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RESEARCH ARTICLE

Effects of Male Goat Pheromones on Feeding Behavior of Female Markhoz Goats during Breeding Season

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ABSTRACT

The present study was carried out to investigate the effects of male goat on feeding behavior of female goats in breeding season. Sixty four Markhoz female goats, 3.5 years old, two or three parity, 43±2 kg live weight, body condition score 3, along with 10 male goats were used to study the effects of male pheromones on feeding behavior. The study was done in 6 weeks. Female goats were equally divided into three treatments (a_1, a_2 and a_3) along with a control treatment (c) with 8 animals in each group. Variable factor of treatments was the distance of the male goats box (source of pheromone secretion or male effect), which was supposed to be the a_1 (0-5 meters), a_2 (10-15 meters) and a_3 (25-30 meters). The results of study showed a decrease in feed intake of the female goats due to distance from male goats ($P<0.01$). It was concluded that the distance of female from male goats or the concentration of pheromones can significantly affect feed intake of the Markhoz female goats. Therefore, in order to increase livestock production and reproductive performance, the management of nutrition must be paid more attention.

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INTRODUCTION

To increase the efficiency of production, animal production systems in many developing countries tend to industrialization and semi industrialization (Miranda-de la Lama and Mattiello, 2010; Raziq *et al*., 2010). With the industrialization of livestock the animals have lost their normal way of living. It seems that animal behavior expresses its comfort and extent of its adjustment to the environment (Metz and Wierenga, 1997). Much research has been done regarding social behavior of small ruminants, but most of these studies were done on sheep due to the large amount of their population, and goats express a different manner in this regard. Generally, goats are considered to be more irritable and aggressive than sheep (Kilgur and Dalton, 1984; Houpt, 2005).

Among social behaviors, nutritional behavior is considered as one of the most important behaviors in domestic animals. Factors such as hormonal alterations can also affect feed intake. Central Nervous System plays a major role in hormone secretion and its functions are regulated by some external factors including light, sound, smell, feed, temperature, pheromones, etc. Pheromones secreted as chemical signals in small quantities, play a major role in expressing behaviors including opposite sex attractions, pair selection, determining territory and recognizing other animals (Okamura and Mori, 2005). A phenomenon referred as "Male effect" causes the secretion of GnRH/LH pulses and induces ovulation in mammals in the reproductive and non-reproductive seasons (Gelez and Febre-nys, 2004; Delgadillo *et al*., 2009). Pheromones associated with attracting the opposite sex, are small molecules, spread rapidly in the environment causing anestrous termination, inducing estrous synchronization and effective fertility (Cohen-Tannoudij and Signoret, 1987). In fact female goats preferred the male goats with higher testosterone levels in the mating season. Studies indicate that females were potentially able to detect signals from male behavior (Longpre and Katz, 2011). Influence of the males in communications is important. In males, higher development in size and density of sebaceous and apocrine glands, with preorbital gland could depend on hormone (testosterone) production. They may produce pheromonal substances through preorbital gland (secretion) for olfactory communication (Rajagopal and Archunan, 2011). Since pheromones are spread through the air, their concentration in the environment may decrease with increasing distance from the source of pheromones. It seems, no research has been done so far

regarding the effect of the distance of pheromone source or male from female animals on nutritional behaviors of female goats. This research has been conducted to determine whether the distance of the female goats from males could result in a different feeding behavior?

MATERIALS AND METHODS

Experimental design and goats management

Sixty four Markhoz female goats, 3.5 years old, 43±2 kg live weight and two or three parity along with 10 male goats were used. Body condition score of all animals was around 3. Experiment was carried out at Sanandaj Markhoz Goat Research Station, Iran. The average altitude of station from sea level is 1373 meters with mean annual temperature of 13.7°C. The study was conducted in early August until late October, 2009. The distance between female and male goats (source of pheromones) was considered as experimental treatments. The female goats were allocated within six boxes both side of male goats, at intervals of 0-5 meters (group a_1), 10-15 meters (group a_2) and 25-30 meters (group a_3) (Fig. 1A). Control groups were allocated in 2 boxes with 8 animals in each box, in separate saloons with the similar condition in which males (n=5) were freely exposed to females, having no chance of mating with control animals (Fig. 1B). The animals were weighed weekly. The numbers of goats presenting estrus signs in each treatment was recorded weekly. Estrus symptoms included restlessness, making frequent noise, tail moving, reduced feed intake, and inflammation of the vulva, vaginal mucus discharge and estrus mounting. Goats were observed three times per day to detect their estrus behaviors. During 6 weeks of experiment, the average day length (duration of light time) was shortened from 12:15 in the first week to 11:38 in the last week. At the same time the air temperature decreased from 30°C in the first week to 20°C in the last week of experiment.

Feed composition

Ration composition used in this experiment is shown in Table 1. The ration was formulated using care and nutrition guide line of Research Station of Markhoz goats based on SAC (1978). Each animal received 1.02 kg (DM based) equal to an amount of 1.2 kg (as fed bases) of TMR ration. The amount of ration for each experimental group was determined to be 5-10% more than their daily requirements. Animals had a free access to water and mineral bricks. The orts of each group were collected and weighted daily at 7 AM.

Pelleted concentrate contained the following components: 25% barley, 32% maize, 15% soybean meal, 15% cottonseed meal, 5% beet pulp, 5% molasses and vitamin and mineral supplements, salt and dicalcium phosphate and calcium carbonate all having 3%.

Table 1: Chemical components of ration

Feed (Dry matter)	%
Hay (15% crude protein)	28
Barley straw	29
Pelleted concentrate[1] (14% crude protein)	25
Barley	15
Wheat bran	3
Chemical component	
Digestible energy (Mcal/Kg)	2.8
TDN (%)	64
Crud Protein (%)	11.4
Calcium (%)	3.2
Phosphorus (%)	2.05

Statistical analysis

To analyze the effect of pheromones on the feed intake, the average initial weight of female goats was considered as co-variate, using GLM and MIXED procedures of SAS (9.1). Chi-square test was used to analyze the frequency of estrus signs.

RESULTS AND DISCUSSION

Least squares mean of feed intake during 6 weeks of experiment are shown in Table 2. The lowest amount of feed intake was observed during the 3rd week. Considering the highest frequency of estrus signs in the 3rd week of experimental period (Fig. 2), the reduction of feed intake during the same week would not be unexpected. Since 4 h of daily contact with sexually active males is

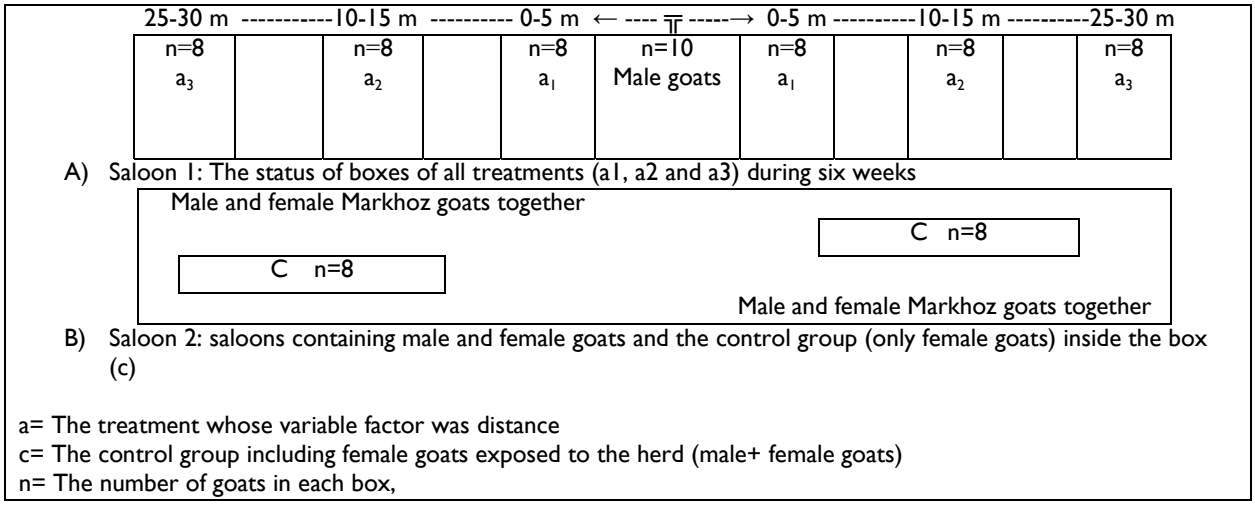

Fig. 1: Categorized schematic figure of experimental animals

sufficient to stimulate ovulatory activity in goats. This effect is not due to the presence of olfactory cues from the males remaining in the pens, but it is dependent on the active presence of males for 4 hours (Bedos *et al.,* 2010). Display of estrus signs together with an increase in the blood estrogen concentration accompanies an alteration in the nutritional behavior and can reduce feed intake of the animals (Schmidt *et al*., 1988). Mechanism activating estrogen to influence the amount of feed intake is not well known, however there is evidence that estrogen may affect adipose tissue metabolism, and adipose tissue can influence feed intake, therefore estrogen effects might be probably associated with both peripheral and central effects (Forbes, 2007). The effect of estrogen on feed intake is associated with regulation of leptin secretion by adipocytes. Estrogen receptors are detected in brain inducing initial effects on the animal behavior. Moreover the amount of gonads steroids affecting peripheral tissue is considerable and can alter their metabolic function, resulting in some changes in the nutritional behavior. Reduction of feed intake at estrus allows female animals to spend more time with the males (Forbes, 2007). In spite of the fact that the weather temperature reduced from 30°C in the first week to 24°C in the third week, the amount of feed intake decreased significantly (Table 2).

No signs of estrus were observed during the first week (Table 3) however, the amount of dry matter intake was significantly different between treatments (P<0.01). This demonstrated that exposure of the females to male goats or male pheromones may reduce feed intake in spite of the lack of estrus signs. Blood estrogen concentration was not determined, but probably the females near to the male goats had higher amount of estrogen compared to the others. More estrus signs observed in the nearest groups of the female goats to the males, during the second week (P<0.05) (Table 3). Datz *et al*. (1987) demonstrated that the plasma estrogen concentration has a dynamic change during the estrous cycle. Feng *et al*. (2009) reported that the concentration of estrogen in female rats reached its highest amount during proestrus period and the lowest amount in diestrus period. Therefore, decreased feed intake of goats in this experiment without any signs of estrus is not much surprising. Forbes (1986) reported that the amount of concentrate usage reduced in goats and sheep one or two days around the estrus.

The total feed intake among experimental groups was affected by distance from male animals (Fig. 3). Increasing distance from the source of pheromones or male goats resulted in enhanced dry matter intake.

Total dry mater intake between a_3 and control groups was significantly different (P<0.05), however the amount of feed intake was very similar in these groups (68.2 vs. 68.9 kg). Therefore, we can suppose that the effect of pheromones or male effect was negligible (Fig. 3). On the other hand, the male effect expressed in saloon B was at its minimum level due to the low ratio of males to females (1:40) and the distribution of male goats. Therefore, the distance in which the Markhoz male goats affect the females' behavior or feed intake would probably be about 25 meters.

According to the researchers, olfactory signals would increase due to the increased concentrations of pheromones and decreasing the distance from male (Over *et al.,* 1990; Hafez and Hafez, 2000; Houpt, 2005). In fact, nerve receptors sensitive to estrogen levels and corresponding signals are involved in this interaction. Discovering visceral feedback signals including leptin and ghrelin has provided the way to detect hypothalamic and cortical cell masses involved in the feed intake regulation. Estradiol plays an important role in diet regulation by binding to the estrogen α-receptors. Estradiol has no influence on the number of the eating meals; however, it causes a

Table 2: Least squares means of feed intake (kg) of treatments during different weeks of experimental period

Week	Treatment			
	a_1	a_2	a_3	c
First	64.89±0.15	67.56±0.14	68.65±0.14	68.49±0.15
Second	61.91±0.16	64.35±0.16	67.34±0.16	69.64±0.16
Third	60.77±0.35	62.64±0.34	66.86±0.34	67.22±0.35
Fourth	62.71±0.39	64.41±0.40	68.39±0.39	68.73±0.44
Fifth	65.40±0.16	67.56±0.16	68.60±0.20	69.26±0.16
Sixth	66.35±0.16	67.10±0.16	68.65±0.18	70.35±0.16

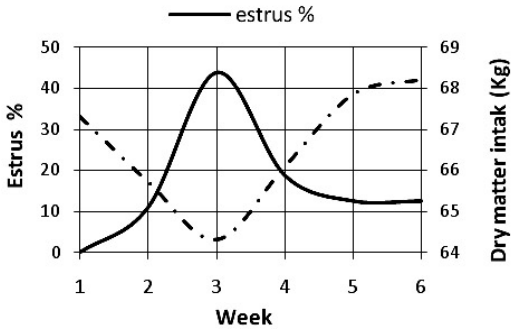

Fig. 2: The percentage of observed estrus and average of feed intake during every week among all the treatments.

Table 3: Goats (%) presenting the estrus every week

Week	Treatment			
	a_1	a_2	a_3	c
First	0	0	0	0
Second	31.25[a]	12.5[b]	0[c]	0[c]
Third	62.5	56.25	31.25	25
Fourth	12.5	12.5	31.25	25
Fifth	12.5	18.75	25	12.5
Sixth	12.5	12.5	18.75	31.25
Total	131.25	112.5	106.25	93.75

The presence of different letters indicates the significant variation in a row (P<0.05)

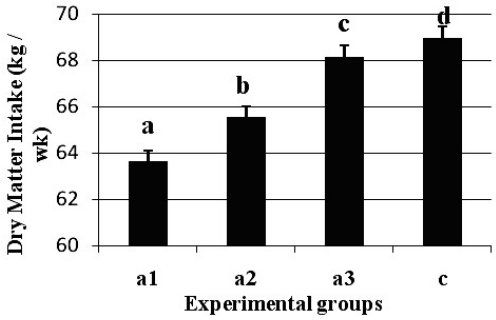

Fig. 3: Treatments, mean feed intake during the experimental period.

reduction of the feed intake in each meal. Since a large number of hypothalamic neurons carry a considerable amount of binding sites to the estrogen, nutritional behaviors of the animals can be regulated by a direct mechanism in hypothalamic neurons (Fricke *et al*., 2006). Therefore, increasing the distance from male or pheromones releasing source would probably lead to a reduction of these effects.

This study showed that the distance of female from male goats or the concentration of pheromones can significantly affect feed intake of the Markhoz female goats. Feed intake showed a considerable reduction when the distance of opposite sexes decreased. Therefore, in order to increase livestock production and reproductive performance, more attention must be paid to the management of nutrition. In the flushing period, presence of the male near the female animals will contribute to a decrease in the amount of feed intake and should be considered as an important factor.

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