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EFFECT OF THE FEEDING OF *PLANTAGO LANCEOLATA* WITH MEADOWS HAY ON MILK EFFICIENCY OF GOATS

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ABSTRACT

The goal of the study was to evaluate the influence of feeding hay with *Plantago lanceolata* on milk yield and composition in goats. The 28-day experiment was divided into 3 periods, using 6 goats. During the first (before trial, 10 days) and the third period (post trial, 10 days) goats received a feed ration that consisted of meadow hay in free choice and 0.5 kg of barley. *Plantago lanceolata* (45 %) was added to meadow hay in the second period (trial, 8 days). There were a total of 10 milk samplings. The highest production of milk was recorded in the second period with *Plantago lanceolata* added to the feed ration. The does yielded more in case of the second period (1017.0 ml) than during the first (799.3 ml) and the third periods (747.7 ml). Significant differences were found in the content of minerals only. The values for period before trial were significantly lower ($P < 0.05$) than values during trial and post trial periods (0.66 % versus 0.76 and 0.78 %, respectively).

Key words: goat; *Plantago lanceolata;* milk yield; milk composition

INTRODUCTION

Goats as intermediate feeders change their feeding behaviour according to seasonal changes in diet availability (Fedele *et al*., 1993). More than any other species, goats are able to choose among the available feedstuffs as well as parts of plants with the highest protein content and the highest digestibility. They select feed on the basis of pretension ease, sensorial characteristics and post-ingestive effects learnt from their own experience (Provenza *et al*., 2003). Most plant species such as *Taraxacum officinale, Plantago lanceolata, Alchemilla vulgaris, Achillea millefolium* and others have a positive impact on animal health and digestion (Klimeš *et al*., 2004, 2007; Čermák *et al*., 2006, 2009). An understanding of diet selection and behaviour of ruminants at natural pasture in fragile ecosystems is important to sustain an environment friendly management strategy and profitable animal production after identifying new species.

The goat, as the first livestock species to be domesticated, might have been the first to be milked by man (Maphosa *et al*., 2009). Milk production of does is an important contributor to an early growth of kids in commercial production systems. Goat milk is unique due to its nutritive and marketing value, as well as its technological characteristics (Bava *et al*., 2001; Kuchtík and Sedláčková, 2003). It depends of endogenous (breed) and exogenous factors (feeding, seasonal variations, age, oestrus, pregnancy, body weight, lactation stage and parity, environmental conditions, management, locality, and health status of the udder) (Guo *et al*., 2001; Morgan *et al*., 2006; Park *et al*., 2007; Oravcová, 2007). The composition and functional properties of goat milk are of considerable importance to the farmer,

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manufacturer, and consumer. There are 3 options for altering the composition and/or functional properties of milk: nutrition and management, genetics, and milk manufacturing technologies (Walker *et al*., 2004).

Goat milk differs from cow or human milk in that it is more easily digestible, and is valuable due to its alkalinity, buffering capacity and certain therapeutic values in medicine and human nutrition (Haenlein, 2001). Composition and the physico-chemical properties of goat milk are essential for successful development of dairy goat industries as well as for marketing of the products. There are distinct differences in physical and chemical properties among goat, sheep and cow milk. Towards the end of lactation, the fat, protein, solids and mineral contents increase, while the lactose content decreases (Park *et al*., 2007). On the other hand, goat milk is produced by seasonal breeding of does changes in milk compositions occur by seasons (Haenlein, 2004).

Milk fat content and its quality are not constant. Milk of most wild or less domesticated mammals usually contains more fats and less lactose than goat milk (Park, 2007). The content and composition of milk fat are the most affected by lactation stage, season of year and nutrition. Differences also persist among breeds (Raynal-Ljutovac *et al*., 2008). Goats seem to be less sensitive to fibre deficiency in their diet than cows, and their milk fat content remains unchanged. Furthermore, diets with various forage/concentrate ratios but a similar energy intake cause small changes in milk fat content (Sanz Sampelayo *et al*., 2007).

Protein content varies widely within species and is influenced by breed, stage of lactation, feeding, climate, parity, season, and udder health. Goat milk contains about 0.7–1.0 % and 0.4–0.8 % N, respectively, which is distributed in fractions, whose importance varies in terms of dairy technology and human nutrition. Goat milk has a higher level of non-protein N and less casein-N than sheep and cow milk. The principal proteins in sheep and goat milk are about the same as in cow milk (Park *et al*., 2007). Lactose content of goat milk is about 0.2–0.5% less than in cow milk (Alker *et al*., 2004; Park *et al*., 2007).

Mineral content of goat milk is much higher than that of human milk. Generally, goat milk has more Ca, P, K, Mg and Cl, and less Na and S contents than cow milk. The concentrations of macro-minerals may not fluctuate much but vary depending on the breed, diet, individual animal, stage of lactation, and status of udder health (Park and Chukwu, 1988; Schmidely *et al*., 2002; Park *et al.*, 2007).

Numerous studies showed that electrical conductivity of milk from cows affected by mastitis is higher than in milk from healthy cows (Maatje *et al.*, 1992; Nielen *et al*., 1995). Some studies also show a larger variation within milking in electrical conductivity of milk from infected cows compared to milk from cows without mastitis. Norberg (2005) found that mean EC in mS for healthy, sub-clinically infected and clinically infected cows were 5.3, 5.75 and 6.73, respectively.

MATERIAL AND METHODS

The goal of the study was to evaluate the impact of feeding hay with *Plantago lanceolata* on milk yield and composition of milk in goats.

The study was performed at an experimental goat farm. Six goats of white shorthaired breed in the sixth month of lactation (calved during October - November) at the age of 2 - 3 years were used. Goats were kept in loose housing bedded pen throughout the study. Animals were not allowed to graze. Goats were milked individually once daily by the mobile machine for the milking of goats (includes a vacuum pump, a pulsation system, clusters of teat cups). The does received 0.4 kg of concentrate mixture as supplement at milking. The concentrate mixture composition (DM %) was: extruded soybean meal (19.4), extruded rapeseed meal (11.0), wheat (29.5), wheat bran (4.9), maize (31.5) and mineral/vitamin premix (3.7). Individual milk yields were weighed and recorded in the milk measuring bucket.

Twenty eight (28) day long experiment was conducted from April 11, 2008 to May 8, 2008. The observations were performed in 3 periods. First period (before trial) was 10 days long, when the group of goats received a feed ration that consisted of meadow hay in free choice and 0.5 kg of barley. The second period (trial) was 8 days long (from 11th to 18th day), when *Plantago lanceolata* was added to meadow hay in the amount of 45 %. Feed was offered in free choice and 0.5 kg of barley was added. The third period (post trial) was again 10 days long (from 19th to 28th day), when goats were fed by meadow hay in free choice and 0.5 kg of barley, with no *Plantago lanceolata* added. In the first and third periods we measured milk yield and composition three times and during the second period four times (total 10 observations). Leftover feed was removed and weighed individually each morning prior to feeding. No animals had a previous experience with the observed dicotyledonous species.

The meadow hay was cut in August 2007 in a locality near České Budějovice (altitude 420 m above see, with an average annual temperature of 8.03 °C and rainfall of 645.0 mm, and loamy soil). *Plantago lanceolata* was obtained from a meadow herbage near Kaplice also in August 2007 (altitude 625 m above see level, the average annual temperature of 6.83 °C, and rainfall of 708.0 mm, and sandy-loamy soil).

Samples of meadow hay, barley, and meadow hay with 45 % of *Plantago lanceolata* were dried at

room temperature until constant weight was reached, and ground in a mill. Aliquots of the dried samples were burned at 550°C. Cell wall constituents (NDF, CF, ADF, ADL) were analyzed in an ANKOM 200 fibre analyzer. Dry matter content and fat were determined by the Weende analysis (Analysis of foods for nitrogen, ether extract, crude fibre and ash, together with soluble carbohydrate calculated by subtracting these values from the total). Milk analysis of fat content, proteins, lactose, non fat solids, mineral substances, and physical and chemical properties were performed in the laboratory of the Agriculture Faculty at South Bohemian University in České Budějovice. Electrical conductivity measures the ability of a solution to conduct an electric current between two electrodes, and it was measured in mili Siemens unit (mS).

The data were analyzed using a paired t-test by the statistical package Statistica. All data confirmed to a normal distribution. Values are expressed in the text of results as means ± standard deviation of the mean.

RESULTS AND DISCUSSION

As we can see in Figure 1, goats had slightly decreased milk yield in first three milk recordings (before trial); however, the milk production was increased in the four observations after the change of feeding. The highest production of milk, though not significant, was recorded in the second period with *Plantago lanceolata* addition to feed ration (Table 1). Does yielded more during trial period than in the first and third periods (1017.0 ± 242 ml versus 799.3 ± 152 ml and 747.7 ± 180 ml, respectively). However, we found response on the feed ration change. Large decrease in milk production was recorded at the third and fifth day after *Plantago lanceolata* was added to meadow hay in the amount of 45 %.

Table 1: Daily milk efficiency of goats during the whole 28 days' experiment

Period	Day of sampling	Milk yield ml	Fat %	Protein %	Lactose %	Non fat solids %	Mineral substances %	pH	Conduction $S.m^{-1}$
Before trial	2	965	2.59	2.95	4.40	7.98	0.60	6.57	7.70
(10 days)	5	745	3.03	2.99	4.41	8.04	0.71	6.60	7.88
	8	688	2.59	2.92	4.38	7.94	0.69	6.59	7.93
Trial	1	1185	2.50	2.87	4.37	7.87	0.74	6.53	7.88
(8 days)	3	845	3.28	3.01	4.41	8.06	0.75	6.65	7.80
	5	983	2.67	2.93	4.39	7.95	0.78	6.56	8.00
	8	1055	2.55	3.02	4.42	8.08	0.79	6.56	7.85
Post trial	2	678	3.20	2.94	4.39	7.96	0.78	6.65	7.68
(10 days)	5	645	3.19	2.98	4.40	8.01	0.76	6.74	7.68
	8	920	2.52	3.05	4.44	8.13	0.81	6.61	8.00
Before trial (avg)		799.3	2.74	2.95	4.40	7.98	0.66^{ab}	6.58	7.83
Trial (avg)		1017.0	2.75	2.96	4.40	7.99	0.76^{a}	6.58	7.88
Post trial (avg)		747.7	2.97	2.99	4.41	8.03	0.78^{b}	6.67	7.78

a,b – means in columns with the same superscripts differ (P< 0.05)
avg = average

In the present study, significant differences were found in the content of minerals only (Table 1; Figure 1). The averages for period before trial was significantly lower (P < 0.05) than averages of trial and post trial periods (0.66 % versus 0.76 and 0.78 %, respectively). Milk fat content was slightly higher during the period post trial (2.97 % versus 2.74 and 2.75 %, respectively; Table 1). Among the other observed parameters (contents of milk protein, lactose, non fat solids, pH, and conduction) the differences were negligible.

In this experiment, we recorded the impact of *Plantago lanceolata* on goat milk composition and the amount of milk. The amount of milk was the highest in the second period when hay with *Plantago lanceolata* was fed. During the feeding hay with 45 % of *Plantago lanceolata*, milk yield increased by almost 218 ml. There was a slight increase in fat in the third period.

Figure 1: Course of milk production during experiment

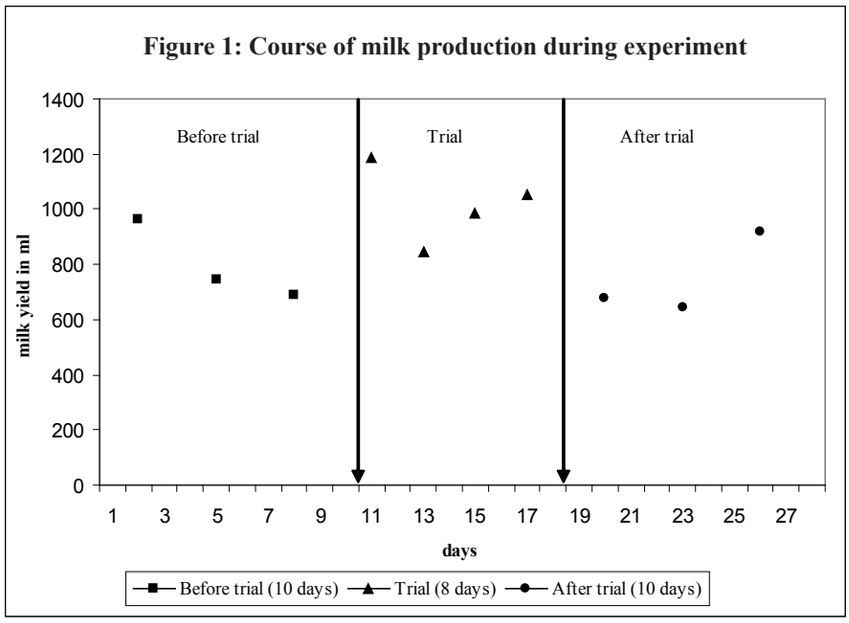
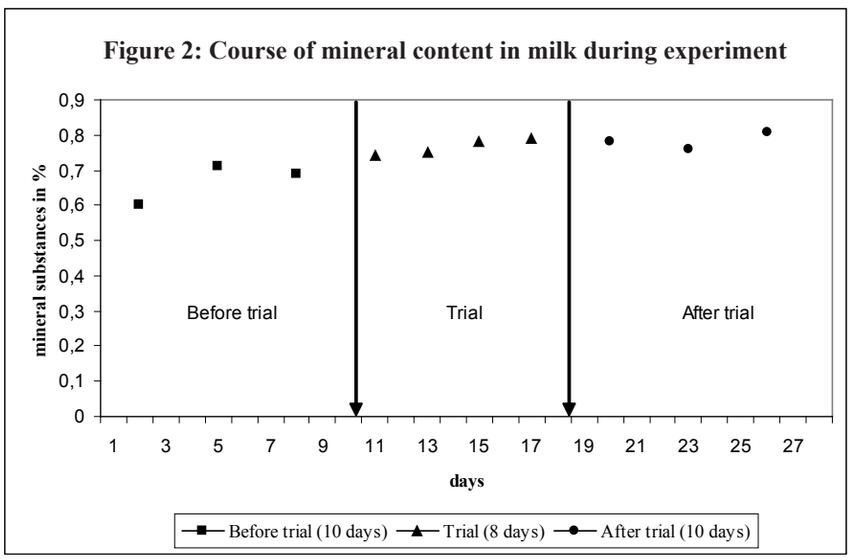


Figure 2: Course of mineral content in milk during experiment



It is well known that animals choose different plant species to meet their nutritional requirements unless limited by forage availability. Species preference differs according to several factors, such as animal species, forage availability and accessibility, and the nutritional and physiological state of the animals (Sanon *et al*., 2007). Goats are known to be browsers, while cattle and sheep are grazers (Ngwa *et al*., 2000). However, faced with a scarcity of feed resources, especially in the late dry season, all animal species fall back on browse species. The availability of browse fodder depends on many factors, especially forage allocation to different types of herbivores, selecting species for reseeding deteriorated ranges, and predicting the outcome of overgrazing by other animals (Morgan *et al.*, 2006; Sanon *et al*., 2007).

In the second and third periods we found a statistically higher content of mineral substances. Trace mineral content of goat milk are also affected by breed, individual animal, and stages of lactation but mainly diet (Park and Chukwu, 1988; Schmidely *et al*., 2002).

Udder health is of crucial importance in the production of hygienic milk and cheese. In milk-producing breeds of goats, subclinical and chronic intramammary infections are more common than overt clinical mastitis (Nielen *et al.*, 1995; Hall and Rycroft, 2007). However, there were no differences in conduction of milk.

The study showed that nutrition had an effect on milk production. The differences between periods without *Plantago lanceolata* and after *Plantago lanceolata* addition in milk yield and milk composition would be more significantly manifested during the first weeks of lactation than in the later weeks.

CONCLUSION

In the experiment with feeding hay with *Plantago lanceolata*, there were no significant changes detected except for milk yield and mineral content. In subsequent observations, longer periods of feeding *Plantago lanceolata* would be appropriate.

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