantly affected by level of PPP. Digestibility of DM (DMD), CP (CPD) and NFE (NFED) were changed in similar trend as OMD, lower coefficients were achieved by lambs fed concentrate diet containing 1.5% PPP. Values for 0 and 3% were closed. Regarding CF digestibility (CFD), results revealed that digestibility coefficients were closed to each other. Values were 51.68, 51.75 and 51.52% for T1, T2 and T3 respectively. Results also showed that ether extract (EE) digestibility (EED) was decreased with increasing PPP levels. Lower coefficient was recorded by lambs fed diet containing 3% PPP (55.09%), whereas, higher values were recorded in control diet (60.17%).

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Table (5): Effect of level of pomegranate peel on digestibility of nutrients (% ±SE)

Treatments (level of pomegranate peel powder, PPP)	T1 0% PPP	T2 1.5% PPP	T3 3% PPP	Significant effect
Dry matter (DM)	59.82 2.65±	58.39 1.04±	60.42 ± 1.83	NS
Organic matter (OM)	62.20 2.74±	59.86 1.16±	62.87 1.55±	NS
Crude protein (CP)	55.49 2.88±	51.78 0.68±	55.34 2.28±	NS
Crude fiber (CF)	51.68 2.61±	51.75 3.30±	51.52 6.13±	NS
Ether extract (EE)	60.17 2.00±	59.92 1.67±	55.09 7.35±	NS
Nitrogen free extract (NFE)	68.95 2.91±	63.85 0.77±	67.04 0.30±	NS

PPP: pomegranate peel powder, NS= non-significant

Discussion

1-Daily intake of nutrients:

Higher (P<0.05) DMI, OMI and NI of wheat straw by lambs fed T2 as compared with T1 may due to improve rumen condition as a result of antioxidative property of PP (16). (17) Demonstrated that addition of PP significantly enhance feed intake. Those workers suggested that antioxidative and immunomodulatory properties of PP might improve immune function, which could benefit calf health. Improvement of lamb's performance as influenced by the antioxidative levels of PP was shown by other studies (18, 19). Reduction of DMI, OMI and NI of wheat straw by lambs fed T3 due to addition of high level of PPP can be explained by increase outflow of tannin that PPP characterized with (6). Tannin content of PP showed positive and negative effects in previous studies (7.18). referred to the positive effect of PP added to Karadi lambs at rate of 1-2%.Since animal choice for feed depends strongly on its palatability (20). The decrease in NI of concentrate containing 3% PPP may due to a decline in palatability as a result of expected increase in tannin content of concentrate with increasing level of PPP. (21) Pointed out that tannin was generally associated with a decline in diet palatability and idleness of animal to consume its diet. (22) Confirmed that high tannin content imbedded preference of diet by cattle, sheep and goats.

2-Weight gain and feed conversion ratio:

Insignificant effect of level of PPP on weight gain is in agreement with study carried out by (20) in which FW, TG and ADG of Kardi lambs were not affected by addition of PP. However, mathematical improvement in growth parameters as a result of addition of low level of PPP may due to protective property of tannin against ruminal degradation of protein. Hence utilization efficiency associated with passage of dietary protein from rumen to abomasum may be improved. Enzymatic digestion of protein in abomasum and subsequent increase of amino acids absorbed in small intestine enhance lambs performance as an increase in FW (4, 23). Improvement of gain by lambs fed T2 (1.5% PPP) can also be explained by low nitrogen loss may occur because of enhancing nitrogen balance (24). (25) Fed Awassi lambs concentrate diets at rate of 2% of body weight, he noticed that there was a mathematical increase in FW by lambs fed diet containing 2% PPP as compared with those fed diet free of PPP. Improve rumen condition and probable increase in microbial protein may be another reason for the priority of low level of PPP observed in the current study (26. 27). Insignificant effect of PPP levels on FCR agrees with (28) in their study, in which concentrate diets were offered to Awassi lambs with addition of three levels of PPP, 0, 2,4 and 6%, FCR values were 7.25, 7.11, 7.75 and 7.62 g DM/g weight gain for these levels respectively. In a current study FCR values were 7.71, 7.25 and 8.30 g DM/g

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weight gain, 7.30, 6.70 and 7.83 g OM/g weight gain for T1, T2 and T3 in which, PPP was added at rate of 0, 1.5 and 3% respectively. Though there was no significant difference among PPP levels in this study, it can be noticed that there was a slight improve in FCR by lambs fed low level of PPP (T2) especially in comparison with lambs fed high level of PPP (T3). (20) found that better TDMI, TG, ADG and FCR was achieved by Karadi lambs fed concentrate diet containing 1% as compared with 2 or 4% PPP. The superiority of low level of PPP shown in a current study may due to existence of tannin which possess protection properties of protein from degradation in the rumen, decreases ruminal ammonia concentration, minimizes loss of N as urea in urine, retained more ingested protein in body tissues and as a result improves its conversion efficiency thereafter (29). Recession of FCR values recorded by group of lambs fed T3 in a present study may due to increase tannin content in its diet. (30) Suggested that tannins considered having both adverse and beneficial effects in ruminant animals, high concentrations of tannins may reduce feed intake, digestibility of protein and carbohydrates and animal performance via their negative effects on palatability and digestion.

3-Digestibility of nutrients:

As affected by PPP levels, (20) obtained similar trend in digestibility that observed in current study, however, higher OMD coefficients were recorded. Values were 67.7, 66.80, 66.30 and 66.10% for 0, 1, 2 and 4% of PPP levels respectively. The difference in OMD may due to level of concentrate offered to lambs in the mentioned study and a current study (3 and 2.5% respectively). Slight increase in digestibility of DM, CP and NFE in T3 can be explained by lower TDMI and subsequent lower CP and NFE intakes. (31) Reported effect of intake on digestibility of mixed ration. (32) Referred to the interchangeable relationship between intake and digestibility. On other hand, digestibility can be affected by C: R ratio may. (33) demonstrated that increase this ratio may reflected positively on digestibility. In a current, study C: R was about 63:37 in both control diet and that containing low level of PPP, and 66:34 in diet containing high level of PPP. Worth mentioning that changes in intake and digestibility is associated with retention time of feed particles in rumen and outflow rate of feed from rumen and whole digestive tract (12).Increase digestibility of DM, CP and NFE in control diet can also be explained on basis of receiving sufficient amount of RDN by rumen microbes in comparison with diet containing low level of PPP. Then addition of PPP may affect the available amount of this important N fraction, which supplies degradable N required to maintain microbial growth and activity. NRC publications (34) confirmed the importance of RDN as a guarantee to optimize and improve ruminant productivity. However, decreased CPD in a current study disagrees with results obtained by (20). These workers noticed significant ($P<0.05$) increase in digestibility of this nutrients due addition of PPP. They added PPP to concentrate diets at level of 0, 1, 2 and 4%, the CPD were 63.5, 71.7, 69.2 and 68.3% respectively. Although, control treatment in their study was free of tannin because PPP was not added to it, those workers attributed the mentioned improvement in CPD to low tannin content. Receiving sufficient energy via concentrate level offered to lambs in a current study may explain the closed coefficients of CFD, because sufficient energy consumption may be reflected in similar activity of ruminal cellulolytic bacteria. This result agrees with results (35) who reported that cellulose digestibility was not affected with increasing level of PP to 4%. However, it disagrees with results of other study, in which CFD decreased due to increase PP levels (20). Moreover, (36) found that number of ruminal cellulolytic bacteria such as Fibrobacter *succinogenes* and Ruminococcus *albus* was *a* significantly decreased due to addition of different levels of PP to the diets of dairy cow. The trend of reduction of EED with increasing PPP levels can be explained by the

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negative effect of high content of tannin associated with high level of PPP. Furthermore, this result may be attributed to a decrease in rumen pH that probably occurred as a result of increasing PPP levels (26, 27).Digestibility coefficient recorded in a current study may be affected by both level of feeding and role of pomegranate peel through positive effect on efficiency of energy utilization and improve ecological safety of rumen as a result of antimethanogenic property that occurred directly via inhibition of methanogenesis process, or indirectly via inhibition of protozoan growth which proved to be associated with addition of PP (26, 27, 37). Since ruminal protozoa are able to phagocytize bacterial cells, inhibition protozoan community may enhance bacterial growth and increase production of volatile fatty acids and microbial protein. Moreover, antioxidative properties of pomegranate peel due to existence of phenolic compounds may acts as free radical scavenger in rumen environment and by this way leads to enhance rumen health and microbial efficiency (35).

Conclusion:

This study revealed that addition of pomegranate peel powder exhibited positive effect on productive performance of Awassi lambs through improve feeding parameters, intake and weight gain. It is believed that limited number of lambs used in this study affects the significance of addition of pomegranate peel on studied traits.

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