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The role of field beans in nutrition of Boer goat

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Abstract. A study on the effective using of field beans to Boer mother goats feeding was carried out on a farm whose main activity is the production of goat meat. Since the Boer goat breed is still very rare in Latvia, there is a lack of experience in the feeding of meat goat. Goat productivity was analyzed according to the birth weight of goat kids and kids live weight at 50 days, as well as the average live weight gain of kids per day up to 50 days old. For control group goats a relatively high energy shortage (14% of the daily requirement) and protein deficiency (29% of the daily requirement) were observed in feed ratio. Adding fodder beans and maize into the feed, it is possible to optimize feed ratio for energy and protein supply. Experimental activities had shown that by the inclusion of field beans and maize in feed ratio of goat's mothers, the average increase in live weight of kids up to 50 days old was by 58.2% higher *($P < 0.05$)* than that of kids in which goats' mothers received only oats as concentrated feed. By the optimization of feed ratio, it is possible to achieve a higher milk productivity of goat mothers and hence larger live weight gain for kids, which reduces the feed costs by up to 9% for 1kg of live weight. By optimizing the breeding and feeding of mother goats and kids, it is possible to achieve greater animal fast-growing, hence, more efficient and cost-effective management.

Key words: Boer goat, live weight, gain.

INTRODUCTION

Goat is thought to have been the earliest animal domesticated besides sheep and dogs. At the present time, goats provide the principle source of animal protein in North African and Middle Eastern nations. Goat is also important in the Caribbean, in Southeast Asia, and developing tropical countries. Three quarters of all the goats in the world are located in the developing regions of the world. Sheep and goats are the major source of livelihood for millions livestock farmers (Hasnain, 1985; Correa, 2016).

Meat is the primary reason to raise goats, which is why meat goats constitute the majority of the world's goat production systems. Goat meat comprises 63 percent of all red meat that is consumed worldwide (Correa, 2016).

The sub-optimal productivity of the existing flocks of goats is mainly attributed to low genetic potential, nutritional and managemental inadequacies. However, some breeds of goats offer a high potential for meat and milk production. One of the traits of economic importance in goats is birth weight. The diversity in performance traits of goats may be attributed to several genetic and non-genetic factors. Although any programme of breed improvement is based on the maximum exploitation of genetic

variation, yet these traits also vary due to certain environmental factors, e.g. climate and seasonal differences, sex of the kid, type of birth and age of the dam. It is, therefore, imperative to estimate the magnitude of all such factors, so that the genetic variation among animals can be used to devise effective breeding plans for their improvement (Afzal et al., 2004).

In the Baltic States goat farming focuses mainly on milk production, however, recently there has been increased interest and demand for goat meat. For milk production most common breeds in Latvia are Latvian local and Saanen, also German White noble and the Alps breed, but the majority of the meat-type goats in Latvia are of the Boer breed and crossbreeds (Selegovska & Spruzs, 2010). The Boer breed was developed in South Africa for the purpose of meat production. This breed is known for its large frame size, muscularity, and characteristic white body and brown or red–colored head (Van Nieker & Casser, 1988).

Boer goats were imported into Latvia in 2005, and used in cross breeding for the improvement of goat meat quality and quantity. If you breed meat goats, then you will not get milk because goats give milk only for kids. Meanwhile, there will be a lot of meat production and goat meat is very valuable. The favorite is 6–8-week old goat kid meat, which is very similar to lamb. Kids are often slaughtered at the age of 3 to 5 months and weight from 10 to 20 kg. Kids do not store much body fat. Many goats are older and heavier when marketed, but most, except aged cull goats, are slaughtered at less than a year of age. The meat of older goats is darker and less tender, but more juicy and with more flavour than that of kid. The meat from males is lighter in color and lower in fat. The meat from females is more desirable for steaks and chops, and is more tender (Piliena & Spruzs, 2007).

Feed can account for up to 50–60% of total production costs, and the goal of providing livestock with high quality feeds must be met in a manner that allows the animals' needs to be met without jeopardizing sustainability while also being economically feasible for the farmer (Vaarst et al., 2004). Usually, nutrient requirements are defined for a certain level of production, using factorial approaches (i.e. calculating requirements) as a function of body weight, physiological status and level of performance, using established factors for use of nutrients and energy (Nutrient requirement…, 2007). The probability of nutrition-related problems increases with increasing level of production, decreasing forage quality and lack of home-grown feedstuffs with a high nutrient concentration. Problems may occur also, in connection with an unbalanced supply of different nutrients. The magnitude of imbalance between protein and energy intake will depend, among other things, on the soil type, the proportion of legumes in the diet, and the availability of feedstuffs with relatively high energy content (Baars, 1998). Typically, goat farmers will focus on forage and pasture systems and use less concentrates and mineral supplements than intensive foreign farmers. Under these circumstances, nutrition will probably limit milk and meat production and eventually affect the milk's and meat's nutrient content (Krutzinna et al., 1996). Because extensive farms rely on home-grown feedstuffs, much more than intensive farms, low feedstuff quality, which may temporarily occur because of unfavorable conditions, will be important for the nutrition of ruminants (Olesen, 1999). Temporary nutrient deficits can be covered by using supplementary feedstuffs such as concentrates or different mineral sources.

The nutritional requirements of goats managed primarily for milk production and those managed primarily for meat production are quite similar with perhaps two notable differences. First, dairy goats are expected to milk at relatively high and persistent levels throughout a 9–10 month lactation; meat goats need only achieve a 4–7 month lactation with high initial milk flow, persistency beyond 4 months being of lesser concern. Secondly, dairy goats are typically fed considerable concentrates (grain mixtures) to encourage maximum and persistent milk flow. In contrast, lactating meat goats are not usually fed concentrates in addition to their forage diet because the extra kid growth achieved from the extra milk may well not repay the added costs. As always, special circumstances may occasionally alter normal cost-benefit calculations. In those situations in which the plants are too low in protein (or in which forage quantity is much reduced), additional protein must be offered to maintain acceptable goat performance. Protein supplementation may take many forms and cost per unit of protein may vary widely. High protein supplemental feedstuffs, used only occasionally by meat goat owners, are soybean meal, peas and field beans meal, urea and others. Choosing between alternative high protein feedstuffs is largely an economic decision (Pinkerton & Pinkerton, 2015).

Boer's goat's mothers have good maternal properties and calm character. Boer sires may also be used for crossbreeding with other related dairy goat breeds, taking into account that the live weight of kids at birth will be 10–18% higher than that of dairy goats. Therefore, for the crossing, select large goats with a well-developed part of the hip, which are usually observed for mild births. Boer goat productivity indicators are: fertility 180–200%; live weight gain of kid 180–230 g per day; goat live weight 65–75 kg; height 65–55 cm; the live weight of the sire is 90–100 kg, the height 75–90 cm. The following main tasks have been identified in Latvia to improve the breeding value of goats: live weight gain of kids till age of 50 days should be 200–230 g per day; fertility 180%–200%; kids at weaning 170%; live weight at birth 3.2–3.8 kg (Ciltsdarba programma..., 2013).

The effect of breed and diet on goat breeding properties and carcass characteristics has been investigated in only a limited number of studies (Oman & Waldron, 1999), and we will try to find the answer to the question of how to improve Boer goat productivity.

The objective of our study was to assess the influence of field beans on Boer goat productivity and make recommendations for feeding of the mother goat.

MATERIALS AND METHODS

Data on pedigree breeding and performance records of Boer goats maintained at a farm whose main activity is the production of goat meat during the period of two years were used. The farm has 23 goat mothers at 1st control period and 13 at 2nd research period and 1 purebred Boer sire. Since Boer goats are still very rare in Latvia, there are no pure-breed goat mothers in the farm, but cross-breeds of different grades. Generally, the does were bred once a year in autumn (September – November) and kids were born during subsequent spring (February – April). The Boer goat does not have seasonal breeding as is the case for dairy goats. The male and female kids are processed into meat at the age of 4 months, but some female kids are kept for breeding. In the summer, animal basic feed is a pasture grass and oats, in winter – fodder beetroot, hay, corn and oats. As the farm does not pay much attention to optimizing of feed ratio, the goat first breeding takes off only at the age of 2 years when optimal live weight is achieved.

The study started in early spring when goat mothers (Research group) after kidding were fed with hay (1.5 kg per day for goat) and as concentrated feed they received farm-produced oats (0.2 kg per day for goats) and purchased field beans (0.3 kg per day for goat) and maize (0.2 kg per day for goat). The study was conducted in a period from the time when the first kids were born to the time when the last spring kids reached the age of 50 days. Goat productivity was evaluated according to the kids live weight at birth and live weight of kids at age of 50 days, as well as the average live weight gain of kids per day up to age of 50 days.

In each study year goat kids were weighed at birth and at the age of 50 days with an electronic scale (accuracy of 0.01 kg). Absolute live weight gain per day for analyzed kids was calculated by formula (1):

$$a = (W_t - W_0)/t \quad (1)$$

where a – live weight gain per day, g; W_t – live weight at the end of period (50 days), g; W_0 – live weight at the beginning of period (at the birth), g; t – period (50), days.

The obtained data was compared with the same goat productivity indicators of the previous year (Control group), when the does after kidding received only the hay (1.5 kg per day for goat) and oats (0.6 kg per day for goat). In addition, phosphorus-containing mineral feed was fed to ensure an optimum ratio of Ca and P in the feed ratio to a range of 1.6–2 : 1.

The analysis of obtained data was conducted according to research scheme (Table 1).

Table 1. The research scheme

Groups	Number of does	Feedstuffs
1st control group	23	Hay + oats
2nd research group	13	Hay + oats + field beans + maize

The following feed nutrient biochemical parameters were established before the start of the trial according with generally accepted methods of analysis: dry matter (DM) according ISO 6496:1999 method; neutral detergent fiber (NDF) according LVS EN ISO 16472:2006; acid detergent fiber (ADF) according LVS EN ISO 13906:2008; crude protein (CP) according LVS EN ISO 5983-2:2009; calcium (Ca) according LVS EN ISO 6869:2002; phosphorus (P) according ISO 6491:1998; ash according ISO 5984:2002/ Cor 1:2005, but undegraded intake protein content (UIP), net energy for lactation (NEL) and digestibility were calculated based on the results of the analysis performed. The quality indicators for nutrients were determined by the accredited laboratory of Agronomic analysis of the Latvia University of Agriculture.

Collected data was analyzed with mathematical data processing methods.

RESULTS AND DISCUSSION

The nutritional requirements for animals were determined by the live weight of goat's (average 60 kg) and milk yield (1.4 kg on average), based on the Latvia and United States standard rules for Boer goat feeding (Nutrient requirement…, 2007). Goats of control group were fed according of the farm's usual scheme (Table 2).

Table 2. Nutrients of feed ration

Feed nutrient	Requirement	1st control group		2nd research group	
		Total	Difference, %	Total	Difference, %
DM, kg	1.8	1.9	+5	1.9	+5
NDF, kg	0.7	0.8	+14	0.8	+14
NEL, MJ	12.7	10.9	-14	11.8	-7
CP, g	236.0	167.0	-29	222.0	-6
UIP, g	76.0	58.0	-24	73.0	-4
Ca, g	9.0	10.0	+11	9.5	+5
P, g	5.0	5.4	+8	5.6	+12

After the analysis of feed ration chemical composition, we found that the animals are not provided with sufficient energy and protein levels, which has an effect on the productivity indices of Boer goat. The base feed rate of control group shows a relatively high level of energy shortage (14% of the requirement), which could be explained by the low quality of grass feed and the lack of protein (29% of the requirement). By the addition of fodder beans into the feed ration of Research group, it is possible to optimize feed ration for energy and protein supply. If the farm has produced low-quality grass fodder - hay, which contains only 8.15% of protein in the dry matter and 60.91% NDF, then it is not possible to balance the feed ration with all the nutrients required. The maximum of NDF level in feed ration is exceeded, which limits the intake and use of valuable nutrients. In countries where goat breeding is developed, the feeding of the dairy goats is dominated by the feeding of concentrated feed and the use of grass fodder is only for the provision of fiber. But it is also considered as cost-effective to grass fodder with small concentrated feed additives for meat goats. In Latvia, the feeding of ruminant animals is dominated by the feeding of grass fodder, as it is the cheapest feedstuff that a farmer can grow and prepare on his own farm (Piliena & Spruzs, 2007).

The experimental farm deals with the production of meat goats, but, as this is a fairly new livestock sector in Latvia, the farm has mother goats with different crossing level. When evaluating reproduction indices in the farm, the results of the study show (Table 3) that better reproduction rates were reported by Boer goat mothers of 1st crossing level where Boer goats are crossed with Latvian Native goats, while lower fertility was observed in goats with higher Boer breed crossing level. In Latvia, 15% of all registered animals are pure-bred Boer animals (Ciltsdarba programma..., 2013), while there is only 1 pure-bred sire in this research farm.

Table 3. Fertility rate of mother goats

Boer breed crossing level	Number of mother goats		Fertility, %	
	1st control	2nd research	1st control	2nd research
0%	1	1	200.0 ± 0.00	200.0 ± 0.00
1st – 50%	11	9	209.1 ± 16.26*	177.7 ± 22.22
2nd – 75%	11	3	163.6 ± 20.33*	133.3 ± 67.42
Average in Latvia	110		120.0	

* – for the fertility, traits signed with asterisks shows significant differences ($P < 0.05$) between traits.

According to the Boer goat breeding program the fertility should be 180 to 200%, and the live weight gain of the kids to age of 50 days should be 180–230 g per day (Ciltsdarba programma..., 2013).

Analyzing the performance indices of the kids (Table 4), we conclude that Boer goat mothers with 1st and 2nd crossing level had heavier new-born kids in 1st control group (no significant differences), while at the age of 50 days kids were heavier in 2nd research group ($P < 0.05$) from 2nd crossing level mothers (average 14.15 kg). In 2nd research group these kids also showed the highest live weight gain ($P < 0.05$) per day (0.218 kg per day), which is a very good indicator. When comparing the fertility rates of the female goat population with the Latvia average indices, we conclude that in the farm, in 2nd research group, these parameters are optimal and are in line with the Boer goat breeding program.

Table 4. Goat productivity indices in a farm

Boer breed crossing level	Number of kids		Live weight at birth, kg		Live weight at age of 50 days, kg		Live weight gain per day, g	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
0%	2	2	3.95 ± 0.05^{A}	3.30 ± 0.20^{B}	10.70 ± 0.20	10.50 ± 0.50*	140 ± 3.2	144 ± 6.0*
1st – 50%	23	16	4.14 ± 0.14^{A}	3.42 ± 0.16^{B}	9.89 ± 0.35^{A}	11.79 ± 0.35*^{B}	115 ± 8.3^{A}	170 ± 7.2*^{B}
2nd – 75%	18	4	4.18 ± 0.13^{A}	3.25 ± 0.32^{B}	8.87 ± 0.48^{A}	14.15 ± 0.35**^{B}	94 ± 8.4^{A}	218 ± 7.7**^{B}
Average in Latvia	66		3.60		11.67		168	

* – for the live weight at age of 50 days and live weight gain per day in 2nd research group, different number of asterisks indicates significant differences ($P < 0.05$); A, B – traits with different superscriptions shows significant differences between trial goat groups within separate goat productivity indices ($P < 0.05$).

Comparing goat trial groups and analyzing the effects of different feed rations on goat productivity, the data of newborn kids live weight and kids live weight at the age of 50 days depending on the kid's sex was analyzed (Table 5). Analyzing the data, we can see that the 1st control group kids had higher birth weight ($P < 0.05$) than that of the 2nd research group kids, but there no significant differences between female and male kids within goat group. After supplementary feeding of 2nd research group goat mothers with field beans, which affected the milk yield, the growth rate of kids increased. The average increase in live weight of kids per day in 1st group reached only 110 g per day for a 50-day period.

Table 5. Productivity of goats according of kids sex

Group	Sex	Number of kids	Live weight, kg		Live weight gain per day till 50 days, kg
			New born	At 50 days	
1st control	Female	23	4.05 ± 0.11	9.19 ± 0.36	0.10 ± 0.008
	Male	20	4.26 ± 0.15	9.85 ± 0.44	0.11 ± 0.008
	Average		4.15 ± 0.09*	9.50 ± 0.28*	0.11 ± 0.006*
2nd research	Female	10	3.43 ± 0.13	12.03 ± 0.60	0.17 ± 0.011
	Male	12	3.33 ± 0.21	12.16 ± 0.16	0.18 ± 0.009
	Average		3.38 ± 0.13**	12.10 ± 0.34**	0.17 ± 0.007**

* – for the live weight and live weight gain per day, different number of asterisks within each productivity indices indicates significant differences ($P < 0.05$).

Following the Boer goat breeding program, it is necessary to achieve at least 180 g of live weight gain per day, and in 2nd group with optimized goat feeding we achieved more efficient and cost-effective farming, reaching 170 g live weight gain for female kids and 180 g for male kids. Feeding of field beans as additional concentrated feed to goat mothers, the average live weight gain for kids was by 58.2% higher than in 1st group, where goat's received only oats as a concentrated feed, and this difference is significant ($P < 0.05$).

In addition to the different feed rations, the effect of litter size on goat's milk yield, kids fast-growing and live weight gain was also analyzed (Table 6).

Table 6. Live weight of kids according the litter size

Group	Liter size	Live weight, kg		Live weight gain per day till 50 days, kg	Number of kids
		New born	At 50 days		
1st control.	1	3.93 ± 0.33	10.08 ± 0.98*	0.12 ± 0.016*	6
	2	4.27 ± 0.09	10.06 ± 0.28*	0.12 ± 0.006*	28
	3	3.92 ± 0.25	7.36 ± 0.30**	0.07 ± 0.007**	9
2nd research	1	3.50 ± 0.16*	12.64 ± 0.83*	0.18 ± 0.014	5
	2	3.41 ± 0.19*	12.36 ± 0.35*	0.18 ± 0.009	14
	3	3.00 ± 0.00**	10.00 ± 0.58**	0.14 ± 0.012	3

* – within each group and each productivity indicator, different number of asterisks indicates significant differences ($P < 0.05$).

Single born kids were heavier than the multiple born kids (Table 6), as they had better opportunities in the uterus of their dams as compared to multiple kids. When analyzing the kids fast-growing and live weight indicators, it was found that there are significant differences ($P < 0.05$) between single or twin with triplet born kids live weight at 50 days (in both goat groups) and live weight gain (in 1st group), and the average live weight of triplet born kids at 50 days is even 20 to 31% lower than that of single or twin kids. Also the male kids were heavier than female twin born or triplet born kids. It may be due to the fact that the gestation period of does carrying male kids is usually slightly longer (1–2 days) than those carrying female kids (Afzal et al., 2004).

Comparing the live weight and live weight gain of different crossing level kids, it was found that better fast-growing indices showed kids with higher level (90%) of Boer breed. The average live weight gain in a day to the age of 50 days in kids from 2nd research group with a higher crossing level was 210 to 230 grams per day, which is a very good indicator and is relevant to the characteristics of the fast growing of Boer goat (Ciltsdarba programma..., 2013). Such fast growing indicators can only be achieved with optimized feed rations, where the goat mothers, in addition to the low quality basic diet also receive protein feed. Assessing feed costs for the feeding of the mother's and analyzing the kids live weight, the calculations of feed costs for goats were made. In 1st control group when goats received only hay and oats, the daily ration cost per animal was EUR 0.24 per day, while in 2nd research group where field beans were included in the ration, the price of daily ration was EUR 0.29 (Table 7).

Table 7. Economical effect of different feed rations

Group	Feed cost to 1 goat per day, EUR	Kids live weight gain per day per 1 goat, kg	Feed cost for 1 kg of live weight gain, EUR
1st control	0.24	0.22	1.09
2nd research	0.29	0.29	1.00

Including of fodder beans and maize in feed ration at a price of 300 EUR t^{-1} increased feed costs per 1 goat per day. However, with optimizing of feed ration it is possible to achieve a higher milk yield of goats and hence also a higher live weight gain for kids, which reduces feed costs by up to 9% for live weight growth.

CONCLUSIONS

Results of this study provide new knowledge about the influence of field beans on Boer goat productivity. Adding fodder beans and maize into the feed, it is possible to optimize feed ratio for energy and protein supply. Experimental activities had shown that by the inclusion of 0.3 kg of field beans and 0.2 kg maize in feed ratio of goat's mothers, the average increase in live weight gain of kids up to 50 days old was higher than that of kids in which goats' mothers received only oats as concentrated feed. By the optimization of feed ratio, it is possible to achieve a higher milk productivity of goat mothers and hence higher live weight gain for kids, which reduces the feed costs for 1kg of live weight. By optimizing the breeding and feeding of mother goats and kids, it is possible to achieve greater animal fast-growing, hence, more efficient and cost-effective management.

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