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EFFECT OF SUPPLEMENTED DIFFERENT LEVELS OF POMEGRANATE PEELS ON PERFORMANCE AND CARCASS CHARACTERISTICS OF LOCAL GOAT KIDS

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Abstract:

By-products obtained from the food processing industry have a potential value as animal feedstuffs and are becoming an important part of the food and fibre system used in livestock production. Pomegranate (Punica granatum L.) is a fruit-bearing deciduous tree that is widely grown in subtropical and tropical regions. Pomegranates are popularly consumed as fresh fruit, beverages, and food products (jams and jellies). Pomegranate peel makes up about 50% of the total fruit weight that remains after pomegranate juice production. This study was designed to investigate the effects of supplementing different levels of pomegranate peel (PP) powder to concentrate diet on the performance and carcass characteristics of Iraqi black goat kids. Eighteen weaned male goat kids were used in the current experiment. The goat kids were blocked according to their live weight and randomly divided into three different groups (6 lambs per group). Three different levels of PP powder were added to the concentrate diet, with 0 g/kg DM as a control group (GC), 20 g/kg DM as a low level of supplemented PP (LG), and 40 g/kg DM as a high level of supplemented PP (HG). Goat kids were kept in individual pens and received one of the three experimental diets for 12 weeks with free access to clean water and wheat straw. Data were analysed as randomized block designs. The results showed that adding different levels of PP significantly ($P<0.05$) reduced average daily weight gain: 95, 80, and 75 g/d, and feed conversion ratio: 10, 12.2, and 13 kg/kg for CG, LG, or HG respectively. While supplementation concentrated diet with PP powder either at 20 or 40 g/kg DM did not have any significant differences in all other studied traits.

Keywords: Feed additives, plant secondary compound, tannin, carcass cuts.

Introduction:

The growth and productive performance of the local goat are important aspects of the economic status (Kak et al., 2020). By-product feedstuffs are becoming increasingly more important in the food and fibre system because they are available for use as livestock feeds at competitive prices relative to other commodities (Mirzaei-Aghsaghali and Maheri-Sis, 2008). By-product feedstuffs (BPF) are obtained from the processing of commercial crops and the food processing industry (Maghsoud, Akbar et al., 2008). Many by-products have a substantial potential value as animal feedstuffs. This means these by-products can largely replace by cereals (Bampidis and Robinson 2006; Mirzaei-Aghsaghali and Maheri-Sis, 2008). Increasing agricultural industrial factories for producing pomegranate juice leads to the production of pomegranate peel as a by-product (Mirzaei-Aghsaghali et al., 2011).

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Pomegranate (Punica granatum L) is a fruit-bearing deciduous shrub or tree that belongs to the Lythraceae family, which is widely grown in many parts of the world (Arendse et al., 2017), including subtropical and tropical regions such as in Iraq, Iran, California, Turkey, Egypt, Italy, India, Chile and Spain (Oliveira et al., 2010). Pomegranates are popularly consumed as fresh fruit, beverages, food products (jams and jellies), and extracts wherein they are used as botanical ingredients in herbal medicines and dietary supplements (Adams et al., 2006). It is a source of numerous chemical compounds of high biological and nutraceutical value, that are present in skin, capillary membranes, arils, and seeds (Viuda-Martos et al., 2010).

Pomegranate peel makes up about 50% of the total fruit weight (Fawole and Opara, 2016) that remains after pomegranate juice production (Panichayupakaranant et al., 2010). It is a good source of tannins, flavonoids, phenolic and other polyphony compounds (Li et al., 2006), alkaloids, aromatic compounds, and enzymes (Kv and Ramasamy, 2016). Pomegranate peel attracts attention due to its apparent wound-healing properties, immunomodulatory activity, antibacterial activity, and anti-atherosclerotic and antioxidative capacities. Antioxidative activity has often been associated with a decreased risk of various diseases and mortality. A positive correlation between oxidative stress and illnesses is widely documented in cattle (Shabtay et al., 2008). It has been demonstrated that dietary supplementation with fresh PP promoted a significant increase in feed intake, with a positive tendency toward increased body weight gain in bull calves. It has been suggested that PP antioxidant and immunomodulatory properties might improve immune function, which could benefit calf health (Shabtay et al., 2008). Another study, also found that presenting fresh PP improved feed intake and increase the final weight (Taher-Maddah et al., 2012). Latest studies also have revealed that the effect of antioxidant levels in PP in lambs fed helps to improve their health and animal performance (Hussein and Shujaa, 2013; Khan et al., 2015). On the other hand Oliveira et al. (2010) reported that feeding young calves a pomegranate extract for the first 70 d of life suppressed the intake of grain and the digestibility of fat and protein which might be due to the high tannin content. Although polyphenolic compounds may improve animal health, they may also reduce proteolytic activity, which compromises protein digestion (Oliveira et al., 2010). There is, in fact, a lack of research regarding productive performance in local goats using pomegranate peel powder. Thus, the objective of the present study was to determine the effect of supplementing two levels of pomegranate peel powder with a concentrated diet on the performance and carcass characteristics of local goat kids.

Materials and methods

The experiment was conducted at the Animal Project, Animal Production Department, College of Agricultural Engineering Science, and the University of Duhok from July to October 2021.

Eighteen weaned male goat kids aged approximately 3-4 months with a body weight of 15±0.3 kg were used in this study. Prior to starting the goat kids were treated against

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external/internal parasites and they were quarantined for 10 days as an adaptation period.

Experimental animals and diets

The goat kids were divided equality, and randomly into 3 experimental diet groups (6 animals/group), the first diet was considered as a control group (CG) containing no PP powder as shown in Table 1, and the second group received the same control diet supplemented with 20 g/kg DM of PP powder (LG) and the third group provided with control diet supplemented with 40 g/kg DM of PP powder (HG).

The diet consisted of a two-part, concentrated diet (Table 1) which was weighed and offered at 3 % of body weight twice at 9:00 and 17:00 every day, and ad libitum wheat straw which was offered at a rate of 300 g/ head/ day. The residual concentrated and straw diets were collected every Sunday and Wednesday every week throughout the experimental period and weighed in order to measure the daily intake. The diet was formulated to meet the requirements of fattening local goat kids (live body weight 15-25 kg) according to AFRC (1993).

Table 1: The diet composition and chemical analysis for concentrated diet.

Ingredients	CG	LG	HG
Barely g/kg	250	250	250
Wheat bran g/kg	350	350	350
Wheat g/kg	250	230	210
Soybean g/kg	150	150	150
Pomegranate g/kg	0	20	40
Chemical composition g/kg DM			
Dry matter	866	865	867
Organic matter	950	948	948
Crude protein	151	151	150
Ether extract	35	35	35
NDF	343	334	346
ADF	150	144	138
ME*	11.34	11.35	11.36

CG: control group, LG: low level of supplemented pomegranate peel powder group, HG: high level of supplemented pomegranate peel powder group, NDF: neutral detergent fibre, ADF: acid detergent fibre, ME: metabolizable energy, *: predicted according to AFRC, 1993.

Housing

The goat kids were selected and housed in individual cages (1.5 m^2) and received the experimental diets with free access to clean water. Samples from all diet groups were collected for proximate analysis during the experiment. Goat kids were weighed on

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Sunday of every week at 10:00 during the 12 weeks of the experimental period using portable sheep scales (IAE Leek, Staffordshire, UK).

Diet chemical analysis and digestibility

Samples of the experimental diet were collected at weekly intervals and stored at room temperature for chemical analysis. Dry matter (DM) digestibility was determined using the acid-insoluble ash method as an indirect marker for diet digestibility as published by Van Keulen and Young (1977). Approximately 25 g of fresh faeces samples were collected from the rectum at week five of the experiment for 4 days respectively. The collected faeces were oven-dried at 60° C for 48 h, grounded, and pooled for individual kid. Feed and faecal samples were chemically analysed for dry matter (DM), organic matter (OM), crude protein (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF) and ether extract (EE) according to AOAC (2000). Organic matter and CP digestibility were analysed based on the DM digestibility and the chemical analysis of diet and faecal samples.

Rumen fermentation measurements

At week six, rumen fluid samples were collected from 5 goat kids in each experimental group before the morning meal at 8:30 am and 3 h after feeding at 12:30 pm using a stomach tube to measure the experimental diet's effect on rumen fermentation including rumen pH, NH3, and rumen protozoa counting. The pH values were immediately determined by a portable pH meter (pH700, EUTECH instruments, Singapore). The rumen protozoa counting was measured according to the method published by Dehority (1984) and the NH3-N concentration in the rumen fluid was measured according to MAFF (1986) using a Buchi AutoKjeldahl Unit K-370 (BUCHI LABORTECHNIK AG CH-9230, FLAWIL, SWITZERLAND).

Slaughtering and carcass measurements

At the end of the experimental period (12 weeks), goat kids were weighed and slaughtered. At slaughter, the weight of edible organs (skin, feet, head, heart, lung, testis, spleen, full and empty digestive tract) and non-carcass fat (testes, heart, mesenteric and pelvic) were recorded. The hot carcass weight of each slaughtered goat kid was measured 30 min post-slaughter. Then the carcass was chilled at 4˚C for 24 hours. The next day, the weight of the child's carcass and, the kidney, and kidney fat were measured. At that time the carcass was halved longitudinally using an electric saw and the right side was taken to study carcass characteristics. The right side was cut into the nine commercial cuts (neck, shoulder, rack, loin, shank, chest, flank, legs and tail). The eye muscle (longissimus dorsi) area at the 12th rib was measured by tracing the muscle on transparent paper and the area was measured using a Placom digital planimeter apparatus (PLANIX7, TAMAYA digital planimeter, Japan). The dressing percentage was calculated by dividing the hot carcass weight over the final live weight, and the shrinkage percentage was obtained by dividing the child carcass weight over the hot carcass weight.

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The right legs of each carcass were used for physical dissection by separating the lean from the fat and bones and the weight of each of these components was recorded.

Statistical analysis

Data were statistically analysed as an ANOVA procedure of GenStat 17 software (GenStat version 17, VSN International Ltd, UK). Goat kid's average daily gain (ADG) was calculated using Microsoft Excel. Feed conversion ratio efficiency was calculated by dividing the total weight gain over dry matter intake (kg/kg). Data of total gain, feed intake, slaughter, carcass traits, commercial cuts, and physical and chemical meat parameters were analysed as one-way ANOVA to study the effect of supplemented different levels of pomegranate peel powder on a concentrated diet, with a statistical model of:

$$Y_{ij} = \mu + A_i + e_{ij}$$

Where: Y_{ij} is the observation value of the animals, μ is the overall mean, A_i is the effect of pomegranate peel powder levels, and e_{ij} is the experimental error.

Results and Discussion

Animal performance

The results of animal performance are shown in Table 2, the results revealed that supplementation concentrated diet with low (20 g/kg DM) or high (40 g/kg DM) levels of pomegranate peels powder did not affect total daily dry matter intake (DMI), concentrated DMI nor straw DMI. However, the results showed that adding different levels of PP significantly ($P<0.05$) reduced average daily weight gain (95, 80, and 75 g/day for CG, LG, or HG respectively). The differences between treatments in average daily weight gain had led to showed differences in total gain. The control group was found to have a higher total gain (8.1 kg) during 12 weeks compared to LG (6.9 kg) and HG (6.1 kg). While there were no differences ($P>0.05$) in weekly gain (Figure 1) or final weight at week 12 between the experimental groups (Table 2). Supplementation of concentrated diet with PP was found to linearly increase feed conversion ratio, adding 40 g/kg DM of PP had the highest FCR compared to adding 20 or 0 g/kg DM of PP (13, 12.2, and 10 kg of diet/ kg of meat for HG, LG and CG respectively).

As pomegranate peel contains tannin, which is regarded as an anti-nutritional component that has unfavourable impacts on animal performance (Ngwa et al., 2003; Elmorsy et al., 2022, Taha et al., 2022). Hydrolysable tannins (punicalin, ellagic acid, gallagic acid, and punicalagin) have been shown to correlate positively with antioxidant activity in pomegranate peel and juice (Gil et al., 2000; Tzulker et al. 2007). Several studies (Perevolotsky et al., 1993; Deaville et al., 2010; Makkar 2003; Taha et al., 2015), demonstrated that tannin levels higher than 50g/kg DM had a negative effect on palatability and digestion, which might reduce feed intake, the digestibility of proteins and carbohydrates, and animal performance in most ruminants, while low or medium levels seems to have a minor effect. Although, in some cases, there is an increase in

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DMI due to tannin supplementation, which are exception to tannin suppression of DMI (Puchala et al., 2005; Beauchemin et al., 2007; Taha, 2015).

Table 2: The effect of supplemented different levels of pomegranate peels on some of the animal performance parameters of local black goat kids

Traits	Supplementation of PP levels (g/kg DM)			Probability	
	CG (0)	LG	HG	SED	P-value
Initial weight kg	16.0	16.1	16.1	0.21	0.85
Final weight kg	24.1	23.0	22.4	0.93	0.25
DMI total kg	0.94	1.03	1.05	0.059	0.21
DMI concentrate kg	0.73	0.77	0.81	0.049	0.28
DMI straw kg	0.21	0.26	0.24	0.032	0.35
ADG g/d	95	80	75	7.2	0.05
Total gain kg	8.1	6.9	6.3	0.61	0.05
FRC kg/kg	10.0	12.2	13.0	1.02	0.04

CG: control group, LG: supplemented 20 g/kg pomegranate peel powder, HG: supplemented 40 g/kg pomegranate peel powder, DMI: daily dry matter intake, ADG average daily gain, FRC: feed conversion ratio.

In the presented study, we detected an increase in feed conversion ratio (FCR) and a decrease in total weight gain (8.1, 6.9, and 6.1 Kg for control, LG and HG respectively), with no differences in final weight and DMI in goat kids. This result is consistent with Moradi et al. (2021) who showed that using 5% PP as feed additives resulted in higher body weight gains than the 10% PP group on Turkey-bred sheep. This may be because PP contains a significant amount of tannin, which may alter the diet's taste. Although Abarghuei et al. (2013) suggested that a lamb-specific internal mechanism may be responsible for the tendency to similar live weight gain in lambs, the addition of PP as half of the forage had a negative impact on the lambs. According to Abarghuei et al. (2013), PP contains high concentrations of saponin, which lowers feed consumption by reducing palatability and decreasing protein digestibility due to adverse effects on digestion. Supporting our findings S Yurtseven (2019) identified no significant differences in the effects of PP additions on feed consumption. However, in contrast to our findings, the same study by S Yurtseven (2019) found no difference in FCR and live weight gain in lambs, indicating that the negative effects of PP on feed consumption may be caused by adaptation to the taste of PP because feeds like pomegranate are more difficult to tolerate. Similar to our results, other research (Amri et al., 2017) found that giving pomegranate extract to rats reduced body weight due to a reduction in intestinal glucose absorption, which in turn led to a drop in caloric intake and weight loss. The current study's findings, however, conflict with those of Hussein and Shujaa (2013), who claimed that the final body weight, DMI, and FCR of lambs fed a diet supplemented with pomegranate peel at the ratio of 2%, 4%, and 6% had no significant

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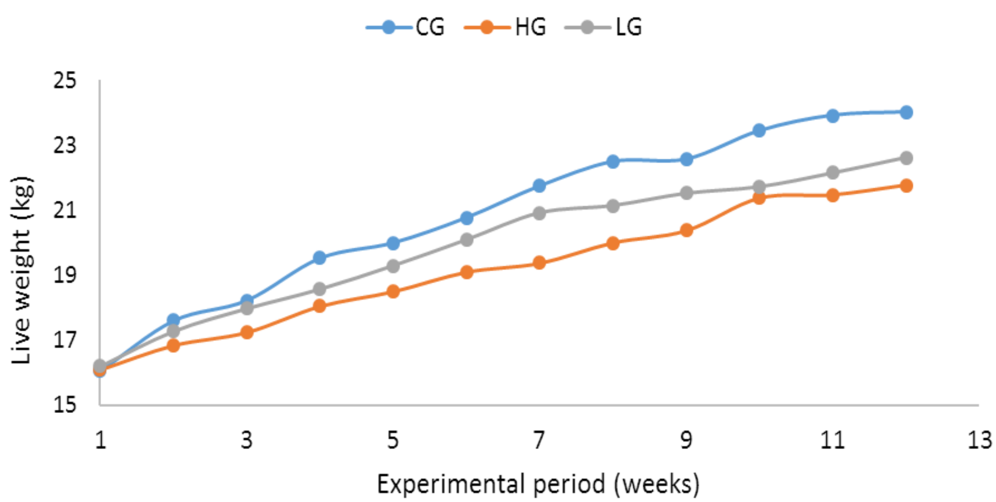
change. Additionally, according to Kotsampasi et al. (2014), adding PP to total mixed rations (TMRs) at concentrations of 0, 120, and 240 g/kg had no appreciable impact on the live weight, live weight gain, DM consumption and feed utilization of fattening lambs. These findings contrast with those of a prior study by Oliveira et al. (2010), which demonstrated that feeding young calves a pomegranate extract for the first 70 days of life suppressed the intake of grain and the digestibility of fat and protein, most likely due to the high tannin content.

Figure 1: The goat kids live weight gain (kg) during the experimental period, CG: control group, LH: supplemented 20 g/kg pomegranate peel powder, HG: supplemented 40 g/kg pomegranate peel powder



Whereas Omer et al. (2019) found that adding dried PP to lamb diets at various amounts (0.5, 1, and 2%) improved weight gain and FCR while reducing feed intake. Correspondingly, Sadq et al. (2016) reported that feeding Karadi lambs 1% or 2% PP significantly increased their total gain and average daily gain. However, they also noticed an increase in feed intake and FCR when feeding lambs pomegranate peel at1%, which may be because it is more palatable than 2% or 4% PP. On the other hand, Shabtay et al. (2008) observed that adding fresh PGP to the meal significantly increased feed intake and had a positive tendency to increase BW gain in bull calves.

Diet digestibility and rumen fermentation parameters

The result of diet digestibility showed that supplemented different levels of PP had no significant effect on DM, OM and CP digestibility. In addition, there were no significant differences between experimental groups in the current study on rumen pH in the morning or three hours after the morning meal, and rumen protozoa counting in the morning or three hours after the morning meal in goat kids as presented in Table 3. Consistently to our findings Safari et al. (2018), observed that diet supplementation with

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pomegranate by-products (PS or PSP) had no effects on DMI and rumen fermentation in transition dairy cows. The digestibility of DM, OM, NDF, and ADF was unaffected by the dietary addition of tannin-rich pomegranate peel extract (up to 1200 mg/day) in dairy cows, according to research by Abarghuei et al. (2013). Additionally, Kazemi and Valizadeh (2021) discovered that feeding fat-tail lambs varied pomegranate by-product silage (PBS) had no evident effects on DM intake, growth performance, or nutrient digestibility. Similarly, when Mahabadi goat kids were fed pomegranate seed pulp, Emami et al. (2015) did not see a notable influence on growth performance and nutrient digestibility. In contrast to our findings, Jami et al. (2012) found that feeding dairy cows 1% to 4% of pomegranate peel extract improved their intake and digestibility of DM, CP, and NDF. Furthermore, Hussein and Shujaa (2013) showed that Awassi Lambs fed various amounts of pomegranate peels, 2, 4, and 6%, significantly increased the digestibility of protein and Ether extract and significantly decreased the digestibility of fibres and dry matter.

Table 3: The effect of supplemented different levels of pomegranate peels on some of the diet digestibility and rumen fermentation parameters of local black goat kids

Traits	Supplementation of PP levels (g/kg DM)			Probability	
	CG	LG	HG	SED	P-value
DM digestibility	0.76	0.74	0.71	0.07	0.54
OM digestibility	0.78	0.79	0.74	0.064	0.69
CP digestibility	0.75	0.77	0.73	0.077	0.78
Protozoa morn log10	4.6	4.5	4.6	0.7	0.43
Protozoa Afte log10	4.1	4.2	4.3	0.6	046
pH morning	6.9	7.0	6.8	0.18	0.73
pH afternoon	6.2	6.4	6.4	0.25	0.12

CG: control group, LG: supplemented 20 g/kg pomegranate peel powder, HG: supplemented 40 g/kg pomegranate peel powder, DM: dry matter, OM: organic matter, CP: crude protein.

In addition, it was shown that lactating goats' feed intake and nutrient digestibility (CP, CF, DM and OM) were increased by pomegranate peel consumption (Kholif et al., 2022). However, recent research by Karamnejad et al. (2019); Shaani et al. (2016); Eliyahu et al. (2015) revealed that giving PP-containing diets to ruminant animals produced a drop in DM, OM, and CP digestibility in contrast to the control. The inconsistency between these studies could be the consequence of variations in the diets applied the amount and type of pomegranate used (i.e., the concentration and nature of the active components), and the type of experimental animals, all of which may affect digestibility (Kholif et al., 2022).

Slaughter weight and Carcass characteristics

The results of slaughter traits including slaughter weight, hot carcass weight, child carcass weight, dressing percentage or shanking percentage are shown in Table 4. The

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results indicated that a supplementation concentrated diet with different levels of PP had no significant difference among all slaughter parameters. Only there was a trend (P= 0.09) for HG to reduce dressing percentage compared to CG and LG. The results of carcass characteristics as shown in Table 5 exhibited that feeding local goat kids a concentrated diet supplemented with different levels of PP did not have any significant differences among all measured carcass parameters. Similar to the current study, Kazemi and Valizadeh (2021) and Kotsampasi et al. (2014) observed that the internal organ weight and carcass yield of fat-tail lambs and growing lambs, respectively, were not affected by the ensiled pomegranate by-products (EPB) diets.

Table 4: The effect of supplemented different levels of pomegranate peels on some of the slaughter parameters of local black goat kids

Traits	Supplementation of PP levels (g/kg DM)			Probability	
	CG	LG	HG	SED	P-value
Slaughter weight	24.1	22.2	23.0	0.93	0.25
Hot carcass	10.7	10	9.6	0.57	0.26
Child	10.3	9.6	9.3	0.53	0.16
Dressing %	0.44	0.45	0.42	0.011	0.09
Shrinking %	3.7	4.0	3.2	0.63	0.24

CG: control group, LG: supplemented 20 g/kg pomegranate peel powder, HG: supplemented 40 g/kg pomegranate peel powder.

It has been suggested that supplementing plants with tannins in ruminants' diets can improve the quality of their carcasses (Priolo and Vasta 2007; Vasta et al., 2007, Taha et al. 2022). Feeding pomegranate seed pulp to Mahabadi goat kids showed no appreciable impact on carcass traits, according to Emam et al. (2015), this is consistent with what we found. According to reports, pomegranate peel contains a high amount of tannins and other polyphenolic components (Ben Nasr et al., 1996). The antioxidant, antimitotic, anti-inflammatory, immunomodulatory, and antimicrobial properties of these phenolic and polyphenolic compounds in PG have been shown to be effective in vivo and in vitro (Adams et al., 2006; Jayaprakasha and Jeya, 2006; Rosenblat, 2006), which may influence ruminant performance and immune response (Mirzaei-Aghsaghali et al., 2011; Taher-Maddah et al., 2012). A recent researchEmami et al. (2015) found that goat kids fed pomegranate seed pulp had increased plasma total phenolic content and total antioxidant capacity (PSP).

Conclusion

Based on the findings of the current study, it can be concluded that increasing the amount of pomegranate peel powder supplementation linearly decreased average daily gain, total gain, and FCR in local Iraqi goat kids fed a diet supplemented with two levels of PP powder. This decrease is most likely caused by the possibility that the structure of

PP contains significant amounts of tannin. The feed conversion ratio and total gain were decreased because tannin was discovered to bond with diet nutrients such as protein and carbohydrates post-ruminally limiting the animal body's ability to utilize these nutrients.

Table 5: The effect of supplemented different levels of pomegranate peels on some carcass parameters of local black goat kids

Traits	Supplementation of PP levels (g/kg DM)			Probability	
	CG	LG	HG	SED	P-value
Bone	285	303	292	23.80	0.61
Lean	872	845	865	108.1	0.94
Fat	110	131	158	31.7	0.36
Flank	163	155	180	35.1	0.77
Chest	490	450	460	107.3	0.99
Kidney	82	85	80	11.9	0.91
Kidney fat	167	118	95	41.1	0.91
Leg	1357	1315	1360	118.5	0.86
Loin	490	420	448	95.9	0.76
Neck	400	465	391	63.5	0.32
Rack	525	408	487	75.1	0.81
Shank	482	455	550	146	0.31
Shoulder	1042	818	890	141	0.86
Tail	42	50	32	9.8	0.59

CG: control group, LG: supplemented 20 g/kg pomegranate peel powder, HG: supplemented 40 g/kg pomegranate peel powder

References

1. Abarghuei M., Rouzbehan Y., Salem A.,& Zamiri M. (2013) Nutrient digestion, ruminal fermentation and performance of dairy cows fed pomegranate peel extract. Livestock Science 157:452-461.
2. Adams L.S., Seeram N.P., Aggarwal B.B., Takada Y., Sand D., & Heber D. (2006) Pomegranate juice, total pomegranate ellagitannins, and punicalagin suppress inflammatory cell signaling in colon cancer cells. J Agric Food Chem 54:980-5.
3. AFRC. (1993) Agricultural Food and Research Council. Energy and Protein Requirements of Ruminants. An Advisory Manual Prepared by the Agricultural Food and Research Council Technical Committee on Responses to Nutrients. . CAB International, Wallingford, UK.
4. Amri Z., Ghorbel A., Turki M., Akrout F.M., Ayadi F., Elfeki A., & Hammami M. (2017) Effect of pomegranate extracts on brain antioxidant markers and cholinesterase activity in high fat-high fructose diet induced obesity in rat model. BMC complementary and alternative medicine 17:017-1842.
5. AOAC. (2000) Official methods of analysis of AOAC international; 17th Edidtion. Editor William Horwitz, Publisher AOAC Intl 2000.
6. Arendse E., Fawole O.A., Magwaza L.S., Nieuwoudt H.H., & Opara U.L. (2017) Development of calibration models for the evaluation of pomegranate aril quality by Fourier-transform near infrared

spectroscopy combined with chemometrics. Biosystems Engineering 159:22-32. DOI: https://doi.org/10.1016/j.biosystemseng.2017.04.004.

7. Bampidis V.A., & Robinson P.H. (2006) Citrus by-products as ruminant feeds: A review. Animal Feed Science and Technology 128:175-217. DOI: https://doi.org/10.1016/j.anifeedsci.2005.12.002.
8. Beauchemin K.A., McGinn S.M., Martinez T.F., & McAllister T.A. (2007) Use of condensed tannin extract from quebracho trees to reduce methane emissions from cattle. J Anim Sci 85:1990-6.
9. Ben Nasr C., Ayed N., & Metche M. (1996) Quantitative determination of the polyphenolic content of pomegranate peel. Z Lebensm Unters Forsch 203:374-8.
10. Deaville, E. R., Givens, D. I., & Mueller-Harvey, I. (2010) Chestnut and mimosa tannin silages: Effects in sheep differ for apparent digestibility, nitrogen utilisation and losses. Anim. Feed Sci. Technol. 157:129– 138.
11. Dehority B.A. (1984) Evaluation of subsampling and fixation procedures used for counting rumen protozoa. Appl Environ Microbiol 48:182-5.
12. Eliyahu D., Shaani Y., Yosef E., Ben-Meir Y., Nikbachat M., Solomon R., Mabjeesh S.J., Weinberg Z.G., & Miron J. (2015) Effect of ensiling pomegranate pulp with solid additives on chemical composition, intake and digestibility by sheep. Small Ruminant Research 131:93-98. DOI: https://doi.org/10.1016/j.smallrumres.2015.08.010.
13. Elmorsy A.M., Shoukry M.M., Soliman S.M., & Soliman M.M. (2022) Influence of Using Pomegranate Peel Silage in Rations of Dairy Cows on Their Productive Performance.
14. Emami A., Ganjkhanlou M., Fathi Nasri M.H., Zali A., & Rashidi L. (2015) Pomegranate seed pulp as a novel replacement of dietary cereal grains for kids. Small Ruminant Research 123:238-245. DOI: https://doi.org/10.1016/j.smallrumres.2014.12.001.
15. Fawole O.A., & Opara U.L. (2016) Stability of total phenolic concentration and antioxidant capacity of extracts from pomegranate co-products subjected to in vitro digestion. BMC complementary and alternative medicine 16:016-1343.
16. Gil M.I., Tomás-Barberán F.A., Hess-Pierce B., Holcroft D.M., & Kader A.A. (2000) Antioxidant activity of pomegranate juice and its relationship with phenolic composition and processing. J Agric Food Chem 48:4581-9.
17. Hussein S.A.M., & Shujaa T.A. (2013) The effect of using different ratios of pomegranate peels in performance and digestibilities in Awassi lambs. Journal of Tikrit University for Agricultural Sciences 13:52-62.
18. Jami E., Shabtay A., Nikbachat M., Yosef E., Miron J., & Mizrahi I. (2012) Effects of adding a concentrated pomegranate-residue extract to the ration of lactating cows on in vivo digestibility and profile of rumen bacterial population. Journal of Dairy Science 95:5996-6005. DOI: https://doi.org/10.3168/jds.2012-5537.
19. Jayaprakasha GK N.P., & Jena B.S.(2006) Antimicrobial activities of pomegranate., in: D. Heber, Schulman, R.N., & Seeram, N.P. (Eds.) (Ed.), Pomegranates: Ancient Roots to Modern Medicine (1st ed.) CRC Press,Taylor and Francis Group. pp. 3–29.
20. Kak, H.F, Al-Doski, S.H., & Taha, V.J. (2020) Effect of implementing zeranol on growth and carcass characteristics of Awassi lambs and goat kids rised under comercial conditions. Iraqi Journal of Agricultural Science. 51:1321-1328.
21. Karamnejad K., Sari M., Salari S., & Chaji M. (2019) Effects of nitrogen source on the performance and feeding behavior of lambs fed a high concentrate diet containing pomegranate peel. Small Ruminant Research 173:9-16. DOI: https://doi.org/10.1016/j.smallrumres.2019.02.004.

22. Kazemi M., & Valizadeh R. (2021) The effect of dietary supplementation of ensiled pomegranate by-products on growth performance, nutrient digestibility, haematology parameters and meat characteristics of fat-tail lambs. Italian Journal of Animal Science 20:1532-1543. DOI: 10.1080/1828051x.2021.1986429.
23. Khan K.M.H., Hamasalim H.J., Sadq S.M., & Ramzi D.O.M. (2015) Changes in lipid profile and some blood biochemical parameters in Karadi lambs receiving different levels of pomegranate peels. Research Opinions in Animal & Veterinary Sciences 5:210-214.
24. Kholif A., AboulFotouh G.E., Ahmed O.G., & Abd El-Mola A.M. (2022) effect of addition of pomegranate peel in the ration with or without polyethylene glycol on productive performance of lactating goats. Egyptian Journal of Chemistry 65:-. DOI: 10.21608/ejchem.2022.116304.5298.
25. Kotsampasi B., Christodoulou V., Zotos A., Liakopoulou-Kyriakides M., Goulas P., Petrotos K., Natas P., & Bampidis V.A. (2014) Effects of dietary pomegranate byproduct silage supplementation on performance, carcass characteristics and meat quality of growing lambs. Animal Feed Science and Technology 197:92-102. DOI: https://doi.org/10.1016/j.anifeedsci.2014.09.003.
26. Kv D., & Ramasamy D. (2016) Pomegranate Processing and Value Addition: Review. Journal of Food Processing and Technology 7:1-11.
27. Li Y., Guo C., Yang J., Wei J., Xu J., & Cheng S. (2006) Evaluation of antioxidant properties of pomegranate peel extract in comparison with pomegranate pulp extract. Food Chemistry 96:254-260. DOI: https://doi.org/10.1016/j.foodchem.2005.02.033.
28. MAFF. (1986) The analysis of agriculture materail. 3rd Edition ed. HMSO, London.
29. Maghsoud B., Akbar T., Hossein J., & Ali M.G. (2008) Evaluation of some by-products using in situ and in vitro gas production techniques. American Journal of Animal and Veterinary Sciences 3:7-12.
30. Makkar H.P.S. (2003) Effects and fate of tannins in ruminant animals, adaptation to tannins, and strategies to overcome detrimental effects of feeding tannin-rich feeds. Small Ruminant Research 49:241-256. DOI: https://doi.org/10.1016/S0921-4488(03)00142-1.
31. Mirzaei-Aghsaghali A., & Maheri-Sis N. (2008) Nutritive Value of Some Agro-Industrial By-products for Ruminants - A Review.
32. Mirzaei-Aghsaghali A., Maheri-Sis N., Mansouri H., Razeghi M.E., Mirza-Aghazadeh A., Cheraghi H., & Aghajanzadeh-Golshani A. (2011) Evaluating potential nutritive value of pomegranate processing by-products for ruminants using in vitro gas production technique. ARPN J. Agric. Biol. Sci 6:45-51.
33. Moradi A.G., Rahmani F., Aziz A.S., & Qiami M.F. (2021) Effects of feeding pomegranate peel silage on feed intake and growth performance of Turkey bred sheep. International Journal of Agricultural Research, Innovation and Technology 10:146-154. DOI: 10.3329/ijarit.v10i2.51588.
34. Ngwa A.T., Nsahlai I.V., & Bonsi M.L.K. (2003) Feed intake and dietary preferences of sheep and goats offered hay and legume-tree pods in South Africa. Agroforestry Systems 57:29-37. DOI: 10.1023/a:1022988200484.
35. Oliveira R.A., Narciso C.D., Bisinotto R.S., Perdomo M.C., Ballou M.A., Dreher M., & Santos J.E. (2010) Effects of feeding polyphenols from pomegranate extract on health, growth, nutrient digestion, and immunocompetence of calves. J Dairy Sci 93:4280-91.
36. Omer H.A.A., Abdel-Magid S.S., & Awadalla I.M. (2019) Nutritional and chemical evaluation of dried pomegranate (Punica granatum L.) peels and studying the impact of level of inclusion in ration formulation on productive performance of growing Ossimi lambs. Bulletin of the National Research Centre 43:182. DOI: 10.1186/s42269-019-0245-0.

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37. Panichayupakaranant P., Tewtrakul S., & Yuenyongsawad S. (2010) Antibacterial, anti-inflammatory and anti-allergic activities of standardised pomegranate rind extract. Food Chemistry 123:400-403. DOI: https://doi.org/10.1016/j.foodchem.2010.04.054.
38. Perevolotsky A., Brosh A., Ehrlich O., Gutman M., Henkin Z., & Holzer Z. (1993) Nutritional value of common oak (Quercus calliprinos) browse as fodder for goats: Experimental results in ecological perspective. Small Ruminant Research 11:95-106. DOI: https://doi.org/10.1016/0921-4488(93)90143-6.
39. Priolo Q., & Vasta V. (2007) Effects of tannin-containing diets on small ruminant meat quality. Italian Journal of Animal Science 6:527-530. DOI: 10.4081/ijas.2007.1s.527.
40. Puchala R., Min B.R., Goetsch A.L., & Sahlu T. (2005) The effect of a condensed tannin-containing forage on methane emission by goats1. Journal of Animal Science 83:182-186. DOI: 10.2527/2005.831182x.
41. Rosenblat M A.M. (2006) Antioxidative Properties of Pomegranate: In Vitro Studies, in: R. N. S. David Heber, Navindra P. Seeram (Ed.), Pomegranates Ancient Roots to Modern Medicine, Boca Raton (FL: CRC Press, Taylor & Francis Group). pp. 14.
42. S Yurtseven Z.K., & Takim K. (2019) THE EFFECT OF POMEGRANATE PEEL AND PISTACHIO HULLS ON PERFORMANCE AND ENTERIC METHANE EMISSIONS IN STRAW-FED LAMBS (Ovis aries L.). APPLIED ECOLOGY AND ENVIRONMENTAL RESEARCH 17:305-316.
43. Sadq S.M., & Ramzi D.O.M., Hamasalim H.J., Ahmed K.A. (2016) Growth Performance and Digestibility in Karadi Lambs Receiving Different Levels of Pomegranate Peels. Open Journal of Animal Sciences 6:16-23.
44. Safari M., Ghasemi E., Alikhani M., & Ansari-Mahyari S. (2018) Supplementation effects of pomegranate by-products on oxidative status, metabolic profile, and performance in transition dairy cows. J Dairy Sci 101:11297-11309.
45. Shaani Y., Eliyahu D., Mizrahi I., Yosef E., Ben-Meir Y., Nikbachat M., Solomon R., Mabjeesh S.J., & Miron J. (2016) Effect of feeding ensiled mixture of pomegranate pulp and drier feeds on digestibility and milk performance in dairy cows. J Dairy Res 83:35-41.
46. Shabtay A., Eitam H., Tadmor Y., Orlov A., Meir A., Weinberg P., Weinberg Z.G., Chen Y., Brosh A., Izhaki I., & Kerem Z. (2008) Nutritive and antioxidative potential of fresh and stored pomegranate industrial byproduct as a novel beef cattle feed. J Agric Food Chem 56:10063-70.
47. Taha, V.J. (2015) Effect of supplemented tannin on silage quality and animal performance. Ph.D. Dissertation, Harper Adams University, Newport, Shropshire, UK
48. Taha, V. J., Huntington, J., A., Wilkinson, R.G. & Daves, D. (2022) The effect of upolmented chestnut tannin to grass silage either at ensling or at feeding on lamb performance, carcass characteristics and meat quality. Agricultural and Food Science. 31:175-186.
49. Taha, V. J., Huntington, J., A., Wilkinson, R.G. & Daves, D. (2015) Effect of supplementary tannin on fed intake and digestibility in ewes offered lucerne silage during late pregnancy and early lactation. British Society of Animal Science, Annual conference. 6 (2):160.
50. Taher-Maddah M., Maheri-Sis N., Salamatdoustnobar R., & Ahmadzadeh A. (2012) Comparing nutritive value of ensiled and dried pomegranate peels for ruminants using in vitro gas production technique. Annals of Biological Research 3:1942-1946.
51. Tzulker R., Glazer I., Bar-Ilan I., Holland D., Aviram M., & Amir R. (2007) Antioxidant activity, polyphenol content, and related compounds in different fruit juices and homogenates prepared from 29 different pomegranate accessions. J Agric Food Chem 55:9559-70.

52. Van Keulen J., & Young B.A. (1977) Evaluation of Acid-Insoluble Ash as a Natural Marker in Ruminant Digestibility Studies. Journal of Animal Science 44:282-287. DOI: 10.2527/jas1977.442282x.

53. Vasta V., Pennisi P., Lanza M., Barbagallo D., Bella M., & Priolo A. (2007) Intramuscular fatty acid composition of lambs given a tanniniferous diet with or without polyethylene glycol supplementation. Meat Sci 76:739-45.

54. Viuda-Martos M., Fernández-López J., & Pérez-Álvarez J.A. (2010) Pomegranate and its Many Functional Components as Related to Human Health: A Review. Compr Rev Food Sci Food Saf 9:635-654