Effect of Addition of Pomegranate Peel in the Ration with or Without Polyethylene Glycol on Productive Performance of Lactating Goats

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Research Article

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Abstract

The industries of Pomegranate juice processing generate enormous waste in peel's form which are suggested and evaluated as a supplement in animal feed but pomegranate peel have high percent of tannins, So the aim of this paper is to assess the impact of mixing pomegranate peel (PP), detanninated pomegranate peel (DPP) and pomegranate peel with polyethylene glycol (PEG) on the digestibility of nutrients, the yield of goats milk and its composition, feed conversion and some parameters of blood. Moreover, simple economic assessment of the examined rations are considered. Sixteen lactating Zaraibi goats of about 3-4 years old (in their 2nd to 4th of lactation seasons with an average body weight of about 25 + 0.5 kg are used in the present study. After 14 days of parturition was randomly assigned into four groups, four animals per each tested ration (R) for 90days, **R_1: Control :** 50% CFM + 25% Egyptian clover and 25% wheat straw, **R_2:** Control ration**+**1% PP, **R_3:** Control ration**+**1% PP + 20 g (PEG) and **R_4:**Control ration**+**1% DPP. The results revealed that the PP contained 90.85% DM, 4.84% CP, 15.53% CF, 87.21%OM, 4.69% EE, 62.15% NFE and 15.28% tannins. No significant differences were found between the tested rations regarding nutrients digestibility except EE digestibility. Nutritive values of R_2 and R_3 were slightly higher than R_4 and R_1, respectively. Ration three (R_3) was the best ration for daily milk yield and total milk yield, where R_4 showed the worst one. Also, there are no significant differences for dry matter, SV and TDN intake. While, values of DCP intake were higher significantly ($P<0.05$), for R_3 and R_2 followed by R_4 then R_1. Regarding feed conversion, R_4 was superior to other tested rations followed by R_1 then R_3 followed by R_2. All blood serum parameters were in the normal rang which support that the healthy effect of tested additives in goats rations. It seems that R_2 and R_3 could be used successfully for lactating goats, but R_3 is very expensive from economical point of view, where R_3 was negatively economical effect, and not recommended.

Introduction

Pomegranate *(Punica granatum L.)* relates to the family of Punicaceae **(**Miguel et al., 2010) and is popularly consumed as fresh fruit, drinks, food items and extracts that are used in herbal remedies and dietary supplements as botanical ingredients. Fruit (peel, seeds and juice) is the main source of dietary pomegranate phytochemicals **(**Mars and Marrakchi, 1999**).** Pomegranate peel can be regarded as a waste from the pomegranate industry, producing comparatively higher polyphenol levels compared to fruit juice or seeds and flower fractions **(Sestili** et al **., 2007).**

The existence of increased molecular weight phenolics, proanthocyanidins, ellagitannins, complex polysaccharides, flavonoids and substantial amounts of microelements that have good anti-mutagenic, antioxidant, antimicrobial and apoptotic characteristics in general is characterised by pomegranate peel, which accounts for around 50 percent of fruit weight **(Prakash** et al ., **2013).**

The average area under pomegranates amounted to 85.676 thousand Fadden representing 5.1% of the average area under fruit crops in Egypt over 2016/2017. Also average production of pomegranates amounted to 381 thousand ton in 2016/2017 according to **Central Agency for Public Mobilization and Statistics. (2019)**. Pomegranate peel represents 50–67% of the total weight of pomegranate fruit according to **Christaki** et al. **)2011(** and **Prakash and Prakash)2011)**, so average production of pomegranates peel amounted to190.5- 255.27thousand ton in 2016/2017.

Hussein and Shujaa (2013a**) and** HamaKhan et al. (2015) showed that the impact of antioxidant rates in pomegranate peel in lambs fed aids in improving their health and animal performance. Also, Abarghuei et al., (2013) indicated that cows fed 800 ml pomegranate peel extract in their diet were significantly increased in milk yield.

High intakes of tannins negatively influence on production; the accessibility of nutrients is decreased due to the complexes produced between tannins and many forms of macromolecules, voluntary consumption of feed and digestibility are decreased, the animal's digestive physiology may be compromised, and mucosal disturbances might happen, etc. **(**Addisu, 2016**)**, but, In any case, it is increasingly recognised that the quantity consumed is important because tannins in many forage types can have beneficial effects in moderate quantities (Waghorn and Mcnabb, 2003**).**

Polyethylene glycol (PEG) is a polymer which irreversibly binds tannins, decreasing the harmful food intake impact of tannins **(**Silanikove et al., 1994), digestibility **(**Silanikove et al., 1996), and preferences **(**Titus et al., 2001). So we used detanninated pomegranate peel and polyethylene glycol (PEG) as a tannin-binding agent in current research to decrease the effect of the compounds of polyphenolic.

The aim of this study was to evaluate the impact of mixing pomegranate peel (PP), pomegranate peel and detanninated pomegranate peel (DPP) with polyethylene glycol (PEG) on nutrients digestibility, goats milk production and its composition, feed conversion and some parameters of blood. Moreover, simple economic assessment of the analysed rations was considered.

Materials And Methods

The current study was performed at the Experimental Farm and Laboratories of Animal Production Department - Faculty of Agriculture - Fayoum University, Egypt, from **April to June, 2019.**

Preparation of pomegranate peel and detanninated pomegranate peel

Dried pomegranate peels were obtained from the derivative unites in Fayoum, Egypt. Peels were compressed in a chopper to decrease it to coarse size peel. Detanninated pomegranate peel wasequipped in line with **(**Kushwaha et al., 2013), Both dried pomegranate peel powder and detanninated were transmitted in polyethylene bags to be investigated chemically and in farm examination.

Polyethylene glycol (PEG) source

Polyethylene glycol 4000 formed by Chem-Lab NV, Industriezone "De Arend" 2, Belgium.

Experimental animals

Sixteen lactating Zaraibi goats of about 3–4 years old (in their 2nd to 4th lactation seasons) with an average body weight of about 25 + 0.5 kg were used in the present study. After 14 days of parturition was arbitrarily divided into four sets, four animals per each tested ration (R) using complete randomized design.

The examined rations:-

The goats were independently supplied rations of concentrate: roughage at ratio of 1:1 on DM basis. The concentrate feed mixture consisted of 60% yellow corn, 20% soybean meal, 17.5% wheat Bran, 1.5% limestone, 0.2% dicalcium phosphate, 0.3% premix and 0.5% NaCl, where, Four tested rations were used in this experiment as shown below: **R_1**: **Control** : 50% CFM + 25% Egyptian clover and 25% wheat straw, **R_2**: Control ration + 1% pomegranate peel, **R_3**: Control ration + 1% pomegranate peel + 20 g Polyethylene glycol (PEG) and **R_4**: Control ration + 1% detanninated pomegranate peel.

Feeding and management of animals:-

Animals were given food to supply their food needs according to NRC (1985**).** The concentrate feed mixture was offered with wheat straw daily at 8.00 am., then Egyptian clover offered once daily at 4.00 pm. The 1% pomegranate peel、1% pomegranate peel + 20 g polyethylene glycol (PEG) and 1% detanninated pomegranate peel were introduced daily to each animal of second, third and fourth group with the concentrate feed mixture. Fresh water was constantly accessible to the animals. The experimental period was extended to 90 days.

Digestibility trial:

Digestibility trial was performed at the end of the site of experiment, the nutrient digestibilities and feeding values were decided utilizing acid insoluble ash (AIA) technique of Van Keulen and Young (1977**).** Feces samples were gathered day by day per every animal for seven days, dried overnight in hot air oven at 60°C, weighted, ground through 1mm screen, then complete drying was performed at 105°C for 3hrs and weighted and saved in tight bottles to be chemically examined in accordance with **AOAC(2009)**.

Lactation trial:-

After 14 days of the goat's parturition, milk production was noted down during the last three days of every month for three months. Goats have been milked (hand milking) twice daily at 7:00 am and 7:00 pm by milking one teat, whereas the other one was lift to lamb for suckling according to Farag (1979**)**. Milk samples were stored in bottles (100 ml) and frozen at (-20 ^{o}C) till the chemical analysis.

Sampling of blood:-

Blood samples were collected at the end of lactation trial (90 day) before morning feeding. A sample of 10 ml of blood per animal was gathered from the jugular vein in dry clean glasses tubes. Blood samples were centrifuged for 20 minutes at 3500 rpm to obtain serum. Serum was divided into an uncontaminated dried glass vial and stored at -18°C to be analyzed chemically.

Methods of analysis:-

Feeds and feces analysis:-

Chemical investigation of feedstuffs and feces samples were performed to find out the proportion of crude protein (CP), crude fiber (CF), dry matter (DM), ether extract (EE) and ash content in line with the approaches of AOAC (2009). The nitrogen free extract (NFE) was computed by difference. Acid detergent fiber (ADF), neutral detergent fiber (NDF), and acid detergent Lignin (ADL) were decided in accordance with Goering and Van Soest (1970). The tannin contents were defined by Folin Denis reagent as explained by Makkar et al. (1993).

Milk analysis:

The Chemical analysis of milk samples were determined according to AOAC (2009), The free radical scavenging activity of milk samples was calculated using DPPH (1, 1 diphenyl 2, picryl hydrazyl) assay (Brand-Williams et al., 1995), and Fat corrected milk (4% FCM) was calculated by using the subsequent equation according to Gaines (1928): FCM = 0.4 M + 15 F

Where: M = milk yield (g/d), F = fat yield (amount of fat = M x fat %).

Blood serum analysis

Serum protein, aspartate aminotransferase (AST), albumin, urea,alanine aminotransferase (ALT), creatinine, cholesterol, glucose, tri-glycerides and HDL concentration were decided utilizing specific kits (Stanbio Laboratory, Boerne, TX, USA) following producer directions.

Statistical analyses:

Numerical analyses were made by the general linear model procedure adapted by SPSS (2007) in line with the subsequent model:

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

Where: Y_{ij}, is the dependent variable, μ is the overall mean, T_i, is the effect of treatment and e_{ij}, is the residual error. Duncan's multiple test (Duncan, 1955) was carried out to separate among means.

Simple economic evaluation

Economic return of the tested rations were calculated on the assumption that the price of one kg of raw milk was 7 L.E. and the cost of one ton DM of Egyptian clover, corn, wheat bran, soybean meal, wheat straw and Pomegranate Peel were 2500, 4100, 3900, 6700, 1000, and 500 L.E, correspondingly and the price of one Kg Polyethylene glycol was 950 L.E.

Results And Discussion

Chemical composition of feed ingredients

Chemical composition of feed ingredients is presented in **Table (1).** The detanninated pomegranate peel (DPP) contained lower OM (84.12%), EE (1.62%), NFE (57.72%) and tannins (14.65%) compared with dried pomegranate peel (PP), while DPP recorded higher content of DM (96.75%), CP (5.89%), CF (18.87%), NDF

(30.10%), ADF (29.17%), ADL (12.09%), hemicelluloses (1.82%), cellulose (17.07%) and lignin (6.89%) than PP.

Chemical constituents of dried peels are almost close to the findings of Taher-Maddah et al. (2012), Kushwaha et al. (2013) and Sadq et al. (2015). Conversely, some differences are uncovered between chemical compositions of PP in the current study in contrast with those shown by **Mirzaei-Aghsaghali** et al., **(2011)**, Ebrahimi (2012**) and** Delavar et al., (2014). These differences in the chemical constitution of PP may be produced by different unique materials, growing conditions (geographic, seasonal variations, changes of weather, and land characteristics). Chemical compositions of DPP were in harmony with Kushwaha et al., (2013) thatthey informed that DM (17.63%), ash (3.29%), EE (1.43%), CP (6.43%), CF (24.36%), NDF (28.54%), ADF (26.11%) and lignin (7.59%). Higher chemical compositions in DPP than PP showed that preservation and growth of the above compositions during the detannination process but in case of lower test values in DPP than PP showed that losses of the above components during the detannination process. The summative analysis of concentrate feed mixture; Egyptian clover and wheat straw were in the common range.

Digestibility and nutritive values of tested rations

Date in Table (2) presented the average values of digestibility coefficients and nutritive values of the tested rations. No significant differences were found between the tested rations regarding nutrients digestibility except EE digestibility, where R_2, $R_{3,}$ and R_4 were superior to R_1. The result indicated that CP and CF digestibilies were the highest in R_3 compared to other treatment groups. Furthermore, the mean value of OM and EE digestibilies were the highest value was found in R_2. Also, DM digestibility was higher value in R_2, $R_{3,}$ and R_1 than R_4 .While, NFED showed higher digestibility in control group (R_1) followed by R_2, R_3, and R_4.

Hatami et al., (2018), Sadq et al. (2015) and Jami et al. (2012) discovered that utilizing pomegranate peel helped in improving the digestibility of nutrients in diets in comparison of the control treatment. These scholars stated that the development in digestibility may occur because of the added nutritive value of the PP extract itself and low and moderate (2% – 4.5%) concentrations of condensed tannins in the diet improved production efficiency in ruminants, by growing the flow of non-ammonia nitrogen and essential amino acids from the rumen. In ruminants, a mainly significant positive impact of tannins is dietary protein protection from ruminal microflora attack (McNabb et al. 1996). The high digestibility of ether extract (EED) was discovered in lambs fed 4% PP, due to tannin was protected the ether extract to degrade in the rumen and it escapes and flow rate from rumen into the tiny intestine and it is more fitting to absorption **(**Patra and Saxena, 2011**)**. These findings may support the obtained results of EE digestibility.

In contrast, Karamnejad et al. (2019), Shaani et al., (2015), Eliyahu et al., (2015), that found feeding PP containing diets brought about a decline in DM, OM, and CP digestibility in comparison of the control. Also, Abarghuei et al. (2013) reported that dietary inclusion of tannin- rich pomegranate peel extract (up to 1200 mg/day) had no influence on the digestibility of DM, OM, NDF, and ADF in dairy cows. The inconsistency among these works might be connected with variations among studies, in the diets used as well as the differences in the amount and type of pomegranate (i.e., the concentration and nature of the active ingredients), and kind of experimental animals, all which can influence digestibility.

Data in Table (2) cleared that no significant differences were obtained between the tested rations for SV, TDN, DCP, DE, ME and NE_L.

The R_2 and R_3 were recorded slightly higher of SV, TDN, and DCP than R_4 and R_1. The increases in TDN, SV, and DCP value for R_2 and R_3 may reflect the results of digestibility coefficients of CP, EE, CF, and NFE.

Digestible energy (DE), metabolizable energy (ME) and net energy for lactation (NE_L) were deceased with R_1 and R_4 compared with R_2, and R_3. The results that obtained by Sadq et al. (2015) in this regard may support our findings they found that the higher TDN, DE, and ME are increased in lambs fed 1% PP compared to lambs fed 0, 2, and 4%.

Milk yield and milk composition

Overall mean values of milk production and composition are shown in Table (3**).** The R_3 was the best ratio for daily milk yield, where R_4 showed the worst one. Also, The R_3 recorded the highest values of FCM followed by R_4 then R_1 and finally R_2. There are significant differences ($p > 0.05$) for fat% and total solids % between the tested rations, where the ration four (R_4) was the highest value compared with other rations. There are no significant differences ($p > 0.05$) for solids not fat %, total protein % and lactose % between the tested rations, where the ration two (R_2) was the highest value compared with other rations. Moreover, There are no significant effect ($p > 0.05$) for ash % between the tested rations.

These results of daily milk yield and fat correct milk are inaccord with those got by Safari et al., (2018) **and** Kotsampasi et al., (2017) who discovered that the diet containing pomegranate peel had no effect on milk yield and FCM. However, Shaani et al., (2015) reported that the addition of ensiled pomegranate pulp mixture (PPM) in the diet of cow reduced milk yield and increased 3.5% fat corrected milk (FCM) compared with the control. Moreover, Abarghuei et al., (2013) indicated that cows fed 800 ml pomegranate peel extract in their diet were significantly increased in milk yield and FCM. Such differences may reflect the effect of animal breed and the differences in the amount and type of pomegranate.

This result is an agreement with the results of Alphonsus and Essien (2012**)** who found the same relationship between milk fat% and milk yield and the opposite relationship between milk total solids % and milk yield.

Safari et al., (2018) found that the supplementing diet containing pomegranate seed and peel significantly increased milk fat percent and milk fat yield dairy cows, and Shaani et al., (2015) reported that the addition of ensiled pomegranate pulp mixture (PPM) in the diet of cow increased milk fat percent. Such findings may support the obtained results. On the other hand Kotsampasi et al., (2017) who indicated that there were no effects of addition of pomegranate pulp silage on milk fat percent and milk fat yield of lactating dairy cows, Also Abarghuei et al., (2013) found that there is no effect of addition of 800 ml pomegranate peel extract in the diet on milk fat percent, but there were significantly increased in milk fat yield.

These results of milk TS%, and milk TS yield are in accord with those obtained by Kotsampasi et al., (2017) who indicated that there were no effects of addition of pomegranate pulp silage on milk TS% and milk TS yield of lactating dairy cows, Also Abarghuei et al., (2013) indicated that there is no effect of addition of 800 ml pomegranate peel extract in the diet on milk TS %. Moreover, Shaani et al., (2015) and Safari et al., (2018) found that the supplementing diet containing pomegranate peel significantly increased milk TS% and milk TS yield.

Such results nearly similar to that obtained by Safari et al., (2018) found that the supplementing diet containing pomegranate seed and peel significantly increased milk SNF % and milk SNF yield of dairy cows. The contrast trend was found by Kotsampasi et al., (2017) indicated that the addition of pomegranate pulp silage on diet of lactating dairy cows decreased milk SNF % and SNF yield.

Such results were followed the same trend obtained by Abarghuei et al., (2013), Kotsampasi et al., (2017) and Shaani et al., (2015) who indicated that there is no effect of addition of pomegranate peel in the diet on milk TP % and milk TP yield, but Safari et al., (2018) found that the supplementing diet containing pomegranate seed and peel significantly increased milk TP % and milk TP yield of dairy cows.

The obtained results were nearly similar to those obtained by Abarghuei et al., (2013) indicated that there is no effect of addition of 400, 800 and 1200 ml pomegranate peel extract in the diet of dairy cows on milk lactose % and milk lactose yield, Moreover Shaani et al., (2015) reported that the addition of ensiled pomegranate pulp mixture (PPM) in the diet of cow decreased milk lactose %. These results expect R_4 contrast to those obtained by Safari et al., (2018) and Kotsampasi et al., (2017) who found that the supplementing diet containing pomegranate peel significantly increased milk lactose % and milk lactose yield.

These results are agreement with those obtained by Safari et al., (2018) found that there is no effect of the supplementing diet containing pomegranate seed and peel on milk ash % and increased milk ash yield of dairy cows, but Kotsampasi et al., (2017) who reported that the addition 75 of pomegranate pulp silage in the diet of dairy cows decreased milk ash % and there is no effect on milk ash yield.

Such finding differences may support the different animal breed and methodology of pomegranate prepared.

Data exhibited in Table (4) showed that overall mean values of milk yield and composition in the different lactation periods

Regarding the effect of milking period, data showed increasing milk yield and FCM from P_I to P_{Π} and then decreasing in P_{III}. There are significant differences for milk yield between periods of lactation for each ration. Period Π showed the highest yield, but P_{III} was the lowest one, Abedo et al., (2013) found the same trend with advance of lactation. Concerning the results of the effect of milking period on milk fat %, it was clear that highest value significantly ($p \leq 0.05$) was found with P_I and P_{III} compared to P_{II}. Such differences may also reflex the milk yield results, while there are no significant differences ($p > 0.05$) for milk fat yield.

Data showed that there are important differences for milk total solids % and milk total solids yield between periods of lactation, where the values of milk total solids % of P_{Π} and P_{III} were higher than $P_{I;}$ and the value of milk total solids yield of P_{Π} was higher than P_{I} and P_{III}. The values of milk total solids % were 14.13, 14.45, and 14.44(g/head/day) for P_{I}, P_{Π} and P_{III}, respectively. Also, there are significant differences for both milk SNF %, milk SNF yield, milk TP %, milk TP yield, milk lactose %, milk lactose yield, milk ash % and milk ash yield between periods of lactation, where the values of milk solids not fat % and milk solids not fat yield of P_{II} were higher than and P_{I} and $P_{I\Pi}$.

Milk radical scavenging activity

There are no noteworthy differences ($p > 0.05$) for antioxidant activity between the tested rations Table (5), where the R_3 recorded the highest antioxidant activity followed by R_2 then R_4 and finally control (R_1). These findings are in accord with those obtained by Shabtay et al., (2012) who indicated that the milk from cows fed pomegranate peel extract was higher antioxidant activity than the control, where hydrolyzable tannins are exposed to positively relationship with antioxidant activity and polyphenol content in pomegranate peel and juice (Gil et al., 2000; Tzulker et al., 2007) and In pomegranate, hydrolyzable tannins contain punicalin, ellagic acid, gallagic acid and punicalagin (Gil et al., 2000). Punicalagin has high lipid peroxidation-inhibitory and radical-scavenging activities (Kulkarni et al., 2004), and its health encourging elements might be of significance to the health of the animal which use it (Adams et al., 2006). So, encourage use of milk enriched with antioxidants in human diets to support human health and avoid complaints connected to oxidative stress, including cancers (Serrano et al., 1998).

Feed intake and feed conversion

There are no significant differences for dry matter and energy intake (SV, and TDN) of the tested rations Table (6), while the values of DCP intake were higher significantly ($P < 0.05$), for R_3 and R_2 followed by R_4 then R_1. These findings are in accord with those obtained by Safari et al., (2018) **and** Kotsampasi et al., (2017) who reported that there is no effect of the addition of pomegranate peel in the diet on dry matter intake, Also, Saeed et al., (2017) indicated that the diet lambs containing low level (1.5%) of PP was higher nitrogen intake compared to the control.

There were no important variations were found in feed conversion of DM, SV, TDN, and DCP between the tested rations Table (6). Regarding feed conversion of DM, SV, and TDN, R4 was insignificantly superior to the other tested rations followed by R3 then R1. Ration two (R2) was the worst one regarding feed conversion. Safari et al., (2018) concluded that milk efficiency of dairy cow fed diet containing pomegranate seed and peel was similar across the control ration.

Some blood serum parameters

No important variations were detected between the tested rations for serum total protein, albumin and globulin Table (7), where all values of them were within the normal range (6.1–7.5, 2.3–3.6 and 2.7–4.4 g/dl, respectively) as found by Boyd (2011). Generally no changes in the blood metabolites (serum albumin, total protein and globulin) suggested that damage to the liver did not occur. These results are an agreement with Hatami et al., (2018) who found that the addition of PEG to the PP diets has no effect on plasma albumin and total protein concentration. **However**, Safari et al., (2018) indicated that the level of albumin and total protein was lower for cows fed pomegranate by-products than control during postpartum. Also, Khan et al., (2015) found that no significant difference was found in total protein level between control and groups fed PP, while was found increased in albumin level in tested groups compared to the control.

The result indicated that the differences between rations for serum urea and creatinine Table (7) were not significant. The values of serum urea and creatinine were within the normal range (10–50 mg/dl) as reported by Kaneko (1989) and (0.7–1.5 mg/dl) as noticed by Boyd (2011), respectively. Such finding may suggest no negative effect on goat kidneys. Also, it was clear that no significant differences were obtained regarding serum glucose Table (7) of goat fed R_1, R_2, and R_3, but there are significant differences between R_4 and other tested rations. The values of serum glucose of the tested rations were within the normal range (48–76 mg/dl) as observed by Boyd (2011).

Table (7) showed no significant changes in AST and ALT levels and the values of serum AST and ALT were within the standard sort (8–40 and 5–30 Unit/dl, respectively) according to (Kaneko, 1989), which indicated the healthy effect of tested additives to goat's diets, where serum levels of AST and ALP are those conventionally used for domestic animal hepatic damagem, Specifically, ALP is used to detect bile obstruction, i.e. mild and progressive damage to the liver (Silanikove and Tiomkin, 1992), whereas liver enzymes like ALT, which is a liver specific hepatocellular enzyme released by hepatocellular damage, is used to assess liver damage (Mahgoub et al., 2008). These results of serum AST and ALT were similar to those obtained by Hatami et al., (2018) who found that the addition of PEG to the PP diets has no effect on plasma AST and ALT concentration. **However**, Safari et al., (2018) indicated that the level of AST was lower for cows fed pomegranate by-products than control during postpartum. **Also**, Ramzi, (2016) indicated that the level of AST was highest in lambs fed PP than the control, while ALT level was highest in lambs of the control compared to groups that fed PP in the diet. Such differences may support the effect of animal breed.

There were no significant differences among all groups in the overall means of serum cholesterol, triglyceride, HDL, LDL, and LDL/HDL ratio Table (7). The obtained results of lipid profiles were similar to Hussein and Shujaa (2013b) they reported that the addition of PP in the diet of Awassi had no effect on cholesterol, and triglyceride concentration. On the other hand, Safari et al., (2018) indicated that the level of cholesterol was lower for cows fed pomegranate by-products than control during postpartum, and Khan et al., (2015) found that total cholesterol and HDL concentration in lambs fed 1% PP were decreased, while triglyceride, LDL concentration, and LDL/HDL ratio increased compared to control group.

Simple economical evaluation of the tested rations

Ration two (R_2) had higher net revenue and relative percentage of net revenue compared with other tested rations Table (8). The cost of feed consumed for R_3 was higher than the other tested rations because of the price of polyethylene glycol was higher, Moreover, R_3 showed negatively net revenue. Finally R_2 was the best one.

Conclusion

It seems that the rations containing pomegranate peel (R_2), and pomegranate peel with polyethylene glycol) R_3) could be used successfully for lactating goats since it improved feed intake, nutrients digestibility, milk yield and composition, but R_3 is very expensive compared with control one from economical point of view, R_3 showed negatively economical effect and not recommended.

Declarations

The contributions made by each listed author:

Abdelkader Kholif was supervised the work, made statistical analysis and publishing the manuscript.

Gamal Eldeen Aboulfotouh was supervised the work in the farm, methodology and wrote the manuscript the manuscript,

Ola Gamal A. Hassan works in the farm, labs, , and wrote the manuscript the manuscript.

Abdelalim M. Abd El-Mola was supervised the work in labs. methodology and review of the original draft

All authors read and approved the manuscript.

Ethics declarations

Statement of animal right

The research was performed in line with appropriate worldwide, nationalized and institutional procedures for the care and use of animals

Declaration of competing interest

The authors report no declarations of interest.

The data was available to provide.

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Tables

Table (1): Chemical composition of feed ingredients that used in the tested rations (%).

Item	Ingredient				
	CFM	EC	WS	PP	DPP
DM	87.56	93.54	92.36	90.85	96.75
OM	83.46	78.27	73.04	87.21	84.12
CP	16.45	18.39	4.11	4.84	5.89
EE	2.08	4.50	0.91	4.69	1.62
CF	4.18	16.14	32.62	15.53	18.87
NFE	60.76	39.24	35.39	62.15	57.72
Ash	4.10	15.27	19.32	3.64	12.64
NDF	11.50	49.45	57.53	20.58	30.10
ADF	5.16	40.99	49.76	19.46	29.17
ADL	1.20	12.40	12.18	7.68	12.09
Hemicelluloses	6.33	8.47	7.75	1.11	1.82
Cellulose	3.96	28.58	37.57	11.78	17.07
Lignin	0.53	10.32	5.66	4.15	6.89
Tannins	---	---	---	15.28	14.65

(CFM): Concentrates feed mixture, (EC): Egyptian clover, (WS): Wheat straw, (PP): Pomegranate peel and (DPP): Detanninated pomegranate peel.

Table (2): Digestibility coefficients and nutritive values of the tested rations (on DM basis %)

Item	Tested rations				±SE
	R_1	R_2	R_3	R_4	
Digestibility coefficients %:					
DM	72.26	72.64	72.62	70.72	0.39
OM	73.90	74.49	73.94	71.72	0.45
CP	70.15	71.62	71.77	69.93	0.50
EE	56.73^{b}	66.89^{a}	64.41^{a}	62.99^{a}	1.35
CF	60.99	61.63	61.78	58.19	0.64
NFE	79.63	79.48	78.63	76.66	0.48
Nutritive values:					
TDN, %	59.97	60.74	60.23	58.44	0.37
SV,%	52.78	53.48	52.99	51.22	0.36
DCP, %	9.71	9.92	9.94	9.68	0.07
DE, MCal/kg *	2.64	2.68	2.66	2.58	0.02
ME, MCal/kg *	2.22	2.25	2.23	2.15	0.02
NE_L, MCal/kg *	1.35	1.37	1.36	1.31	0.01

Average in the same row having different superscripts are differ significantly ($P \leq 0.05$) for a, and b.

*calculated according to **NRC (1985)**, DE: 0.04409*TDN, ME: 1.01*DM-0.45 and NE_L: 0.0245* TDN-0.12

R_1: Control: 50% CFM + 25% Egyptian clover and 25% wheat straw, **R_2: R_1** + 1% pomegranate peel, **R_3: R_1** + 1% pomegranate peel+ 20g Polyethylene glycol (PEG) and **R_4: R_1** + 1% detanninated pomegranate peel.

Table (3): Overall mean values of milk yield and composition for the tested rations of lactating goat:

Item	Treatments				
	R_1	R_2	R_3	R_4	±SE
Milk yield (g/h/day)	842.33^{a}	844.56^{a}	851.78^{a}	808.22^{b}	15.19
Fat corrected (4%) milk yield	800.58	756.52	827.25	823.53	13.90
Fat %	3.68^{bc}	3.33^{c}	3.83^{ab}	4.16^{a}	0.10
TS%	14.24^{bc}	14.11^{c}	14.39^{ab}	14.62^{a}	0.07
SNF%	10.55	10.78	10.56	10.46	0.08
TP%	3.96	4.04	3.96	3.92	0.03
Lactose %	5.72	5.84	5.72	5.67	0.04
Ash%	0.88	0.90	0.88	0.87	0.01
Fat yield (g)	30.91	27.91	32.44	33.35	0.74
TS yield (g)	120.03	119.28	122.42	118.16	2.24
SNF yield (g)	89.12^{a}	91.37^{a}	89.98^{a}	84.81^{b}	2.07
TP yield (g)	33.42^{a}	34.26^{a}	33.74^{a}	31.81^{b}	0.78
Lactose yield (g)	48.27^{a}	49.49^{a}	48.74^{a}	45.94^{b}	1.12
Ash yield (g)	7.43^{a}	7.61^{a}	7.50^{a}	7.07^{b}	0.17

Average in the same row having different superscripts are differ significantly (P<0.05) for a, b and c. TS: total solids, SNF: solids not fat and TP: total protein

Table (4): Overall mean values of milk yield and composition in the different lactation periods:

Item	Treatments			
	P_I	P_{II}	P_{III}	±SE
Total milk yield (g/h/day)	833.00^b	941.83^a	735.33^c	0.85
fat corrected (4%) milk yield	819.18^a	850.35^a	736.38^b	9. 34
Fat %	3.89^a	3.35^b	4.01^a	0.14
TS%	14.13^b	14.45^a	14.44^a	0.12
SNF%	10.24^b	11.09^a	10.43^b	0.10
TP%	3.84^b	4.16^a	3.91^b	0.04
Lactose %	5.55^b	6.01^a	5.65^b	0.05
Ash%	$.85^b$	$.92^a$	$.87^b$	0.01
Fat yield (g)	32.40	31.57	29.48	1.26
TS yield (g)	117.70^b	136.05^a	106.17^c	1.46
SNF yield (g)	85.30^b	104.48^a	76.69^c	1.15
TP yield (g)	31.99^b	39.18^a	28.76^c	0.43
Lactose yield (g)	46.20^b	56.59^a	41.54^c	0.62
Ash yield (g)	7.11^b	8.71^a	6.39^c	1.10

Average in the same row having different superscripts are differ significantly ($P<0.05$) for a, b and c. **P_I:** First period of lactation, **P_{II}:** Second period of lactation and **P_{III}:** Third period of lactation. TS: total solids, SNF: solids not fat and TP: total protein

Table (5): Effect of the tested rations on milk radical scavenging activity of lactating goat.

Tested rations	Inhibition %	Remaining of *DPPH%
R_1	14.36	85.64
R_2	17.01	82.99
R_3	17.34	82.66
R_4	15.65	84.35
±SE	0.52	0.52

*DPPH (1, 1 diphenyl 2, picryl hydrazyl)

Table (6): Effect of the tested rations on daily feed intake and feed conversion of lactating goats:

Item	Tested rations				±SE
	R_1	**R_2**	**R_3**	**R_4**	
Feed intake					
DM, Kg	1.40	1.41	1.43	1.41	0.003
TDN, Kg	0.81	0.83	0.83	0.78	0.007
SV, Kg	0.71	0.73	0.73	0.68	0.007
DCP, g	121.59^{b}	135.25^{a}	137.10^{a}	127.52^{ab}	2.25
Feed conversion					
DM/FCM, kg/kg	1.76	1.88	1.74	1.72	0.04
SV/FCM, kg/kg	1.02	1.11	1.01	0.95	0.02
TDN/ FCM, kg/kg	0.89	0.97	0.88	0.83	0.02
DCP/ FCM , g/g	0.15	0.18	0.17	0.16	0.004

Average in the same row having different superscripts are differ significantly ($P<0.05$) for a and b.

Table (7): Effect of the tested rations on some blood serum parameters of lactating goats:

Items	Rations				±SE	Normal range
	R_1	R_2	R_3	R_4		
Total protein, g/dl	7.30	7.23	7.23	7.40	0.05	6.1-7.5
Albumin, g/dl	3.33	3.37	3.5	3.37	0.08	2.3-3.6
Globulin, g/dl	3.97	3.86	3.73	4.03	0.08	2.7-4.4
Urea, mg/dl	29.67	28.67	29.00	28.00	0.7	10-50
Creatinine, mg/dl	0.76	0.67	0.7	0.66	0.03	0.7-1.5
Glucose, mg/dl	61^{a}	61.67^{a}	63^{a}	43^{b}	2.7	48-76
AST,IU/dl	11.03	11.87	10.20	10.60	0.32	8-40
ALT, IU/dl	16.33	16.67	17	19.33	0.61	5-30
cholesterol, mg/dl	97.67	101.67	103.67	97.67	1.08	-
Triglyceride, mg/dl	62.33	65.00	65.33	64.33	2.08	-
HDL, mg/dl	42.67	45.33	49	45.33	1.06	-
LDL, mg/dl	42.53	43.33	41.53	39.47	0.57	-
LDL/HDL ratio	1.00	0.96	0.85	0.87	0.03	-

Average in the same row having different superscripts are differ significantly ($P<0.05$) for a and b.

Table (8): Simple economical evaluation of the tested rations of lactating goats:

Item	Rations			
	R_1	R_2	R_3	R_4
Milk yield (kg/head/90d)	75.81	76.01	76.66	72.74
Dry matter consumed(kg/head/90d)	126	127.26(126+1.26)	129.06(126+1.26+1.8)	127.26(126+1.26)
Price of one kg DM of the ration, L.E.	3.25	(3.25+0.007)	(3.25+0.007+19)	(3.25+0.007)
Cost of feed consumed (L.E /head/90d).	409.5	410.13	2120.13	410.13
*Total revenue, L.E	530.67	532.07	536.62	509.18
**Net revenue, L.E	121.17	121.94	-1583.51	99.05
Relative percentage of net revenue	100	100.64	-1306.85	81.74

*, Total revenue, L.E= Milk yield (kg /head /90day) × 7.0 L.E (price of one kg goats milk).

**, Net revenue, (L.E./h/90d) = Total revenue (L.E./h/90d) - Cost of feed consumed (L.E./h/90d), LE= Egyptian pound.