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Impact of Propylene Glycol on some Nutritional, Chemical and Technological Properties of Dairy Zaraibi Goats

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ABSTRACT

To evaluate the effects of propylene glycol (PG as powder) on some nutrition parameters (digestion coefficient and nutritive values) and some productive parameters (milk yield and composition) and its effects on the quality of milk processing for Domiatti cheese). An experiment was conducted by eighteen lactating Zaraibi goats in 3rd lactation season with an average body weight of 36±5.46 Kg and aged 39 months. In this experiment, three treatments were employed as six does in each treatment. The treatments done up to 21 weeks during lactation season and included: (1) control without PG (PG0), (2) 10g PG /doe/day (PG1) and (3) 20 g PG/doe/day. All treated goats were received basal ration contained 50% concentrate feed mixture (CFM) + 50% roughage (as berseem hay and rice straws) through lactation period up to 21 weeks. Apparent digestibility of CP, TDN and DCP was affected (P<0.05) by PG administration. Acetate and propionate were increased by using PG, but level of butyrate has increase significant for PG0. Moreover, the results could be showed that milk yield and milk compositions were affected (P<0.05) by the PG addition compared to control. Also, increasing PG levels from 10 to 20 g /does/day did not have any significant effect on milk yield, milk composition and other nutrition parameters. The cheese sample yield was slightly decreased particularly within PG1 and PG2 compared to PG0 cheese. The total solids and titratable acidity were slightly increased and pH values were slightly decreased by using PG milk. The PG cheese samples had significant (P<0.05) differences in TN/DM%, FA/DM% during the ripening period. The cheese made from PG1 and PG2 had the higher (P<0.05) score points for organoleptic properties than PG0 after continually storage period for 60 days. The results indicate that PG is an appropriate alternative for goats to prevent energy deficiency in the lactation period, while increasing the daily PG dose from 10 to 20 g has no significant but observed beneficial effect.

Keywords: Nutrition parameters, milk yield, milk composition and manufacturing Domiatti cheese, dairy goats.

INTRODUCTION

The use of alternative nutrients is important in the composition of feedstuffs because they help to reduce production costs. In this context, the biofuels industry has increased the availability of propylene glycol (PG), which may become an increasingly important material for concentrate feedstuffs for livestock (Lien *et al.,* 2010).

Thus, the same authors defined that PG is rich in energy (4.7 Mcal NE/L), rapidly absorbed and in the rumen approximately 80-90% usually metabolized 3h after feeding. It may be used to reduce the negative energy balance after calving and limiting the risk of ketosis and fatty liver. Shankare Gowda *et al.* (2013) revealed that PG is metabolized in the rumen to lactic acid and propionic acid, which are converted to glucose by hepatocytes which absorbed by the rumen wall or from the gastrointestinal tract and is converted to glucose by the liver. Furthermore, Cruz *et al.* (2014) refers to a successful use of PG that reduced plasma concentrations of free fatty acids, urea and increased plasma concentrations of glucose, insulin, cholesterol and Insulin- growth factor 1 (IGF-I). Recently, Nalawade *et al.* (2015) mention that PG has been the most carefully studied glucogenic supplement, that may has antibacterial and antifungal effects. Also those authors claimed that PG had bactericidal effects on many bacteria, especially *E. coli.* In general, PG is a substance used to prevent negative energy balance (NEB) in pre-parturient and prevention ketosis (Azza *et al.,* 2015). The PG could be increased the energy in the late phase of pregnancy and reduction levels of metabolites used for interpretation of energy balance such as beta-hydroxybutyric acid (BHBA) and non-esterified fatty acid (NEFA) concentrations (Mecitoğlu *et al.,* 2017). It also optimized the metabolic parameters in pre and post-partum periods of sheep which have no negative effects on the suckling lambs (Santos *et al.,* 2017). On the other hand, Akamatsu *et al.* (2018) suggests that PG prevents liver dysfunction related to an insufficiency of bile excretion occurs in cows with ketosis.

In this sense, the objective of this article was to assess the effect of PG supplementation on nutrition parameters (as digestion coefficient and nutritive values) and productive parameters (as milk yield, milk composition and milk manufacturing as domiatti cheese) of dairy Zaraibi goats.

MATERIALS AND METHODS

Study area

This experimental study was carried out at El-Serw Research Station, Damietta government which belonging to Animal Production Research Institute (APRI), Agriculture Research Center, Ministry of Agriculture, Egypt. The experimental period lasted from June to October 2018.

Experimental animals

A total number of 18 dairy Zaraibi goats in 3rd lactation season were appeared healthy and clinically free of diseases diagnosed at the time of study. The average live body weight of goats was 36±5.46 kg and aged 39 months. Three experimental goats' groups were used to evaluate the effect of supplementation 0.0, 10 or 20g of PG to basal ration offered to dairy goats during 21 weeks of lactation season.

Experimental diets

The dairy goats were randomly allotted to three groups with six does in each group. The goats in the1st group served as a control (PG0) without any addition

of PG. They were received basal herd ration routinely practiced in the farm. The PG0 group was fed 50% CFM (1000 g/h/d) +50% roughage included 800 g/h/d as berseem hay (BH) and 200 g/h/d rice straws (RS).

However, propylene glycol (PG) was added to basal ration herd in the 2nd group (PG1) and 3rd group (PG2) at 10 and 20 g/h/d, respectively. All goats were received PG0, PG1 and PG2 rations twice daily, one part at 9 a.m and other part at 4 p.m. Each experimental group was fed individually and its feedstuff provided to the goats to achieve the milk production needs according to National Research Council recommendations (NRC, 2007). Also, the fresh water and mineral blocks were available as free choice all trial period.

The chemical compositions of the forming essential ingredients (as CFM, BH and RS) were analyzed according to AOAC (2007) as shown in Tables 1. In addition, data in Table 2 explained that calculation of fiber fraction and feeding values of basal ingredients ration as the Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Acid Detergent Lignin (ADL) that determined for essential ingredients according to the methods of Van Soest *et al.* (1991). Also, hemicellulose was calculated as NDF – ADF, cellulose as ADF – ADL (Rinne *et al*., 1997), total digestible nutrients (TDN) = 129.39- 0.9419 (CF+ NFE), digestible crude protein (DCP) = 0.9596 (CP) - 3.55, digestible energy (DE) = 0.04409 (TDN %), metabolizable energy (ME) =1.01(DE) - 0.45 and net energy (NE) = 0.0245 (TDN %) - 0.12 according to NRC (2007).

Table 1. Chemical analysis of forming essential ingredients according to dry matter base.

Chemical analysis	Experimental rations (% as DM)		
%	CFM	BH	RS
OM	87.77	87.65	78.33
CP	14.42	13.15	2.94
CF	10.07	30.91	35.82
EE	2.42	2.33	2.24
NFE	60.86	41.26	37.33
Ash	12.23	12.35	21.67

Table 2. Chemical analysis of forming essential ingredients according to dry matter base.

Chemical analysis	Fiber fraction % of DM		
%	CFM	BH	RS
NDF	42.95	55.88	69.48
ADF	17.29	43.29	43.95
ADL	5.79	36.96	35.85
Hemicelluloses	25.66	12.59	25.53
Celluloses	11.50	6.33	8.10
Feeding values % of DM			
TDN	62.75	61.41	60.49
DCP	10.29	9.07	-1.35
DE (M cal/kg DM)	2.76	2.71	2.67
ME (M cal/kg DM)	2.34	2.29	2.25
NE (M cal/kg DM)	1.42	1.38	1.36

Nutrition parameters

During an experimental feeding period (post-weaning up to 21 weeks of lactation season), digestibility trials were conducted to determine nutrients digestion coefficient and rumen liquor of the experimental rations.

Three does from PG0, PG1 and PG2 groups were chosen to determine digestibility coefficients and rumen liquor parameters of the experimental rations.

Digestibility coefficients

Feces samples were taken from the rectum of each doe twice daily at 12 hours as an interval during the collection period (5 days). Representative samples of the tested feedstuffs were taken as well as samples of feces.

Each day's fecal output of each group was weighed and 20% was sub-sampled and stored frozen at -20°C. The daily total fecal excretion per group was used for the determination of digestibility coefficient. Then, samples of feces were dried at 55°C for about 72 hrs in a forced draft oven and ground to pass 1 mm mesh screen size and used for determination of chemical composition according to AOAC (2007). Neutral detergent fibers (NDF) and acid detergent fiber (ADF) were analyzed based on the method of Van Soest and Robertson (1985).

Rumen liquor

During the digestibility trials, rumen liquor was obtained *via* rubber stomach tube using gentle mouth suction. Rumen liquor was sampled before feeding (0 hour) and at 3 and 6 hours after feeding. The samples were filtered through two layers of surgical gauze. Immediately post- rumen liquor collected, the values of ruminal pH were determined using a pH meter. Then, 1.0 ml of saturated $HgCl_2$ solution was added to inhibit microbial fermentation. After acidification of rumen liquor samples using concentrated orthophosphoric acid and 0.1 N hydrochloric acid, concentration of volatile fatty acids (VFA's) was determined by steam distillation methods as described by Warner (1964). However, determination of NH_3-N concentration was carried out according to Conway and O'Malley (1957).

Volatile fatty acid (VFA's)

During the digestibility trials, samples of rumen liquor were collected for VFA's analysis using 1.0 ml extracted from the flasks at 12 h of incubation and conserved with 4 ml of 25% metaphosphoric acid. Samples were centrifuged at 2500 × g for 20 min. The supernatant was obtained and aliquots were taken for VFA analysis by gas chromatography (Erwin *et al.,* 1961).

Milk yield

Post-weaning (at 90 days), the commercial milk amount was recorded weekly up to 21 weeks of lactation season. The hand is used within 12 hours as interval periods between morning and evening lactation. At the day of evaluated milk value, the morning milk harvest from each goat / trial group was cooled at 5°C and added to the evening cooled milk which well mixed as one amount.

Then, this amount of milk obtained was multiplied in 7 days to give milk harvest weekly.

Milk composition

The composition of commercial milk was evaluated at 21 weeks of lactation period. The milk samples were taken up to 200 ml / goat during the previous periods. The 200 ml of milk samples were analyzed included 100 ml / doe from cooling morning milk plus 100 ml / doe/ from cooling evening milk which had well mixed as one sample.

The milk samples were analyzed for total solids (TS), fat (FA), solids not fat (SNF) and lactose by using digital Lactoscans, Milk analyzer, Wide LCD 8900 Nova Zagora, Bulgaria.

Some characteristics of manufacturing domiatti cheese

Goat's milk of different treatments was heated to 40°C. Salt was added to all treatments at 12% and finally milk was renneted. After complete coagulation, the resultant curds were ladled in wooden frames, lined with muslin cloth. After 24 hours, the resultant cheese of all treatments were weighed and pickled into their own whey. The cheese samples were stored in plastic jars at 25°C for 2 months.

Samples of cheese were analyzed. The organoleptically and cheese samples analyzed after 0, 30 and 60 days of ripening period using three replicates of each treatment. The organoleptically was conducted as following: 15 points for appearance, 35 points for body and texture and 50 points were given for flavor. While, cheese sample were analyzed for total solids (TS), fat/dry matter (FA/DM), TN/DM as the methods described by (Ling, 1963) and (A.O.A.C., 2007), pH was measured by using a digital pH-meter by direct immersing the glass electrode in cheese sample. Cheese yield was confined according to the formulation which reported by Metzger *et al*. (2000). Cheese sensory was evaluated according to Nelson and Trout (1965).

Statistical Analysis

Data were explored for comparison among treatment groups as PG0, PG1 and PG2 rations, sampling were performed using the one-way Repeated Measure Analysis of Variance (ANOVA) that applied to evaluate the influence of the propylene glycol on the considered parameters (as nutrition parameters, milk yield, milk composition and milk manufacturing) using the SPSS/PC computer program (Version 22.0 SPSS, 2013). Differences were considered significant when p values were less than 0.05 using the Duncan post hoc test of SPSS program.

RESULTS AND DISCUSSION

Chemical composition

Data presented in Table 3 summarized chemical composition for tested ratios.

Table 3. Chemical analysis of trial rations (% dry matter basis).

Chemical analysis	Experimental rations		
%	PG0	PG1	PG2
OM	86.59	81.51	79.29
CP	13.66	13.45	13.35
CF	25.49	24.52	23.14
EE	2.33	2.78	2.67
NFE	45.11	40.75	40.13
Ash	13.41	18.49	20.71
	Fiber fraction		
NDF	48.24	45.59	43.20
ADF	39.11	37.55	35.21
ADL	20.38	19.56	18.34
Hemicelluloses	9.13	8.04	7.99
Celluloses	18.83	17.99	16.87
	Feeding values		
TDN	62.89	67.91	69.80
DCP	9.56	9.36	9.26
DE (M cal/kg DM)	2.77	2.99	3.08
ME (M cal/kg DM)	2.35	2.57	2.66
NE (M cal/kg DM)	1.42	1.54	1.59

The chemical analysis of diets showed that contents of EE and ash were higher; while contents of OM and CP were lower in PG1 and PG2 than in PG0 ration. Increasing OM in PG0 compared to PG1 and PG2 was due to ash content in CFM, BH and RS. However, contents of CF were nearly similar among all rations. In addition, total fat content as measure by ether extract was higher in PG0 than PG1 and PG2 rations due to the lowest fat content in propylene glycol. The current results reported that all experimental rations were isonitrogenous and isocaloric during time of lactation. The calculated chemical composition is in agreement with the chemical composition of experimental rations obtained by Ben Salem *et al.* (2005) with dairy goats, in early lactating cows (Gowda *et al.*, 2013), in primiparous buffalo (Abdel-Latif *et al.,* 2016), and in sheep (Santos *et al.,* 2017) which supplied with propylene glycol.

Digestibility coefficients

Digestibility coefficients of PG0, PG1 and PG2 ration indicated that OM, CF, EE and NFE did not significantly (P>0.05) differ among trial rations (Table 4). This response is similar to that obtained by Ben Salem *et al.* (2005) who indicated that feeding value of diets (OM, CF, EE and NFE) was not affected by the amount and the frequency of PG supply. The PG administered daily at a rate of 10 or 20g increased crude protein digestibility. From this, Madibela *et al.* (2006) attributed the high crude protein (CP) digestibility and NH_3-N concentration to tannin deactivate by PG. Consequently, the improvement of CP digestibility due to PG supplementation in this study is consistent with the report of Gowda *et al.* (2013). There is confirmation with previous studies by Ben Salem *et al.* (2005) who reported that crude protein digestibility was 531, 625 and 614 g/kg when PG supplemented at 0, 10g and 20g to diet, respectively. Interestingly, Franzolin and Dehority (2010) found that extended periods of low rumen pH are probably more detrimental to the survival of ciliate protozoa population in the rumen that is a good indicator to increase DCP. On the other hand, Besharati and Taghizadeh (2011) showed that addition of PG to basal diets had an increasing effect on digestibility of crude protein (DCP) by liberate protein from the preformed tannin-protein complexes. Also, these latter authors have noted that the presence of PG could increase microbial plant adhesion and/or the fibrolytic microbial activity. As well as, Al-Masri (2016) suggested that the PG might have bound with tannins; allow to releasing proteins for microbial breakdown, this linked with higher production of microbial nitrogen in the presence of PG. In the current study, the digestibility values of dry matter (DVDM) were significantly (P<0.05) increased in PG0 compared to PG1 and PG2 ration. This effect was observed in study of Hilton *et al.* (1986) who clearly that elevation of PG from 0% to 10% could increase DVDM from 69.8% to 71.0%, respectively. Also, Madibela *et al.* (2006) proved that *in vitro* dry matter digestibility (IVDMD) using PG was improved. However, the study of Ben Salem *et al.* (2005) revealed that DVDM was 596, 609 and 597 g/kg when PG supplemented at 0, 10g and 20g to diet, respectively.

However, calculation of TDN and DCP during the experimental feeding, showed significant (P<0.05) greater values in PG1 and PG2 goats than those goats in PG0 group. Hence, the present results indicated significant (P<0.05) improvement in digestibility coefficients of most nutrients and in nutritive values as TDN and DCP of

ration, when PG were supplied to ration in particular during feeding with BH and RS. Thus, these include mainly the use of polyethylene glycol (PG) that releases forage proteins and improves fodder potential of these forages (Santos *et al.,* 2017).

Table 4. Average digestibility coefficients, fiber fraction and feeding values of the experimental rations.

Chemical analysis	Experimental groups		
%	PG0	PG1	PG2
Digestibility coefficients (%)			
DM	68.97[a]	64.45[b]	62.98[b]
OM	67.98	64.95	63.54
CP	61.13[b]	65.95[a]	65.88[a]
CF	57.21	54.93	53.67
EE	79.68	81.16	80.24
NFE	67.42	64.82	64.57
Fiber fraction (%)			
NDF	51.14	49.61	48.51
ADF	45.25	43.95	43.98
ADL	25.49	23.89	23.55
Hemicellulose	5.89	5.66	4.53
Cellulose	19.76	20.06	20.43
Feeding values (%)			
TDN	12.00[b]	16.60[a]	18.02[a]
DCP	55.11[b]	59.72[a]	59.67[a]

a and b: Means within the same row within different superscripts for each feeding system are significantly different at (P<0.05).

Rumen liquor

Result in Table 5 revealed that inclusion of PG at both levels in PG1 and PG2 rations of dairy goats during lactation season has significantly (P<0.05) decreased pH value and concentration of VFA's but increased ammonia concentration in sampled before or post-feeding. In this context, Alipour and Rouzbehan (2007) reported the greater ruminal ammonia and VFA's concentration caused with more rapid ruminal fermentation when PG was given. The lowest pH in rumen liquor of goats received PG1 and PG2 ration may be due to great concentration of lactic acid.

The highest pH produced with PG was similar to those found by Kristensen and Raun (2007) who suggested that PG has effects on metabolism by the following modes of action: (1) supply of glucogenic substrates by increasing absorption of PG as well as propanol, propionate and propanal originating from ruminal metabolism of PG makes PG glucogenic in the classical sense, (2) increased supply of l-lactate and propionate to gluconeogenesis, and (3) insulin resistance of peripheral tissues induced by increased concentrations of PG. From this, Ferraro *et al.* (2016) found that VFA's increased and ammonia-N decreased in the rumen liquor of sheep received PG orally.

They also noted that PG rapidly diffuse through the rumen wall and is fermented by rumen microbes resulting in VFA's production by the greatest propionate and acetate, but has the lowest butyrate after fermentation. Results from our experiment indicate that PG increased ammonia-N; the fermentation pattern obtained in this study was similar to that reported by Madibela *et al.* (2006). Based on these results, inclusion of PG adversely affected pH and VFA's production in rumen liquor. Kristensen and Raun (2007) recorded that pH was 6.60-6.63, total VFA's reached to 97.0 and 93.0 mM (included acetate 65.1- 61.6 mol/100, propionate 21.5 - 24.9 mol/100 and butyrate 9.6 - 9.1mol/100) in control and PG fed to Holstein cows, respectively. Regarding to great ruminal NH_3-N concentration, the increase in the gas production in the presence of PG is possibly due to an increase in the available nutrients to rumen micro-organisms, especially the available nitrogen. Besharati and Taghizadeh (2011) confirmed that PG caused a significant and marked increase in the rate and extent of ammonia production in the rumen.

Table 5. Effect of feeding PG0, PG1 and PG2 rations on rumen liquor parameters at each of sampling time.

Rumen liquor parameters	Assay Time /hours	Experimental rations		
		PG0	PG1	PG2
Ruminal pH value	0	7.29 ±0.45	7.35 ±0.66	7.34 ±0.56
	3	6.77[a] ±0.44	6.33[b] ±0.63	6.38[b] ±0.67
	6	6.88[b] ±0.57	6.72[a] ±0.77	6.84[a] ±0.79
Concentration of VFA's (meq/100 ml)	0	11.66[a] ±3.45	9.42[b] ±2.44	9.37[b] ±2.66
	3	16.57[a] ±3.58	13.78[b] ±3.25	13.79[b] ±3.55
	6	14.56[a] ±4.55	10.86[b] ±4.66	10.98[b] ±4.56
Ruminal NH_3-N concentration (mg/100 ml)	0	19.13 ±5.44	19.41 ±4.22	20.19 ±6.11
	3	22.14[b] ±7.44	23.87[a] ±6.98	24.58[a] ±6.58
	6	19.58[b] ±5.88	21.27[a] ±5.98	21.57[a] ±6.45

a and b: Means within the same row within different superscripts for each feeding system are significantly different at (P<0.05).

Volatile fatty acid (VFA's)

Average of VFA's values included acetate, propionate and butyrate % of experimental rations computed by goats are shown in Table 6.

Table 6. Effect of feeding PG0, PG1 and PG2 rations on proportions of VFA's produced by ruminal fermentation.

Experimental rations	Volatile fatty acid (VFA's) %		
	Acetate	Propionate	Butyrate
PG0	55.14[b] ±2.11	24.57[b] ±2.11	20.48[a] ±1.07
PG1	58.29[a] ±3.13	28.58[a] ±2.33	13.13[b] ±1.16
PG2	60.32[a] ±3.14	28.40[a] ±2.45	11.28[a] ±1.26

a and b: Means within the same column within different superscripts for each feeding system are significantly different at (P<0.05).

The improvement benefit of the effect of PG supplementation in this study is consistent with some other results (Madibela *et al.*, 2006, Besharati and Taghizadeh, 2011, Pechová *et al.,* 2014 and Ferraro *et al.*, 2016), but contrasts to other report (Kristensen and Raun, 2007) revealed the lowest acetate values in blood plasma flow in hepatic artery (2.48 mmol/h) in PG cows compared to control cows (3.01 mmol/h). However, these authors noticed that propionate (131 and 77 mmol/h) and butyrate (28 and 41 mmol/h) in blood plasma flow in hepatic artery of PG and control cows were in agreement with the present results, respectively.

Milk yield

Milk production was recorded weekly up to 21 weeks of lactation for goats which received supplementation of propylene glycol at PG1 and PG2 compared to PG0 as shown in Table 7. Although PG supplementation had no significant effect on milk yield during the experimental period from7th week to11th weeks of lactation season; yet, they were superior to PG0. In this context, the results observed in the present study are in agreement with those reported by Formigoni *et al.* (1996) who found non significant effect of PG supplementation on milk yield during mid carve of lactation. At the beginning week of lactation, it was similar among the treatments as reported by Borş *et al*. (2014), their results showed no effect on milk yield when PG supplied to diet.

Moreover, Azza *et al.* (2015) revealed that PG at 100 and 200 ml had no effect on early milk yield then, their averages were 10.12 and 10.36 kg compared to 11.56 kg in control dairy cows, respectively. In the current study, a higher milk yield (P<0.05) was observed for PG1 and PG2 goats from 14th to 21st weeks of lactation. Apparent the advanced to offered PG through lactation season; the milk yield tended to increase (P>0.05) to reach the highest average amount in PG2 goats compared to those goats treated with PG1 ration. Similarly, Rukkwamsuk and Panneum (2010) did not find significant increase in mean milk yield on PG supplementation in early and mid lactation period but increased in late milking compared to control cows. In this context, Kupczyński *et al.* (2005) found that milk amount for cows fed PG at 500ml / d /h was 38.63 and 42.85 kg compared to 35.04 and 42.52kg in the period of 3 and 10 first weeks of lactation, respectively.

Similar results were obtained by Gavan and Motorga (2009) who demonstrated that PG is a glucogenic precursor may be justified by potentially higher milk yields thus; average greater milk production was 32.2 kg/day for cows receiving PG than those receiving the diet without PG (29.2 kg/day) during lactation period. In addition, the current findings are in close conformity with the reports of Lomander *et al.* (2012) who documented that a significant increase in milk production by PG supplementation in early and late lactating cows. Therefore, there is a suggestion that PG could improve energy status by providing additional gluconeogenic precursor for the hepatic production of glucose which leads to increase milk yield (Rukkwamsuk and Panneum, 2010). Also, Lien *et al.* (2010) recorded that PG has significantly higher milk yield at 27.27 kg/d than 26.63 kg/d in control dairy cows. In addition, Gowda *et al.* (2013) concluded that the supplementation of PG resulted in favorable effect on milk yield; hence average milk yield was reached to 14.52 and 16.01 kg/day for control and PG cows, respectively.

Furthermore, in a previous work (Hussein *et al.,* 2015), it was stated that there is a positive relationship between energy balance and milk yield, but rather energy balance is a function of both feed intake and milk yield.

Hence, those authors defined that the milk yield was higher in the PG (10.7 kg/day) group than control (8.4kg/day) group; such increase could be attributed to the energy for milk production increased because of PG supplementation. As well as, Mecitoğlu *et al.* (2017) found that PG caused significantly higher milk yield in 6, 7, 8 weeks (as a late weeks of production), it was 42.52, 43.00 and 44.03kg than 38.82, 39.72 and 38.66 kg in control cows, respectively. Generally, positive effects of PG on milk production are mainly attributed to increases in glycogenic precursors and maintained a moderated metabolic energy status which resulting on bacterial populations that synthesize propionic acid which reflected on milking amount (Melendeza *et al.,* 2018).

Table 7. Effect of feeding PG0, PG1 and PG2 rations on weekly milk yield harvest.

Milk yield	Experimental rations		
weekly	PG0	PG1	PG2
W1	3.50±0.18	3.73±0.17	4.14±0.28
W2	3.26 ±0.19 ^{b}	3.97 ±0.29 ^{ab}	4.55±0.32 ^{a}
W3	2.92 ±0.31 ^{b}	3.68 ±0.32 ^{ab}	4.31 ±0.25 ^{a}
W4	2.69±0.37	3.43±0.11	3.44±0.34
W5	2.68 ±0.29 ^{b}	3.38 ±0.28 ^{ab}	3.79±0.27 ^{a}
W6	2.86 ±0.31 ^{b}	3.38 ±0.44 ^{ab}	4.18 ±0.27 ^{a}
W7	2.73±0.32	2.93±0.36	3.44±0.29
W8	2.68±0.25	3.43±0.27	3.44±0.25
W9	2.86±0.43	3.13±0.29	3.73±0.25
W10	2.80±0.44	3.32±0.29	3.44±0.26
W11	2.86±0.46	3.33±0.23	3.38±0.27
W12	2.57±0.41 ^{b}	3.27 ^{ab}±0.26	3.56 ±0.12 ^{a}
W13	2.39±0.33 ^{b}	3.09±0.32 ^{ab}	3.76±0.18 ^{a}
W14	2.22±0.26 ^{b}	3.09±0.23 ^{a}	3.27±0.17 ^{a}
W15	2.03±0.24 ^{b}	3.19±0.27 ^{a}	3.38±0.35 ^{a}
W16	1.81±0.21 ^{b}	2.69±0.15 ^{a}	3.03±0.21 ^{a}
W17	1.75±0.34 ^{b}	2.68±0.15 ^{a}	2.98 ±0.21 ^{a}
W18	1.52±.33 ^{b}	2.58±0.25 ^{a}	2.86±0.25 ^{a}
W19	1.46±0.37 ^{b}	2.51±0.32 ^{a}	2.92±0.25 ^{a}
W20	1.17±0.35 ^{b}	2.39±0.22 ^{a}	2.57±0.21 ^{a}
W21	0.99±0.29 ^{b}	2.33±0.19 ^{a}	2.39 ±0.27 ^{a}

a and b: Means within the same row within different superscripts for each feeding system are significantly different at (P<0.05).

Milk composition

Data is presented in Table 8 recorded the average of milk composition for goats which received PG1 and PG2 compared to PG0. The current study presents that the differences among the PG0, PG1 and PG2 groups was in fat content of goat milk. The fat content was significantly (P<0.05) higher in does of PG1 and PG2 than those in PG0 ration, but, PG1 and PG2 goats as well as in fat content. Kupczyński *et al.* (2005) obtained similar higher significant values in fat content use of PG at 250 ml /h/d, it was 51.28g/l than 34.83 g/l in control cows. Similarly, Lien *et al.* (2010) noticed that cow received PG could be recorded higher fat concentration at 3.62% than 3.53% in control group. Energy source of PG could be stimulated the release of fat and it increased milk fat synthesis in the udder (Nogalski *et al.*, 2012). It is possible that the PG supplement extracted an impaired fat release from the adipose tissue, a process that was reflected in the milk fat value variation (Borş *et al*., 2014). Generally, the reduction of milk fat content is in agreement with the most published work as reviewed by Mecitoğlu *et al.* (2017) who suggested that reduced milk fat content could be due to: firstly the decrease in plasma non-esterified fatty acids (NEFA) since lowered NEFA concentrations lead to decreased NEFA-uptake by the mammary gland and secondly the lowest proportion of acetate in the rumen which may reduce the amount of acetate available for devolve fatty acid synthesis in the mammary gland.

Table 8. Effect of feeding PG0, PG1 and PG2 rations on milk composition.

Milk composition%	Experimental rations		
	PG0	PG1	PG2
Fat	3.50±0.06[b]	4.09±0.05[a]	4.11±0.05[a]
Protein	3.08±0.05	3.18±0.05	3.19±0.06
Lactose	4.35±0.04[b]	4.67±0.06[a]	4.68±0.06[a]
SNF	7.43±0.09[b]	7.86±0.06[a]	7.86±0.05[a]
TS	10.93±0.09[b]	11.95±0.10[a]	11.97±0.10[a]
Acidy	0.16±0.07	0.17±0.06	0.17±0.05
pH	6.51±0.05	6.58±0.06	6.66±0.06

a and b: Means within the same row within different superscripts for each feeding system are significantly different at (P<0.05).

With regard to protein content, the differences among PG0, PG1 and PG2 groups in protein content of goat milk were not significant at lactation period but PG1 and PG2 goats were more in protein content than PG0 goats. From this, Kupczyński *et al*. (2005) recorded that protein amount in milk cows could show non-significant difference among 500ml /d /h of PG and 0.00ml /d /h of PG , it was117.73-117.78 g/l, respectively. Actually, toward to decrease milk protein content due to decrease of amino acid requirements for gluconeogenesis and thus there would not be a shortage of the spared amino acids for the milk protein synthesis (Toghdory *et al.,* 2009). Also, those authors noticed that protein percentage in cows was 3.00, 3.02, 3.04, 3.03% when PG supplied at 0, 250, 500 and 750 ml /h/d, respectively. As well as, Lien *et al.* (2010) confirmed that an increase in energy content of the feed by adding PG would stimulate an increase in milk protein percentage; hence, they found that protein percentage was up to 3.22- 3.28% in PG and control cows, respectively.

Concerning to the lactose content, the result showed that lactose content was significantly (P<0.05) lower in does fed PG0 ration than those fed PG1 and PG2 ration. Hence, feeding PG during lactation has positive effect on content of milk lactose (Kupczyński *et al*., 2005) revealed that improvement of lactose amount up to 19.13 g/l for cows fed PG at 500 ml h /d compared to 18.90 g/l for control ration. Furthermore, Liu *et al.* (2009) indicated that higher percentage of lactose up to 4.61, 4.64 and 4.65% in dairy cow supplied with PG at 150, 300 and 450 ml / day than 4.58% in untreated cows, respectively. In contrast to this, Toghdory *et al.* (2009) found that lactating cows had a tendency to decreased milk lactose percentage with PG supplemented to ration; it was 4.42, 4.34, 4.33 and 4.32% when rations contained 0, 250, 500 and 750 ml of PG, respectively.

Table 8 is showed significant (P<0.05) differences among the experimental groups in TS and SNF content of goat milk. Actually, the significant values of fat%, lactose% may be resulting in TS and SNF content in goats' milk. The general trend of change in the mean total solids of milk during lactation period is in full agreement with those reported by Toghdory *et al.* (2009). Protein, acidity and pH values were not affected significantly by dietary treatment at all times of milking periods. Generally, acidity and pH values showed marked reduction in PG0 compared to PG1 and PG2 goats. Form this, Hussein *et al.* (2015) found that PG could ameliorate TS, SNF, and acidity up to 14.6, 10.5 and 16.5% compared to 14.0, 9.9, and 17.0% in control buffaloes ration, respectively.

Chemical composition of Domiatti cheese

The results given in Table 9 described the impact of different feeding trial as PG0, PG1 and PG2 in the chemical composition of Domiatti cheese during storage times at 0, 30 and 60 days. There were pronounced (P<0.05) differences among PG cheese samples and control for TS, FM/DM and TN/DM contents of fresh cheese and during ripening stage. The yield of Domiatti cheese through all treatments was decreased during storage period. A surpass of PG1 and PG2 cheese may be due to the soften curd, which resulted in higher retention of moisture content. Similar trend was found by Ismail and Osman (2004). A higher significant differences (P<0.05) were found in the total solids (TS %) than PG0 cheese.

Table 9. Effect of feeding PG0, PG1 and PG2 rations on chemical composition of Domiatti cheese.

Item %	Storage days	Experimental rations		
		PG0	PG1	PG2
Total solid (TS)	0	36.17±0.44[b]	38.00±0.29[a]	38.68±0.44[a]
	30	40.63±0.40[b]	45.03±0.59[a]	45.43±0.26[a]
	60	41.23±0.07[b]	45.10±0.16[a]	45.53±0.14[a]
Fat/dry matter (FA/DM)	0	39.60±0.06	39.72±0.02	40.60±0.06
	30	43.95±0.19[b]	45.13±0.62[a]	46.74±0.55[a]
	60	43.77±0.17[b]	44.93±0.28[a]	46.61±0.19[a]
T.N/DM	0	5.88±0.11	5.91±0.01	5.98±0.08
	30	5.08±0.05[b]	5.35±0.22[a]	5.59±0.01[a]
	60	5.03±0.04[b]	5.25±0.22[ab]	5.51±0.01[a]
pH	0	6.20±0.05	6.20±0.02	6.28±0.06
	30	4.17±0.18	4.31±0.11	4.37±0.11
	60	3.90±0.0	3.91±0.04	3.95±0.08

a and b: Means within the same row within different superscripts for each feeding system are significantly different at (P<0.05).

Thus, improvement of PG1 and PG2 cheese may be due to the development of acidity which induces shrinkage in the cheese matrix and exudation of moisture from cheese curd. These results are closed with those reported by Hamad and Ismail (2012). Moreover, analysis data in Table 9 explained that the percentages of fat in dry matter (FA /DM %) increased (P<0.05) gradually in PG1 and PG2 cheese, but the total nitrogen in dry matter (TN/DM %) decreased (P<0.05) in all treatments within advanced of storage period. From this, El-Tahra *et al.* (2015) found that changing in either FA/DM or TN/DM in cheese might be attributed to the pasture, animal metabolism and amino acid catabolism or microbial activity. The current result could be recorded that there is (P>0.05) values in pH values among PG0, PG1 and PG2 during storage time up to 60 days. By advanced storage period from 0 to 60 days, the titratable pH values decreased from 6.28 to 3.90 in PG0 cheese, from 6.20 to 3.91 in PG2 cheese and from 6.28 to 3.95 in PG2 cheese when cheese stored from 0 up to 60 days, respectively. These results are discussed with those reported by Hamad and Ismail, (2012). On the other hand, Khosrowshahi, *et al.* (2006) reported that changing in pH through storage time of cheese may be related to the microbial growth and peptidase activity of lactic acid bacteria and the liberation of amino acids and free fatty acids which stimulate the bacterial activity.

Organoleptic properties of Domiatti cheese

The organoleptic properties of fresh white cheese treatments using three rations as PG0, PG1 and PG2 during the ripening period formed 0, 30 and 60 days are presented in Table 10. As shown, there are no clear differences among PG0, PG1 and PG2 cheese samples in color and appearance values. Then, the scores of color and appearance at the 60 days of ripening stage for treatments PG0, PG1 and PG2 were 14.17, 14.33 and 14.07, respectively. These results are in agreement with those reported by El-Tahra *et al.* (2015) who revealed that samples of Domiati cheese markedly improved during ripening period while color and appearance scores decreased at the end of ripening period. The body and texture results of cheese samples done from PG0, PG1 and PG2 milk after 60 days of ripening period were 32.33, 33.90 and 33.60, respectively. In addition, the flavour scores of treatments milk from PG0, PG1 and PG2 after storage up to 60 days as maturation period were 39.00, 40.67 and 40.67, respectively. Hence, flavor is the sensation produced by a material taken in the mouth, perceived principally by the senses of taste and smell, and also by the general pain, tactile, and temperature receptors in the mouth (Hamad and Ismail, 2012). Flavor also denotes the sum of the characteristics of the material which produces that sensation (El-Tahra *et al.,* 2015).

Table 10. Effect of feeding PG0, PG1 and PG2 rations on organoleptically properties of Domiatti cheese.

Storage time (days)	Proprieties	Score of test	Experimental rations		
			PG0	PG1	PG2
Zero	Color and appearance	15	13.50± 0.29	14.33± 0.28	14.50± 0.44
	Body and texture	35	29.50± 0.28	32.33± 1.02	32.67± 0.177
	Flavour	50	36.83± 0.44	37.50± 0.104	37.60± 0.59
	Total	100	79.83± 1.56^{b}	84.16± 1.78^{a}	84.77± 2.12^{a}
30	Color and appearance	15	14.00± 0.28	14.33± 0.16	14.50± 0.10
	Body and texture	35	31.77± 0.96	33.17± 0.60	33.33± 0.44
	Flavour	50	37.83± 0.44	39.10± 1.01	39.17± 0.97
	Total	100	83.60± 1.68^{b}	86.60± 2.01^{ab}	87.00± 1.32^{a}
60	Color and appearance	15	14.17± 0.33	14.33± 0.44	14.07± 0.23
	Body and texture	35	32.33± 0.44	33.90± 0.35	33.60± 0.55
	Flavour	50	39.00± 1.00	40.67± 2.36	40.67± 1.89
	Total	100	85.50± 2.11^{b}	88.90± 2.54$^{a b}$	88.34± 2.61^{a}

a and b: Means within the same row within different superscripts for each feeding system are significantly different at (P<0.05).

Latest authors confirmed that flavors increased during ripening period. Improving in organoleptic characteristics of domiatti cheese may be attributed to different aroma which came from propylene glycol (PG) which used in feeding dairy goats. Elgersma *et al.* (2006) explained that forage may affect the organoleptic characteristics of cheese. Generally, in all cheese treatments, the sensory evaluation scores gradually increased during ripening period. Thus, the total scores of organoleptic properties of samples PG1 and PG2 at the beginning of ripening period at zero day up to 60 days observed the highest (P<0.05) significant values compared to cheese samples obtained from PG0 milk.

CONCLUSION

The present results indicate that the PG can be used as an effective glucogenic precursor to improve the metabolic status of transition dairy goats. The PG supplementation in dairy goat diet was beneficial to improve digestion coefficient, nutritive values, milk yield, milk composition and milk manufacturing as Domiatti cheese. The dosage of PG at 10 or 20g/ day/ head under the present experimental conditions was suggested as safety dosage without any negative effects occurred among the tested animals.

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تأثير البروبيلين جليكول على بعض الخواص الغذائية والكيميائية والتكنولوجية للماعز الزرايبي الحلاب

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لدراسة تأثير البروبيلين جليكول على بعض الخواص الغذائية والكيميائية والتكنولوجية للماعز الزرايبي الحلاب تم تغذية عشرة من الماعز الزرايبى فى الموسم الثالث من الحليب بمتوسط وزن جسم 36 كجم وعمر 39.00 شهرًا لبثلاثة أيام البروبيلين جليكول (PG) كمصروف) على مقام المغذية (مثل مقام الهضم والزوم الغذائية) و ا داء ا ناجي (مثل إنتاج اللبن ، تكوين اللبن ومحتوى اللبن كجين دهناطي). في هذه التجربة ، تم استخدام ن تة مقام ت سنة عنزات لكل مقام. تمت المقام ت لمدة تصل إلى 21 أسبوعًا خ ل موسم الحليب وتشمل: (1) مجموعة المقارنة (PG0) بدون إضافة2) PG) مجموعة المقامة (PG1) إضافة 10جم PG/رأس /يوم (3) مجموعة المقامة (PG2) إضافة 20جم PG/ رأس /يوم. تم تغذية جميع المقامات على العليقة ا ساسية المحتوية على 50 ٪ أع ف المركزة + 50% مواد خشنة (دريس البرسيم+ قش ا رز). أوضحت النتائج أن مقام الهضم لـ CP، TDN، DCP كان أعلى للمقامة مع PG1، PG2 مقارنة مع PG0. لم احدث زيادة معنوية للخ ت ، بروبيونات باستخدام PG2،PG1 مقارنة PG0 ولكن المستوى ا على معنويا للبيوريت مع PG0 مقارنة مع PG1، PG2. ع وة على ذلك ، أظهرت النتائج أن إنتاج اللبن ، كفاءة الحليب حقق زيادة معنوية بإضافة PG2 PG1' مقارنة بمجموعة المقارنةPG0. وأيضا زيادة مستويات PG من 10 إلى 20 جم /رأس / يوم لم تكن لها أي تأثيرمعنوى على إنتاج اللبن ، كفاءة وغيرها من المقام ت الغذائية. أيضا حدث انخفاض طفيف بين عينات الجبن الدهناطى بين PG1 و PG2 مقارنة بجبن PG0. زادت المواد الصلبة الكلية والرطوبة بشكل طفيف وانخفضت قيم ا س الهيدروجيني قليلاً باستخدام لبن PG2,PG1 مقارنة مع PG0. لوحظ أن عينات الجبن الدهناطى مع , PG2,PG1 اختلفت معنوية كبيرة في TN / DM ٪ ، FA / DM ٪ خ ل فترة التخزين وبعد 60يوم من التخزين. وكان للجبن الدهناطى المصنوع من PG1 و PG2 أعلى قليلا معنوية في الخصائص الحسية من PG0 لفترة تخزين إستمرت حتى 60 يومًا. تشير النتائج إلى أن PG هو بديل مناسب للماعز لمنع رقص الطائفة في فترة الحليب ، في حين أن زيادة الجرعة اليومية لل PG من 10 إلى 20 جم /رأس ليس له تأثيرمعنوى. وبالتالي هذه النتائج تستنبط الضوء على أهمية الجوانب المرضية في تقييم PG لتغذية الماعز الحلاب.