INFLUENCE OF EXTRUDED RAPESEEDS AND FABA BEANS MIXTURE ON PRODUCTIVITY AND PRODUCTION QUALITY OF DAIRY COWS

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Abstract. The study was conducted to evaluate the influence of extruded rapeseeds (30 %) and faba beans (70 %) mixture on productivity, product quality and composition of dairy cows. For this purpose, a total of 46 Holstein Lithuanian Black-and-White dairy cows of II-IV lactation were selected. Indicators of milk quantity, quality and composition were determined during control milking. It means fats, proteins, lactose and urea were investigated with the "LactoScope FTIR" instrument (FT1.0. 2001; Delta Instruments, the Netherlands) using the method of absorption of infrared radiation medial region rays. The results of this study showed that the mixture of extruded rapeseeds and fodder beans did not have essential influence on the milk quality of dairy cows. However, milk yield during the whole experiment increased by 3 kg per day. i. e. 15.25 % ($P<0.05$) for the control group. Meanwhile the trial group had an increase on average of 2.33 kg per day or 11.36 % ($P>0.05$). The results revealed that cows of the control group produced 7.74 % more milk compared to the cows from the trial group during the whole experiment. Adding extruded fodder beans to compound feed for the control group, protein content increased and milk fat content decreased. Milk fat content dropped by 0.26 % for the control group cows and increased by 0.69 % ($P<0.05$) for the trial group cows. Protein content increased by 0.19 % in the control group, and for the trial group the increase was 0.33 % ($P<0.01$). Protein content for the trial group cows at the end of the experiment was 0.15 % higher compared to the control group.

Keywords: Dairy cow, extruded soybeans, rapeseeds and faba beans mixture, milk, productivity

Introduction

Feeding of cows is a dynamic process which influences not only cows' physiological condition but also the quality and quantity of their production. The main problem related to dairy cows' nutrition, is creation of a completed and balanced ration that meets the physiological needs of ruminants, i. e. would ensure maintenance of energy and milk production (Zebeli et al., 2010).

Productivity of dairy cows depends on kind and quantity of feed intake, also on feed efficiency in the rumen. Good quality and well-balanced diet consisting of high quality feed materials is very important for cattle nutrition.

The rumen of ruminants is the largest part of the digestive tract where all the vital processes and main feed fermentation are happening. Shortage of energy, proteins, vitamins, and minerals and their inadequate proportion in the ration negatively impact cows' productivity, milk composition and quality indicators (Südekum, 2006; Буряков, 2009).

During their studies Ölschläger (2007) and Witzig (2009) noticed that properly shredded and prepared forage and also a balanced ration of dairy cows influence the number (quantity) of rumen cellulolytic microorganisms. The mentioned factors also affect the activity of rumen cellulolytic microorganisms *in vivo* as well as *in vitro*. Forage shredding affects the assimilation of forage, rumination, rumen fermentation and rumen acidity (balance of alkali) (Tafaj et al., 2005, 2007; Zebeli et al., 2006).

Ruminants receive only half of forage nutrients if they are fed with silage or grass and get combined forage only in addition. The main part of such forage is used for digestion. Also too high starch content can cause acidosis for ruminants. Therefore extruded forage started in recent years for feeding cows. While extruding the grain, extruder–a special device–makes half of the job for the rumen of ruminants. Accordingly ruminants use not all the energy of the extruded forage but part of it, broken starch has better absorption and the productivity is higher. It is considered that feeding cows with extruded forage encourage their rumen fermentative process that leads to a more efficient use of forage in the production synthesis (Gauthier, 2004[b]).

Today the biggest problem in the dairy sector is to get the most cost-effective production. Various ways and forage materials are tested to increase the production and its quality. For this reason considerable interest in the fodder beans has increased for the last years. Milk protein is increasing by inserting faba beans to dairy cows' ration. Most relative fodder beans crops besides soybeans are beans, peas, and lupines.

Fodder beans (soybeans, beans, and peas) are assigned to forage that has high protein content (20–40 %) and carbohydrates and ensure nutrients for cows that other forage cannot provide.

The aim of this study was to assess the influence of extruded soybeans and mixture of extruded rapeseeds (30 %) and fodder beans (70 %) for dairy cows milk productivity and quality.

Material and methods

The experimental part of this study was carried out at a dairy cow farm in Marijampole district. The experiment lasted for 104 days and had two periods - preparatory 14 days and experimental 90 days. Dairy cows were divided into 2 groups: 23 cows in a trial group and 23 cows in a control group. For the experiment the cows were selected randomly (considering prior lactation, parity, body weight, expected calving date, productivity during last lactation, milk yield, milk fat and milk protein contents). Cows were kept tethered, watered by automatic drinkers, milked using milking pipelines and fed twice a day. The experiment was carried out with the Lithuanian Black-and-White dairy cows of II-IV lactation. The feeding scheme is displayed below, Table 1.

Table 1. **Feeding scheme**

Group	Cows quantity in the group, pcs.	Feeding characteristics
Control	23	Basic ration + 0.850 kg extruded soybeans for each cow per day
Trial	23	Basic ration +0.850 kg extruded rapeseeds (30%) and fodder beans (70 %) mixture, for each cow per day

The research was carried out complying with the Law of the Republic of Lithuania on Animal Care, Housing and Use" (No. XI–2271) as well as complying with the amended Order of State Food and Veterinary Service "On Approval For Requirements For Housing, Care and Use of Animals for Experimental and Other Scientific Research" (No. B1-872 of 24-09-2015).

In the Agricultural Company, dairy cows are fed with the forage that is made in the same farm. Rations of both groups are balanced according to the need for nutrients, minerals and vitamins (Table 2).

Nutrient and energy value of the rations was calculated with the feeding program HYBRIMIN® Futter 2008.

Table 2. **The average daily ration of the control and trial groups**

Forage	Control group	Trial group
Grass haylage, kg	20.00	20.00
Maize silage, kg	16.00	16.00
Hay, kg	0.50	0.50
Molasses, kg	1.00	1.00
Sugar beet pulp silage, kg	8.00	8.00
Compound feed (+extruded soya 10 %), kg	8.50	-
Compound feed (+extruded rapeseeds (30 %) and faba beans (70 %) mixture), kg	-	8.50
Ration consists of:		
Dry matter, kg	24.93	24.95
NEL (net energy for lactation), MJ/kg SM	6.71	6.73
Crude protein, g/kg SM	171	178
Crude fat, g/kg SM	27	29
Crude fiber, g/kg SM	160	164
Crude ashes, g/kg SM	84	86

Methods/technique

Nutritional and energy value of forage and grains was investigated at Lithuanian University of Health Sciences, Institute of Animal Raising Technology, Laboratory of Animal Productivity, Department of Animal Breeding and Nutrition, Laboratory of Animal Nutriciology Research and Department of Systemic Evaluation of Nutrigenomics and Animal Husbandry Processes as well as at the Institute of Husbandry.

During the experiment, control milking was performed once a month. The control milking showed the milk yield, and the milk samples were assessed for: Milk fat, protein, lactose, and urea; determined with the instrument "LactoScope FTIR" (FT1.0. 2001; Delta Instruments, the Netherlands) using the method of absorption of infrared radiation medial region rays. Milk testing was performed at State Enterprise "Pieno tyrimai".

Statistical analysis

Statistical results were defined using a statistical package „SPSS for Windows", version 15.0 (SPSS Inc., II, USA, 2006). Arithmetic mean values of indicators and errors were calculated. The difference between the obtained results of productivity, milk composition and quality was statistically significant when $P<0.05$.

Results

Valuable milk of good quality is produced when the ration is completed with appropriate nutrients and mineral content, as well as content of vitamins and energy. If there is a lack of the mentioned substances, the cow's health is deteriorating,

the milk yield decreases, reproduction is disrupted. Accordingly, the nutrient content in milk drops and the quality of the production gets worse.

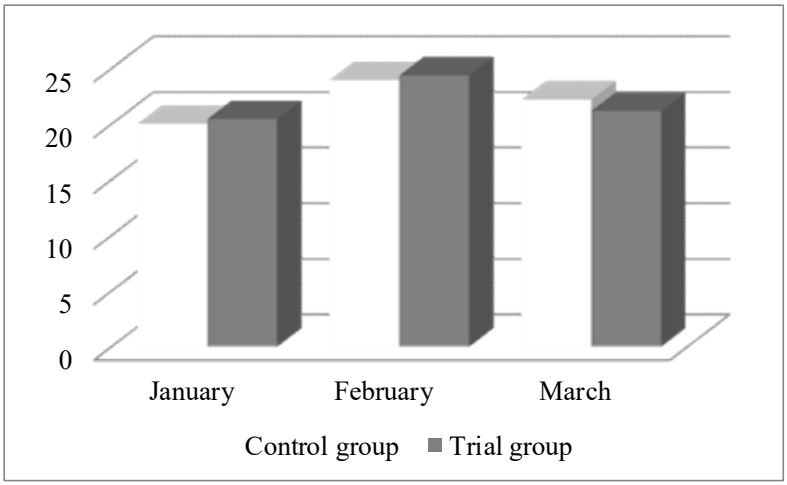

Fig. 1. **Milk yield variation during experimental period, kg per day.**

Compared with the beginning of the experiment, the milk yield of the control group increased by 3.93 kg per day or 19.61 % ($P<0.05$) in February and 2.18 kg per day or 10.88 % in March. Milk yield from the trial group was by 3.92 kg per day or 19.15 % ($P<0.05$) higher in the middle of the experiment (in February). Comparison of the trial group's results at the beginning and at the end of the experiment shows that the milk yield is higher by 0.73 kg per day or 3.57 % ($P<0.01$). During the whole experimental period, the control group cows produced 7.74 % more milk than the cows from the trial group.

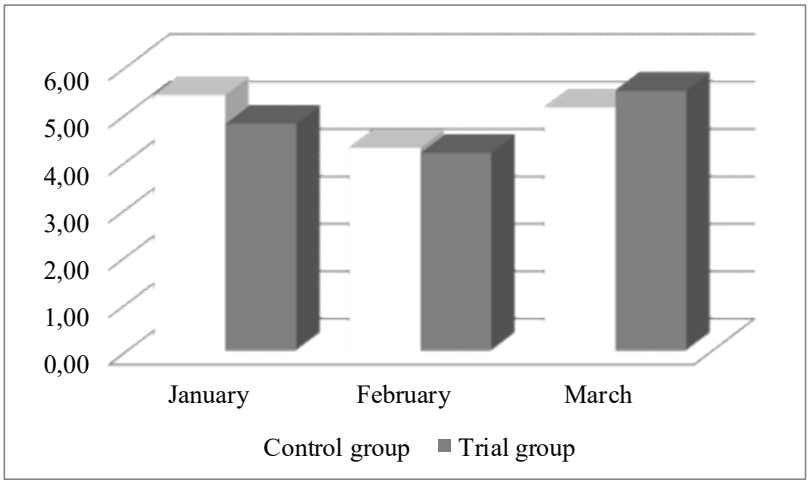

Fig. 2. **The dynamics of milk fat, %**

As Fig. 2 demonstrates, in January, fat content of the control group was 5.4 % and 4.8 % ($P<0.05$), and of the trial group it was 4.8 % ($P<0.05$). It shows that milk of the control group had 0.6 % more fat than milk from the trial group. Comparison of the data from the beginning and from the end of the experiment shows that fat from the control group milk decreased by 5.14 % i.e. 0.26 %. Meanwhile fat from the trial group increased by 5.49 %, i.e. 0.69 %, ($P<0.05$).

The data from Fig. 3 demonstrates that at the beginning of the experiment the trial group as well as the control group had almost the same content of proteins in milk, 3.59 % and 3.60 %, respectively. Protein content in milk of cows from both groups evolved differently during the experiment. Comparison of the beginning of the experiment to the end of it shows that protein content from the control group milk increased by 0.19 % and the trial group had an increase of 0.33 % ($P<0.01$). At the end of the experiment, the milk protein results of the trial group cows were higher by 0.15 % compared to the control group cows.

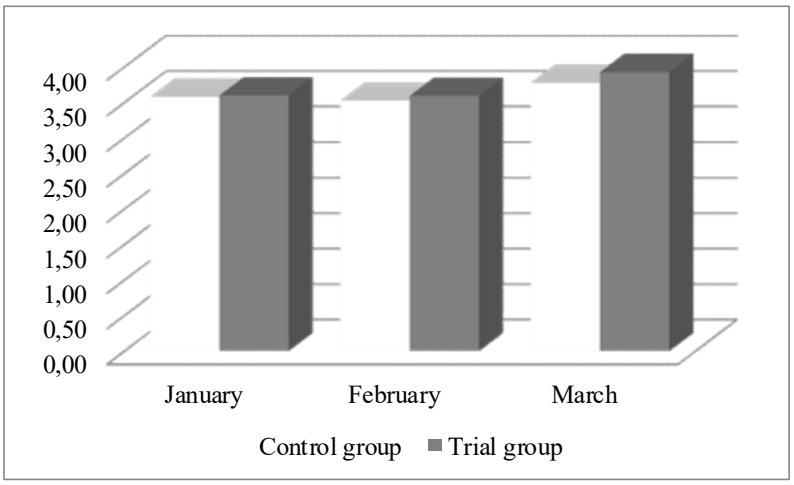

Fig. 3. **The dynamics of milk proteins, %**

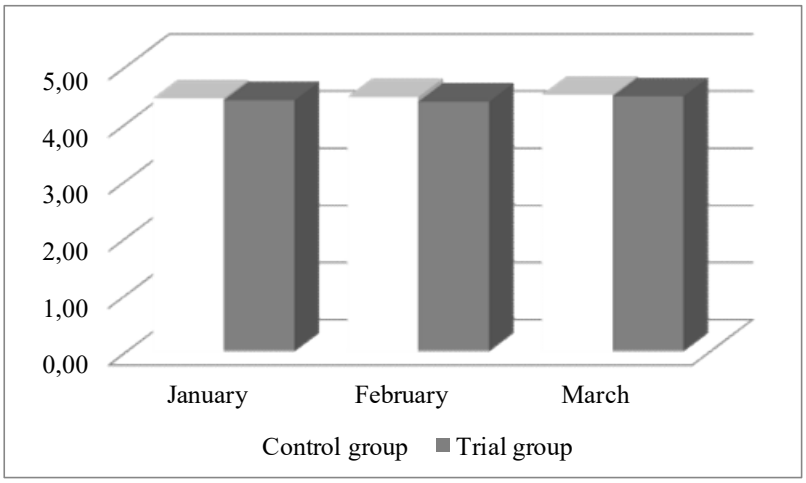

Fig. 4. **The dynamics of milk lactose, %**

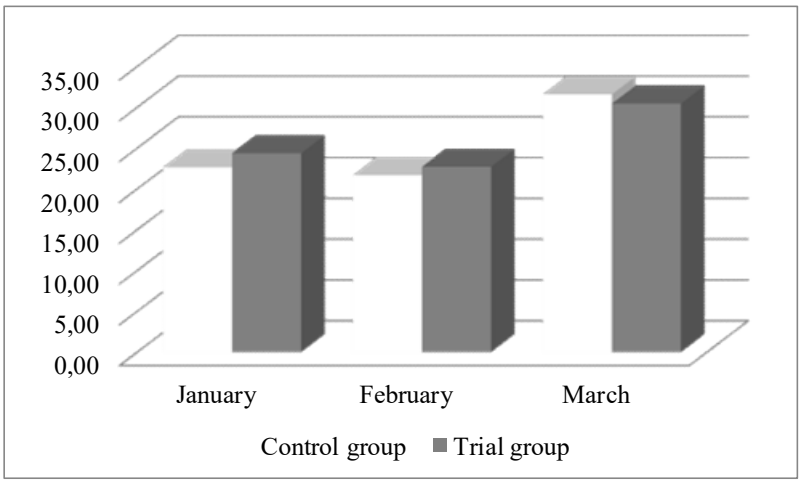

Fig. 5. **The dynamics of urea, mg%**

Concentration of lactose in the milk of cows of both groups was almost the same and varied evenly during the whole experiment. Comparison of the beginning of the experiment to the end of it shows that lactose content from the milk of the control group milk increased 0.06 % ($P<0.05$), and the trial group had an increase of 0.07 % ($P<0.05$).

As Fig. 5 demonstrates concentration of urea in both groups varied unequally during the whole experiment. Comparison of the beginning of the experiment to the middle of it shows that concentration of urea in the milk of cows

from the control group decreased by 0.96 mg% and reached 21.74 mg%, and the trial group had a decrease of 6.09 mg% and reached 30.52 mg%.

Discussion

Insertion of soybeans to the rations as a source of protein and fat has been commonly and widely used at dairy farms in recent years. Extruded faba beans contain a lot of amino acids that are well digested in ruminants' rumen compared to other protein forages (Schwab, 1995).

Soybeans consist of 42 % crude proteins and 19–20 % crude fat (NRC, 2001) of which only 26 % of proteins are digested in ruminants' rumen (Faldet and Satter, 1992).

A very practical and economical decision is to add soybeans and their by-products to the rations of ruminants. Soybeans have full complex of amino acids and that is the reason to add it to composition for any ration. Depending on the processing method, soybeans contain high quality and well digestible proteins, fats, are rich in fiber. Inserting soybeans to dairy cows' ration helps to reduce or avoid acidosis, also gastric pH decreases. Soybeans shells have little lignin and structural carbohydrates, yet plenty fiber that are well digested in the rumen. As Solomon states, milk yield increases to 4 % by inserting soybeans to nutrition (Solomon et al., 2000).

Results from this study shows that including 10 % of extruded soybeans to the compound feed during the whole time of experiment, increases milk yield approximately by 3 kg per day, i. e. 15.25 % ($P<0.05$). This agrees with the results obtained by other authors who claim that soybeans have positive impact on dairy products and chemical composition of milk (Grummer et al., 1991). Other authors argue that milk yield improves. Over the last years many experiments have been held by feeding dairy cows with extruded, crude, heat treated soybeans or soybeans meal (Chouinard et al., 2001). Many different opinions and plenty experiments with various results have appeared over the years (Solomon et al., 2000).

After replacing extruded soybeans with extruded rapeseeds and faba beans mixture, milk yield from the trial group increased by 3.92 kg per day or 19.15 % ($P<0.05$) in the middle of the experiment (in February) and by 0.73 kg per day or 3.57 % ($P<0.01$) comparing the beginning of the experiment to its end. During the whole experimental period, the control group cows produced 7.74 % more milk compared to the cows from the trial group. Other authors argue that it is a very practical decision to add rapeseeds as they have 35 % crude proteins and highly digestible amino acid complex (Bell et al., 2005). Compared to soybeans, rapeseeds have more than double crude fats but almost 40 % less crude proteins. Rapeseeds are full of fiber but have practically no starch. Heat treatment of rapeseeds has positive nutritional value (Burel et al., 2000). Anti-nutritional substances are destroyed while extruding. Rapeseeds have enzymes that release phosphorus compounds into the oil. Rapeseeds oil is a good source of energy, nutrients and calories and also is very cost-effective to use for feeding cows. Extruded rapeseeds flour has 7–15 % higher content of oil than basic rapeseeds. Also, digestibility of fats and amino acids improves after the extrusion (Schumann, 2005). Beans, as well as other legumes, have very good and easily digestible proteins. Protein content in beans usually ranges between 22–24 % (16–32 % DM). They are full of amino acids (lysine) (Bernard, 1990), also aplenty starch (48–54 % DM). Valentine and Bartsch (1987) states that extruded soybeans involving to the ration of cows change milk composition and quantity. Degradation rate of starch in the rumen changes as well (Gonthier et al., 2004[a]). Beans decomposition of starch is slower than other grains (4–6 %/hour), which reduces the risk of acidosis. Digestibility of crude proteins increases by extruding the soybeans (Goelema et al., 1999).

Analysis of the results of the experiment and comparison of the beginning and the end of the experiment show that fat content of the control group cows decreased by 5.14 % i. e. 0.26 %, and fat content in the milk of the trial group cows increased by 5.49 % i. e. 0.69 % ($P<0.05$). Thus, it can be concluded that extruded rapeseeds and fodder bean mixture inserted to the mixed feed increases milk fat content. While extruded soybeans inserted to the compound feed decreases milk fat content. Comparison of the data from the beginning of the investigation and from the end of it shows that protein content from the control group milk increased by 0.19 %, and the trial group had an increase of 0.33 % ($P<0.01$). At the end of the experiment, the trial group cows had higher milk protein results by 0.15 %, compared to the control group cows. This is also confirmed by other researchers, e. g. Dhiman et al. (1999) states that because dairy cows are fed with extruded soybeans, fat content of milk is reduced and protein is increased.

Concentration of lactose in the milk of cows from both groups was almost the same and variated evenly during the whole experiment. Data comparison from the beginning of the experiment to the end of it shows that lactose content from the control group milk increased by 0.06 % ($P<0.05$), and the trial group had an increase of 0.07 % ($P<0.05$).

Data comparison from the beginning of the experiment to the end of it shows that concentration of urea increased by 8.95 mg% for the control group cows and was 31.65 mg%, and the trial group had an increase of 6.09 mg% and reached 30.52 mg%.

Conclusion

Results from this study suggest that extruded rapeseeds (30 %) and faba beans (70 %) mixture did not have significant influence on milk quality indicators. During the whole experiment, milk yield increased approximately by 3.00 kg per day i. e. 15.25 % ($P<0.05$) for the control group and approximately by 2.33 kg per day or 11.36 % ($P>0.05$) for the trial group. During the whole experimental period, the control group cows produced 7.74 % more milk than the cows from the trial group.

Milk fat content decreased and milk protein content increased when the dairy cow ration was enriched with extruded soybeans (the control group). Data comparison from the beginning of the experiment to the end of it shows that fat content

from the control group milk decreased by 0.26 %, while fat content from the trial group increased by 0.69 %, ($P<0.05$). Protein content from the control group milk increased by 0.19 % and the trial group had an increase of 0.33 % ($P<0.01$). At the end of the experiment, the trial group cows had 0.15 % higher milk protein results compared to the control group cows.

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