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EFFECT OF FEEDING PROPYLENE GLYCOL AND NIACIN IN LATE PREGNANCY AND EARLY LACTATION ON THE PERFORMANCE OF DAMASCUS GOATS

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SUMMARY

Damascus goats (9 animals/treatment) were randomly allocated, four weeks prior to expected parturition, to one of three treatments: 1) control, 2) propylene glycol (40 g propylene glycol/h/d) and 3) 40 g propylene glycol plus 0.67 g of niacin/h daily. Animals continued on the same *pre-partum* treatment and for six weeks into lactation. There were no differences between treatments for initial body weight, body weight prior to kidding and at kidding, as well as in litter weight. Similarly, there were no differences in dry matter intake (DMI), milk production and milk composition and live weight changes among the three diets. Overall, DMI was considerably low and animals were loosing weight despite low milk yields in all three diets. Plasma glucose level was elevated by propylene glycol (PG) but not by niacin. Both diets with PG had higher plasma glucose levels than the control group. Plasma glucose was lower in the pre- than post-feeding samplings. There was no effect of diet and sampling time on plasma urea concentration, whereas, plasma albumin was higher in the pre- than in post-feeding samples. Results of the present study reinforce the concept that the use of PG and/or PG plus niacin for increasing milk yield and/or reducing ketosis incidence is not necessary when optimum feeding and management is applied.

ΠΕΡΙΛΗΨΗ

Στις τελευταίες 2 έως 3 βδομάδες της εγκυμοσύνης η πρόσληψη τροφής σε πολύδυμες φυλές αιγοπροβάτων ελαττώνεται σημαντικά. Αυτό έχει σαν αποτέλεσμα την κινητοποίηση σωματικών αποθεμάτων λίπους για ικανοποίηση των αυξημένων αναγκών σε ενέργεια. Η κινητοποίηση σωματικού λίπους για ικανοποίηση τέτοιων αναγκών οδηγεί στη μεταβολική ασθένεια οξέωση. Η προπυλαινική γλυκόλη που έχει χρησιμοποιηθεί για τη θεραπεία της κέτοσης μετά τον τοκετό, δοκιμάζεται επίσης για αποφυγή οξοναιμίας της εγκυμοσύνης. Ενώ είναι γενικά αποδεκτό ότι τα μηρυκαστικά ζώα είναι σε θέση να συνθέτουν με τους μικροοργανισμούς της μεγάλης κοιλίας τη νιασίνη (Βιταμίνη Β) που χρειάζονται, το τελευταίο αμφισβητείται όταν τα ζώα καταναλίσκουν μεγάλες ποσότητες συμπυκνωμένου μίγματος. Στη μελέτη αυτή έγκυες αίγες Δαμασκού (9 ζώα/δοκιμή) τοποθετήθηκαν τυχαία σε 3 δοκιμές [Μάρτυρας, Μάρτυρας+40 γρ προπυλαινικής γλυκόλης (PG), Μάρτυρας+40 γρ προπυλαινικής γλυκόλης και 0.67 γρ νιασίνη/ζώο/μέρα (PGN)] τέσσερεις βδομάδες πριν τη γέννα και για 42 μέρες μετά τον τοκετό. Δεν υπήρξε διαφορά μεταξύ δοκιμών στην πρόσληψη ξηρής ουσίας, τον αριθμό και το βάρος γεννηθέντων ριφιών, τη γαλακτοπαραγωγή και σύνθεση του γάλακτος και στη μεταβολή του ζωντανού βάρους των ζώων. Επίσης δεν υπήρξαν προβλήματα υγείας ή απώλειες ζώων που θα μπορούσαν να αποδοθούν στις δοκιμές. Η περιεκτικότητα γλυκόζης στο αίμα αυξήθηκε με την προσθήκη προπυλαινικής γλυκόλης αλλά η προσθήκη νιασίνης δεν αύξησε περαιτέρω τη γλυκόζη στο αίμα. Τα επίπεδα γλυκόζης ήταν χαμηλότερα στο δείγμα που λήφθηκε πριν το πρωινό τάισμα. Τέλος, δεν υπήρξαν διαφορές μεταξύ δοκιμών στη συγκέντρωση ουρίας και ολικής πρωτεΐνης στο αίμα. Με βάση τα αποτελέσματα της μελέτης αυτής και σε συμφωνία με άλλες μελέτες με αγελάδες συμπεραίνεται πως ακολουθώντας την ορθή διατροφή και διαχείριση δεν υπάρχει ανάγκη χρήσης προπυλαινικής γλυκόλης και νιασίνης για αποφυγή της οξοναιμίας της εγκυμοσύνης και αύξηση της γαλακτοπαραγωγής.

INTRODUCTION

Concentrate supplements are commonly offered to pregnant ruminants in increasing doses during late pregnancy and may exceed half of daily dry matter intake (DMI) during the last 2 to 3 weeks. Concentrates are given as a single daily meal with roughage of moderate quality (cereal hay). Large intakes of concentrates can, however, depress rumen pH and adversely affect rumen fermentation and roughage digestibility (Mould *et al*., 1983) to the potential detriment of performance.

From about 2 to 3 weeks prior to parturition the DMI of the prolific ewe and goat drops by 15 to 25%. When intake drops, blood glucose levels also decrease. The animal reacts by mobilizing body reserves, mainly fat. This effect is accentuated by the fact that the demand for energy is increased by the growth of the unborn offspring, which increases considerably during the last weeks of gestation (ARC, 1980). Fat mobilization, which is a consequence of the lower feed intake, combined with a higher demand for energy provides the liver with a large amount of fat resulting in a fatty liver that will promote ketosis, more retained placentas and difficulties in rebreeding.

Propylene glycol, a glucogenic compound used to treat clinical ketosis *post-partum*, largely escapes rumen fermentation intact and is converted to glucose by the liver, resulting in lower levels of non-esterified fatty acids and ketone bodies which are the cause of ketosis. Niacin is a B vitamin synthesized by rumen microorganisms. The Agricultural Research Council (ARC) and the National Research Council in the UK and USA, respectively, consider those amounts sufficient to meet the needs of lactating ruminants (ARC, 1980; NRC, 1985; 1988). However, numerous studies have reported increased milk yield (Jaster *et al*., 1983), milk fat (Jaster *et al*., 1983; Horner *et al*., 1986) and milk protein (Horner *et al*., 1986) contents in high-producing dairy cows fed niacin supplemented diets. The response has generally been greatest in early lactation (Bartlett *et al*., 1983; Jaster *et al*., 1983). It has also been reported (Riddell *et al*., 1981) that in addition to higher milk yields and milk protein content, microbial protein synthesis is also enhanced by adding niacin to the diet.

The objective of the present work was to study the possible beneficial effect of a supplement of propylene glycol alone or in combination with niacin on preventing ketosis, and the overall performance of pregnant and lactating Damascus goats.

MATERIALS AND METHODS

Damascus goats (9 animals/treatment) were randomly allocated to 3 treatment diets four weeks prior to expected parturition. The three treatment diets were: 1) control (feeding of a conventional concentrate mixture) [C], 2) control plus propylene glycol (40 g/head/day, replacing an equal amount of barley grain) [PG], and 3) treatment two with additional niacin (0.67 g/head/day) [PGN]. The control concentrate mixture was composed (kg/t) of 759 rolled barley grain, 170 soybean meal, 50 wheat bran, 5 dicalcium phosphate, 10 limestone, 4 salt and 2 vitamin trace element mixture. The two kg of vitamin trace element mixture supplied 6000 IU vitamin A, 1000 IU vitamin D_3, 8.5 IU vitamin E, 23 mg Mn, 1.75 mg I, 45 mg Zn, 30 mg Fe, 2 mg Co, and 60 mg Mg per kg concentrate mixture (as fed basis). The daily allowance of 40 g of propylene glycol (treatment 2), and/or 40 g of propylene glycol plus 0.67 g of niacin (treatment 3) were made available by providing them along with 200 g of the control mixture. The 200 g mixture was offered to the animals first, and the remaining control mixture was offered following the complete consumption of that mixture. Animals were housed individually in adjacent pens. Concentrate and roughage were offered from separate feed containers. Feed residues were collected and weighed daily. All goats were offered 0.8 kg of chopped barley hay, harvested at the milk stage of grain maturity, plus concentrate to cover their maintenance and pregnancy requirements according to ARC (1980). Animals continued on the same *pre-partum* treatment and for the first 42 days in lactation. Following kidding, the concentrate feed allowance was increased gradually, reaching 2 kg per goat one week *post-partum*. Feed allowance during the *post-partum* period was adjusted weekly based on body weight and the fat corrected milk yield of the previous week. All goats were offered 0.8 kg of the same barley hay plus concentrate to meet their maintenance energy (0.401 MJ ME/kg weight$^{0.73}$) and production requirements (Economides, 1986) [Dietary ME MJ/kg milk, Y=(1.64+0.42X)/0.62, where X=fat percentage and 0.62 the efficiency of utilization of dietary ME for milk production]. Animals had free access to water from a separate plastic bucket. Kids were separated from their dams at birth.

Animals were weighed weekly from day 28 *pre-partum* until delivery. Offspring was weighed within a few hours of birth. Dams were also weighed on the day after parturition, and fortnightly during the course of the 42-day post-weaning experimental period. Milk yield of goats was recorded thrice a week. Milk samples were analyzed for fat, CP, ash and TS once a week. Data on animal performance were analyzed using a linear model (SAS, 1989) that accounted for treatments.

Blood sampling and analyses. Jugular blood was sampled at 08.15 h (pre-feeding, animals were fed at 08.45 h), 10.15 and 14.45 on each of days 14 and 7 *pre-partum*. Blood was allowed to clot for 1 h at ambient temperature, kept overnight at 4 ^{o}C, and serum removed, aliquoted and frozen (-25 ^{o}C) pending analysis. On day 7 *pre-partum* only, fluoridated-oxalated plasma was also taken for glucose analysis. Composite same-day sera from each animal were analyzed for albumin, globulin, urea and total protein. Glucose was assayed in all day 7 *pre-partum* plasmas. Data within stage of production (*pre-* or *post-partum*) were analyzed using a linear model (SAS, 1989) that accounted for treatment, sampling time and their interaction.

RESULTS AND DISCUSSION

Two goats, one on the control and another on the PG diet were removed from the experiment because of sudden decrease in feed intake two weeks after parturition. Furthermore, one goat on the PGN diet died because of uterus puncture three weeks before kidding. Data of all three animals were excluded from analyses. The chemical composition of the feedstuffs used is in Table 1. The effect of treatment on DMI, blood metabolites and animal performance in the *pre-* and *post-partum* period are in Table 2. There were no differences in DMI, live weight changes, litter weight and body weight changes between animals on the three experimental diets. The non-significant effect of PG and niacin on the *pre-* and *post-partum* DMI is in line with the data of Ruegsegger and Schultz (1986), Studer *et al*. (1993) and Belibasakis and Tsirgogianni (1996). Milk production and milk composition did not differ among groups (Table 2). Similar findings have also been reported by Studer *et al*. (1993) and Ruegsegger and Schultz (1986).

Although niacin is considered nonessential in ruminant diets, due to rumen bacterial synthesis, unlike the present findings positive responses in milk yield have been reported by Riddel *et al*. (1981) and Muller *et al*. (1986). In line with our data are those of Dufva *et al*. (1983) and Bernard *et al*. (1995) where milk yield was unaffected by niacin supplementation. Furthermore, some studies have reported trends towards increased milk fat content with supplemental niacin (Riddell *et al*., 1981). The present data however, are in line with those of Dufva *et al*. (1983) and Bernard *et al*. (1995) where niacin supplementation did not affect milk fat and other milk component proportions. Milk yields of goats were considerably lower than those previously reported (Economides, 1986; Hadjipanayiotou, 1990). This can be partly ascribed to the separation of kids from their dams at birth (Hadjipanayiotou, 1990), to the fact that goats were individually housed and to the low DMI. Initial body weight and body weights at kidding and during the lactation period were similar in the three treatment diets.

Plasma glucose level was elevated by PG, but not by niacin. Both PG and PGN groups had higher ($P<0.01$) plasma glucose level than the control group during the *pre-partum* period. The effect of sampling on plasma glu-

Table 1. Chemical composition (%, dry matter basis) of the feedstuffs used

	Concentrate	Barley hay
Dry matter	89.4	93.1
Ash	4.7	8.8
Crude protein	17.3	10.1
D	-	66.0

D in vitro digestibility of organic matter in the dry matter (Tilley and Terry, 1963).

Table 2. *Pre-* and *post-partum* performance of Damascus goats fed propylene glycol alone or in combination with niacin

	Treatment			
	C	PG	PGN	SE
Prepartum period				
Initial wt (kg)	86.4	88.6	85.3	3.39 ^{NS}
Weight prior to kidding (kg)	87.4	89.3	87.0	3.40 ^{NS}
Weight at kidding (kg)	75.8	79.3	76.6	3.37 ^{NS}
Concentrate intake (kg/d)	1.047	1.047	1.100	0.053 ^{NS}
Barley Hay intake (kg/d)	0.432	0.488	0.474	0.048 ^{NS}
Blood metabolites				
Glucose (mg/dl)	41.3^{b}	48.0^{a}	45.9^{ab}	2.064^{*}
Urea (mg/dl)	34.8	35.8	36.7	1.827 ^{NS}
Protein T. (g/dl)	6.67	6.71	6.61	0.140 ^{NS}
Albumin (g/dl)	2.84^{a}	2.93^{a}	2.70^{b}	0.047**
Postpartum period				
Litter weight (kg)	8.425	7.425	7.975	0.705 ^{NS}
Weight at kidding (kg)	75.8	79.3	76.6	3.37 ^{NS}
Final weight (kg)	70.6	76.5	74.3	4.19 ^{NS}
Weight change (kg)	-4.2	-2.8	-2.3	1.76 ^{NS}
Daily weight loss (kg)	-0,123	-0,066	-0,056	0,042 ^{NS}
Milk composition (%)				
Fat	5.96	6.37	5.63	0.303 ^{NS}
Protein	4.27	4.62	4.46	0.125 ^{NS}
Ash	0.79	0.804	0.771	0.013 ^{NS}
TS	14.72	15.43	14.59	0.354 ^{NS}
Feed intake (kg/d)				
Concentrate	1.787	1.811	1.807	0.105 ^{NS}
Barley hay	0.330	0.315	0.396	0.063 ^{NS}
Blood metabolites				
Glucose (mg/dl)	49.0	50.5	49.8	1.772 ^{NS}
Urea (mg/dl)	30.4	42.1	38.1	3.65 ^{NS}
Protein T. (g/dl)	7.33	7.47	7.22	0.140 ^{NS}
Albumin (g/dl)	2.89	2.99	2.90	0.061 ^{NS}

cose was highly significant (P<0.01). Plasma glucose obtained prior to morning feeding (08.15 h) was lower than that at 10.00 and 14.00 h samplings. The effect of diet on plasma glucose concentration during lactation was less obvious than during pregnancy; plasma glucose was higher (P<0.05) in the PG than the control group, but the difference between the PGN and the C group was not significant (P>0.05).

There was no effect of diet and of sampling time on plasma urea concentration on either the *pre-* or the *post-partum* period. The only significant effect on plasma T-protein concentration was the time of sampling. Plasma T-protein was higher (P<0.01) in the second sampling. Treatment and sampling time effects on plasma urea were not significant (P>0.05), but there were differences between the two sampling periods; urea concentration being higher (P<0.01) in the first sampling period. Both treatment (P<0.01) and sampling time (P<0.01) had a significant effect on plasma albumin. Plasma albumin was higher in the pre- than the two post-feeding samplings. There is no easy explanation for the lowest plasma albumin concentration in the PGN group than the other two groups.

Results of the present study reinforce the concept that optimum feeding and management reduces the need for additives for ketosis control.

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