EFFECT OF CARBOHYDRATE FERMENTATION RATE FOR SHORT TERM NUTRITION ON REPRODUCTIVE PERFORMANCE AND BLOOD GLUCOSE OF KHALKHALI DOES

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Abstract

The objective of this study was to investigate the effects of feeding carbohydrates sources with different fermentation rate on reproduction performance of Khalkhali does under pasture. Sixty Khalkhali does were randomly allocated to three nutritional groups including 1) without supplemental feeding (CONTROL), 2) feeding 500 g whole barley grain per day (BARLEY) or 3) feeding 500 g whole corn grain per day (CORN). There were no significant differences between supplemented groups for fecundity, prolificacy and twinning rate. Twinning rate was 33.3, 58.8 and 61.11 percent for control, barley and corn groups, respectively. Feeding carbohydrate supplement increased blood glucose concentration after 8 days feeding relative to control group (P<0.05). The results showed that carbohydrate supplement feeding as short term nutrition during second week of estrus synchronization improved the energy situation of does and therefore their reproductive performance whereas there was no difference between carbohydrate sources with different fermentation rate. Therefore, applying short term nutrition program during synchronization programs can be recommended.

Key words: *khalkhali goat, nutrition, carbohydrate, fermentation rate, reproduction*

1. INTRODUCTION

Nutrition was known to affect many aspects of the reproductive process and much research effort was devoted to puberty, gamete production (particularly ovulation rate), placental growth and lactation. Nutrition plays an essential and special role in the systems of goat farming and directly impacts the other components of systems of goat production, such as pathological conditions and the reproductive performance of flocks. Moreover, a nutritional program for goats must always be established by taking into account the genetic characteristics of the breed or genotype used (potential of production, ability for adaptation, etc) (Morand-Fehr, 2005).

Extremes of nutrition can increase embryo mortality or delay embryo development in ewes. Undernutrition has been shown to delay embryo development during the first 2 weeks after fertilization (Parr et al., 1987; Abecia et al., 1997) and increase embryo mortality in the first 2 weeks of pregnancy (Rhind et al., 1989; Abecia et al., 1995). Different signals and different target organs seem to be responsible for the short- and longterm aspects of the response. Short-term dietary treatments lead to changes in blood concentrations of glucose, fatty acids, insulin and leptin, as well as in cerebrospinal fluid (CSF) concentrations of glucose, insulin, leptin and some amino acids. Among these, the most important factors seem to be fatty acids, insulin and leptin, all of which can increase GnRH/LH pulse frequency. Current studies are suggesting that there are neuroanatomical linkages between the centers that control reproduction and those that control appetite (Blache et al. 2002, 2003; Martin et al., 2004).

The Khalkhali goat is one of the most important breeds of Iran and reared mainly for its high milk production, with approximately 250000 heads in the southern regions of Ardabil province. This breed is also regarded as an endangered breed, and some flocks have been established aimed at their preservation. The program involves estrus synchronization and artificial insemination, based on information published in the literature because there is no published information on the reproductive characteristics of these goats. The Khalkhali goat is the autochthonous goat from Iran and belongs to

the same indigenous population that lives throughout west-north of Iran. It is a long-haired and small-sized goat and commonly reared in extensive mixed farming systems, together with sheep and cows, or in semi-intensive oasis systems. Currently, national projects for development of the small ruminant sector and biodiversity conservation strategies are developed in Iran for the native goats.

There are no published reports on the reproductive characteristics of this breed under different nutrition condition. Therefore, the objective of this study was to investigate the effects of feeding carbohydrates sources with different fermentation rate on reproduction performance of Khalkhali does under pasture.

2. MATERIALS AND METHODS

2.1. Animals, location and diets

This trial was performed in Khalkhal (Ardabil province), located in west north of Iran (37°, 37', 08" N latitude and 48°, 31', 33" E longitude). The area has a semi-arid climate, with cold winters and moderately warm summers. Temperatures vary between -4 and 31°C, and the annual rainfall ranges between 250 and 500 mm. Sixty Khalkhali does were randomly allocated to three nutritional groups including 1) without supplemental feeding during estrus synchronization program (CONTROL), 2) feeding 500 g whole barley grain per day (BARLEY) or 3) feeding 500 g whole corn grain per day (CORN). The goats had free access to the pasture from 5 am to 7 pm and to the water twice a day (at the noon and evening) and the grain supplement was fed to the goats at the evening daily for eight days from d 8 to d 16 of synchronization program.

A sample of feeds were ground through a Wiley mill (1-mm screen) and analyzed for dry matter (method 930.15), ash (method 924.05), crude protein (CP, Kjeldahl N×6.25, method 984.13), and ether extract (EE, method 920.39) according to the procedures of AOAC (1990). Neutral detergent fiber (NDF) was analyzed by the procedure of Van Soest et al. (1991) without a heat stable amylase and sodium sulphite and were expressed inclusive residual ash (Table 2).

2.2. In situ experiment

Rumen degradability parameters were measured with three rumen fistulated Moghani rams (55 ± 4 Kg body weight). Rams were fed a total mixed ration with forage to concentrate ratio of 60:40 that was balanced by sheep CNCPS software (version 1.0.21) for 10 percent more than maintenance requirements. The ingredients and chemical composition of the diet is presented in Table 1. Rams were housed in individual stalls (2 × 1.2 m) and were fed twice daily at 0800 and 1800. For in situ experiment, the feeds (barley and corn) were ground through a Wiley mill (2-mm screen) and triplicate samples (3 g per bag) were incubated in polyester bags (7 × 10 cm, 52 ± 5 µm pore size) for 0, 2, 4, 8, 16, 24 and 48 h (AFRC, 1992; Vanzunt et al., 1998; Orskov and McDonald, 1979). The ratio of sample size to bag surface area was about 21 mg per each mm. After incubation, bags were immediately rinsed in cold water and washed in a commercial washing machine for 3 cycles of 7 min. The 0 h bags were not incubated in the rumen but followed the same washing procedure. Then, Bags were dried in a forced-air oven at 65 °C for 48 h to determine DM disappearance (AOAC, 1990; Kjeldahl N×6.25, method 984.13).

2.3. Estrus synchronization

Estrus synchronization program were performed shortly before starting of the physiologic breeding season in Iran (September to November) for 16 days, using a controlled intravaginal drug releasing device (CIDR, contained 0.3 g progesterone, InterAg, A5439, New Zealand) and at the CIDR removal, an intramuscular injection of 400 IU eCG (Pregnecol®, Australia) was done and the bucks were let to have mating with the does.

2.4. Data collection

Blood samples were taken on days 0, 7 and 16 synchronization program, centrifuged for 10 minutes at 5000 rpm and analyzed for glucose concentration. Reproductive parameters were fecundity,

prolificacy and twining rates. Fecundity rate was calculated as the number of kids per number of does mated. Prolificacy rate was calculated as the number of kids per number of kidding. Twining rate was calculated as the number of twin kids per number of kidding.

2.5. Statistical analysis

Data of blood parameters was analyzed in a completely randomized design by the General Linear Model (GLM) procedure of the SAS (2003). Differences among means were declared by the Duncan's multiple range test. Reproductive rates were analyzed using the heterogeneity chi-squared (χ^2) test. Significance level was considered at $P<0.05$.

Table 1. Ingredients and chemical composition of diets

Ingredients (% DM)	
Alfalfa hay	60.0
Barley grain	24.0
Canola meal	9.8
Wheat bran	5.0
Salt	0.3
Min and Vit premix[1]	0.9
Chemical composition	
Metabolizable energy (Mcal/kg DM)	2.24
Crude protein (% of DM)	12.0
Calcium (% of DM)	0.7
Phosphorous (% of DM)	0.4

[1]Contained 195 g/Kg calcium, 80 g/Kg phosphorous, 21 g/Kg magnesium, 1000 mg/Kg cobalt, 300 mg/Kg copper, 120 mg/Kg iodine, 3000 mg/Kg iron, 2200 mg/Kg manganese, 3000 mg/Kg zinc, 1.1 mg/Kg selenium, 600000 IU/Kg vitamin A, 200000 IU/Kg vitamin D, 2000 mg/Kg vitamin E, 2500 mg/Kg antioxidant.

Table 2. Chemical composition and dry matter degradability parameters of barley and corn (% of DM)

	DM	CP	EE	NDF	Ash	a[1]	b[2]	c[3] (%/h)
Barley grain	87.8	11.2	2.1	19.5	4.3	56.76	34	17.29
Corn grain	85.9	8.9	3.6	10.3	3.5	17.87	70.26	8.29

[1] the fraction of rapidly solubilized protein (%).
[2] the fraction of potentially degradable protein (%).
[3] the fractional rate constant for the disappearance of fraction b (%/h) with the time, t.

3. RESULTS AND DISCUSSION

There were no significant differences between supplemented groups for fecundity, prolificacy and twinning rate (table 3) but does in supplemented groups had numerically higher reproductive traits than control. Twinning rate was 33.3, 58.8 and 61.11 percent for control, barley and corn groups, respectively. It has been reported that low energy intake resulted in adverse effects on prolificacy rate in goat (Sachdeva et al., 1973), sheep (Gunn et al., 1975) and swine (Beltranena et al., 1991). Fitz-Roudriguez et al. (2009) reported that nutritional supplementation improve prolificacy rate in goat and

attributed their observation to lower ovulation rate and higher fetus mortality in un-supplemented group (Abecia et al., 1989). Teleni et al. (1989) stated that energy is more important than protein for stimulating the ovulation rate. De Santiago-Miramontes et al. (2008) reported that supplemental feeding of female goats resulted in higher ovulation rate under grazing condition.

Feeding carbohydrate supplement increased blood glucose concentrations after 8 days feeding relative to control group ($P<0.05$, table 4). No significant differences were between two carbohydrate sources. Zabuli et al. (2010) reported that dams fed high energy diets as short-term nutritional supplement during estrus cycle had higher blood glucose and insulin levels. Munoz-Gutierres et al. (2005) reported that glucose infusion for 3 or 5 days increased folliculogenesis and ovulation rate in ewes. Moreover, glucose infusion resulted in increased insulin level faster that lupin grain nutrition and attributed their findings to delay in lupin digestion.

It has long been known that metabolites and metabolic hormones can be absorbed from the blood and will evoke responses in the uterus and mammary gland with a large degree of independence from brain control. Similar pathways are becoming evident for the gonads. In the female, the process of ovulation is GnRH dependent, but nutritional effects on ovulation rate seem be mediated primarily through pathways that depend very little on a change in the secretion of GnRH, LH or FSH. A critical observation here is that as little as 4 days of supplementation will increase ovulation rate (Stewart and Oldham 1986), so the mechanism is confined to the final stages of folliculogenesis (Martin et al., 2004).

The results showed that carbohydrate supplement feeding as short term nutrition during second week of estrus synchronization improved the energy situation of does and therefore their reproductive performance whereas there was no difference between carbohydrate sources with different fermentation rate. Therefore, based on low costs and positive effects on blood glucose level and energy metabolism, applying short term nutrition program during synchronization programs can be recommended.

Table 3. Effect of different carbohydrate sources for short-term nutrition on reproductive parameters of does

	CONTROL	BARLEY	CORN	SEM	*P-Value*
Fecundity rate	133.3	158.8	161.1	1.705	ns
Prolificacy rate	130.0	150.0	155.0	6.220	ns
Twining rate	33.3	58.8	61.1	0.70	ns

[a,b,c] different letters shows significant differences.

Table 4. Effect of different carbohydrate sources for short-term nutrition on blood glucose concentration of does during synchronization period

	CONTROL	BARLEY	CORN	SEM	*P-Value*
Day 0	54.37	50.75	55.75	1.705	ns
Day 7	50.38	55.37	47.38	6.220	ns
Day 16	52.13[b]	59.00[a]	58.75[a]	2.191	*

[a,b,c] different letters shows significant differences.

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