EFFECTS OF EXTRUDED PEAS *(PISUM SATIVUM)* ON DAIRY COWS' PERFORMANCE, MILK COMPOSITION AND SENSORY PROPERTIES

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Abstract. The aim of our research was to determine the influence of extruded peas on dairy cows' performance, milk composition and sensory properties. Lithuanian Black-and-White cows with analogous characteristics were selected and randomly allocated into 2 groups (control and experimental), 10 animals each. The control group was fed a conventional diet consisting mainly of grass silage, ground barley grain, enriched extruded full fat soybean, and mineral premix. The experimental groups were fed a similar diet, but instead of 1.5 kg of soybean meal, the cows were given the same amount of extruded peas and 700 g of extruded soybean. The results of this study showed that a part of extruded soybeans replacement with peas (*Pisum sativum*) in dairy cows' rations had a negative effect on milk yield, but increased milk fat and protein content. During the experimental period, the amount of urea and lactose in milk, both in control and experimental group, differed non-significantly.

The results of milk sensory properties showed that a part of extruded soybeans replacement with peas (*Pisum sativum*) in dairy cows' rations did not have a negative influence on milk sensory parameters. Milk samples of both groups (control and experimental) did not differ by odour intensity, and every sample had an apparent milk's specific odour. After 2 and 3 months of feeding, milk samples of experimental cows fed extruded peas and soybeans had a light, non-specific bitter and dry alike milk savour.

Keywords: extrusion, peas, dairy cows, milk, milk composition

Introduction

The rapid increase in human population leads to increased demand for animal protein. On the other hand, the deficit of protein feeds in the market and rising costs are the most significant obstacles facing animal production. Therefore, most research studies have focused on improving the status and utilisation of different protein sources in order to reduce costs and maintain optimum performance of animals (Ružić-Muslić, 2014).

Soybean meal is the main protein source used in cattle feeding. The prohibition to use meat and bone meal following the bovine spongiform encephalopathy crisis has increased this undeniable fact. The high proportion of genetically modified crops and the difficulty of ensuring the complete traceability of animal products are the major problems of using soybean meal (Jensen, 2002). The use of alternative plant proteins in place of the soybean meal protein in diets for producing animals aims to reduce the extra-EU soybean import and partially substitute the GMO in the food chain. Among possible alternatives, the heat-processed legume grains seem interesting for dairy cow diets (Volpelli, 2012).

Peas have a number of characteristics that make them a desirable ingredient in dairy rations. Field peas are palatable and contain over 20% of protein and a substantial amount of starch. These are desirable characteristics for supplying available nutrients, which also support favourable rumen conditions for microbial growth and fermentation (Christensen, Mustafa, 2000). In general, the energy value for peas is higher than for barley but lower than for rapeseed and soybean meal. Pea protein consists of albumins and globulins to 85−100%, which leads to the fact that a large part of pea protein is soluble and degradable in the rumen. Starch in peas is, on the other hand, to a large extent resistant to rumen degradation compared with starch from other starch rich feedstuffs. To decrease the ruminal degradability of dietary protein and by means of that increase the total flow of amino acids to the small intestine, several processing methods are used. These methods are often based on some kind of heat treatment, which results in the so-called Malliard reactions (Galméus, 2012). The rumen degradability and the soluble fractions (albumins and globulins) of the protein are higher in grain legumes compared with the SBM (Corbett et al., 1995; Khorasani et al., 2001; Masoero et al., 2005): thus, grain legumes are more suitable as supplements to low protein-forages, or they should be heat-processed (Wilkins and Jones, 2000).

Many research studies have been done in order to investigate peas and faba beans effects on dairy cows' performance and milk composition (Corbett et al., 1995; Petit et al., 1997; Masoero et al., 2006; Martini et al., 2008), but there have been few research studies in pursuance to investigate its effects on milk sensory

profiles. Thus, **the aim** of our research was to determine the influence of extruded peas on dairy cows' performance, milk composition and sensory properties.

Material and methods

The research was carried out in compliance with the Law of the Republic of Lithuania on Animal Care, Housing and Use (No. XI–2271) as well as 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).

Dairy cows' feeding trial. For the trial, 20 Lithuanian Black-and-White cows with analogous characteristics were selected. The animals selected were divided into 2 groups (control and experimental), 10 animals each. The feeding trial was divided into 2 periods: preparatory (14 days) and experimental (90 days). The feeding scheme in the experimental period is provided in Table 1. Raw materials for the trial were extruded by company Kauno Grūdai.

Table 1. **Feeding scheme in the experimental period (90 days)**

Group	Number of cows, n	Feeding characteristics		
Control	10	Diet	+1.5 kg extruded soybean, cow per day	-
Experimental	10	Diet	+1.5 kg extruded peas, cow per day	+700 g extruded soybean, cow per day

The control group was fed a conventional diet consisting mainly of grass silage, barley grain, enriched extruded full fat soybean flour, and mineral premix. The experimental groups was fed a similar diet, but instead of 1.5 kg of soybean meal, the cows were given the same amount of extruded peas and 700 g of extruded soybean.

Table 2. **Diets for control and experimental groups, their energy and nutritional values**

Feedstuff	Units	Groups	
		Control (extruded soybeans)	Experimental (extruded peas+soybeans)
Maize silage	kg	10.0	10.0
Perennial grass silage	kg	12.0	12.0
Grass silage	kg	12.0	12.0
Barley flour	kg	5.0	5.0
Straw	kg	2.0	2.0
Molasses	kg	1.0	1.0
Extruded soybeans	kg	1.5	0.7
Extruded lupins	kg	-	-
Extruded beans	kg	-	-
Extruded peas	kg	-	1.5
Minerals and vitamins supplements	kg	0.83	0.83
1 kg diet DM contains:			
Net energy per lactation (NEL)	MJ	5.70	5.78
Crude protein	g	130	128
Crude fibre	g	196	191
Crude fat	g	39	33
Starch	g	190	211
Sugar	g	38	36

Feed samples were analysed for dry matter, crude protein, crude fibre, crude fat, nitrogen-free extracts, calcium and phosphorus. The energy value of feeds was expressed as net energy for milk production (NEL). The analyses were carried out at the Analytical laboratory of the Lithuanian University of Health Sciences Institute of Animal Science using ordinary methods (AOAC, 2000): dry matter was estimated as a difference between wet and dry samples drying at the temperature of 105°C for 3 hours; crude proteins were assessed using the Kjeldahl method measuring the nitrogen content in the sample; crude fat was assessed after sample extraction with ether; crude ashes were assessed based on the residue of a sample whose organic materials were burnt at the temperature of 550ºC; crude fibre was determined as the residue of nitrogen-free substances insoluble in acids and alkali; NDF, ADF and ADL were determined by the means of the analyser ANKOM 200 Fiber Analyzer (Ankom Technology, Macedon, USA); calculated NEM = dry matter content – crude protein content – crude fat

content – crude fibre content – crude ash content; calcium content was determined by the atomic absorption method; photometric determination of overall phosphorus content was carried out by the means of the vanadate-molybdate method.

Energy and nutritional values of the diets were calculated with the feeding software HYBRIMIN® Futter 2008.

Milk yield and composition analysis. Milk yield was determined by control milking. Milk samples were taken according to sampling requirements. Analysis was carried out by state enterprise *Pieno tyrimai*, using Lactoscope 550 and LactoScope FTIR (FTI.O.2001; Delta Instruments). Milk samples were analysed for milk fat, milk protein, lactose and urea concentration.

Milk sensory analysis. A quantitative descriptive analysis (QDA) was carried out for the assessment of sensory properties, and sensory profiles were created for each prepared beverage. Sensory assessors were staff of Kaunas University of Technology Food Institute. A group of 5 trained assessors (women, age 20–60 years old) with work experience in the evaluation of various food products not less than 20 hours and trained according ISO 8586 was used. All the training and data collection sessions were held at the Sensory Analysis Science Laboratory of Kaunas University of Technology Food Institute established according to ISO 8589 requirements

For the development of sensory profiles, a full balanced randomised sample presentation plan with 2 repetitions was applied. Panel responses were collected using a computerised programme (Fizz, Biosystems, France). The 15 cm line scales with 1 cm indented anchors (left – low intensity/absent, right – high intensity) were used to evaluate each sensory attribute. The scales were presented for each sample on a single screen for evaluation of the attributes of odour, texture and taste. The assessors were asked to rinse their mouth and palate with water and eat a piece of white bread before testing each presented sample.

Before evaluation, the raw milk samples were pasteurised at the temperature 74 ± 2ºC, and then cooled up to the temperature 16 ± 2ºC. Then, the samples (approximately 20 mL) were presented to the panel in 30 mL plastic cups, coded with 3 digital numbers.

The milk samples for the chemical and sensory analysis were taken 3 times: after 1 month of the trial, after 2 months of the trial, and at the end of the trial.

Statistical analysis. Data of milk yield, composition and sensory properties were analysed by ANOVA, and if significant interactions were determined, multiple comparisons were made. The differences were classified by the Duncan multiple comparison test ($P<0.05$). SPSS software, version 15.0 (Chicago, IL, USA, 2006) was used for the statistical analysis of the data.

Results and discussion

Milk yield and composition. Nutritive factors have a big influence upon cow's productivity and milk composition. Factors that influence milk composition are genetics, lactation period, productivity level, cow's age, environmental conditions, health and nutrition. Inheritance influences milk composition by 55%, and the rest 45% are influenced by environmental conditions, such as nutrition (Schroeder, 2012). Di Francia et al. (2007) have assessed the effect of partial replacement of soybean cake with extruded peas in the diet of cows during the first 100 days of lactation and found that peas construed an attractive source of protein (GMO formulations free) in diets for cows whose production is based on organic principles. The protein content of peas is about 25−26% of dry matter. In terms of the amino acid profile, peas have higher lysine and lower tryptophan content as compared with soybean meal (Gatel, 1994).

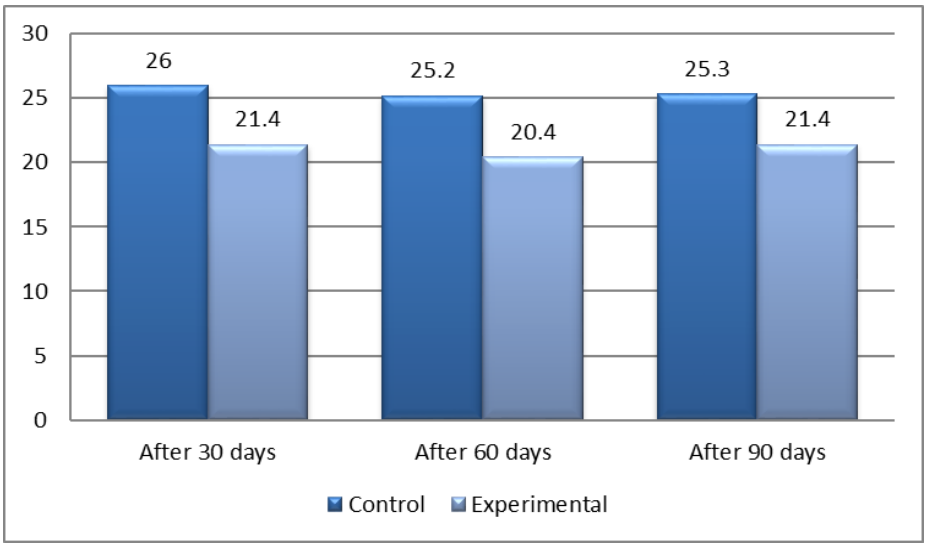

Figure 1. **Raw milk amount during the experimental period, kg/per day (per cow)**

A diet inclusion of 150 g/kg of rolled peas, as a partial substitute of soybean meal and corn grain, did not affect dry matter intake, milk yield, milk protein and fat contents (Vander Pol et al., 2008). As we can see from Figure 1, a part of extruded soybeans replacement with extruded peas in dairy cows' diets had a negative effect

on milk yield. During the first month of the experiment, the experimental group cows gave on average 17.69% less milk compared with the control group (P<0.05). During the second month of the experiment, the experimental group cows gave 19.05% less milk compared with the control group cows (P<0.05). During the third month of the experiment, the experimental group cows gave 15.42% less milk compared with the control group cows (P<0.05). According to Corbett et al. (1995), milk yield and composition were not changed with the addition of peas when rations were properly balanced. Recently, Masoero et al. (2006) reported a significant increase in milk yield replacing soybean meal with extruded peas in a conventional total mixed ration fed to Holstein cows in mid lactation.

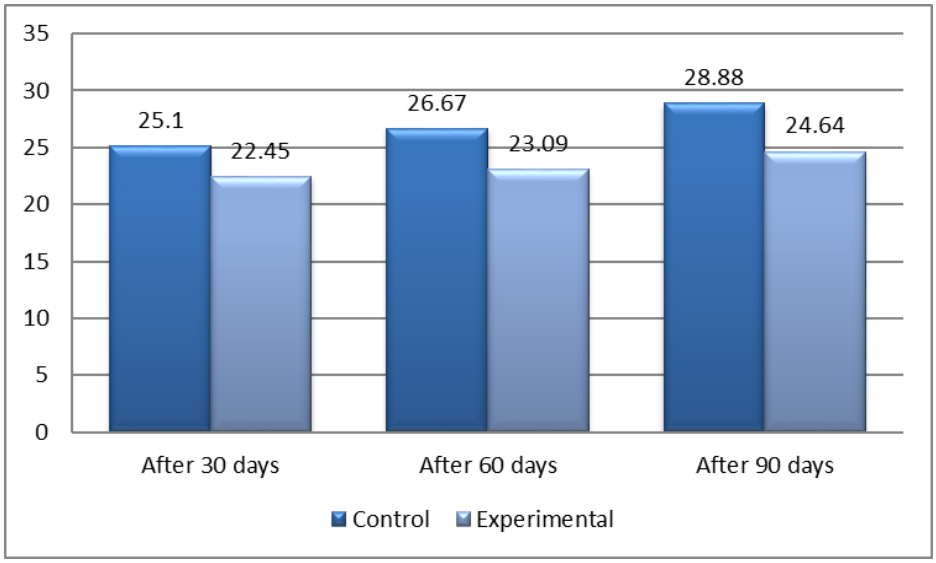

Figure 2. **Average fat-corrected milk yield during the experimental period, kg/d**

Milk manufacturers are accounted for milk considering amount of milk (kg), milk protein and fat basic norms, and milk qualitative factors. All milk is recalculated to basic amount of milk by a formula. As it can be seen from the data in Figure 2, the experimental group cows gave less fat-correlated milk: by 10.56% during the first month of the trial, by 19.42% during the second month of the experiment, and by 14.68% during the third month, compared with the control group (P<0.05). During the entire experimental period, the amount of fat-correlated milk of the experimental group cows fed with extruded peas and soybean protein supplement was 314.1 kg or 12.98% lower compared with the control group.

Nutritive factors strongly influence cow's milk composition. Nutrition is the most effective means to change milk composition. Among milk components (fat, protein, lactose, trace elements and vitamins), fat and proteins are most sensitive to cow's nutrition alterations (Santos, 2002).

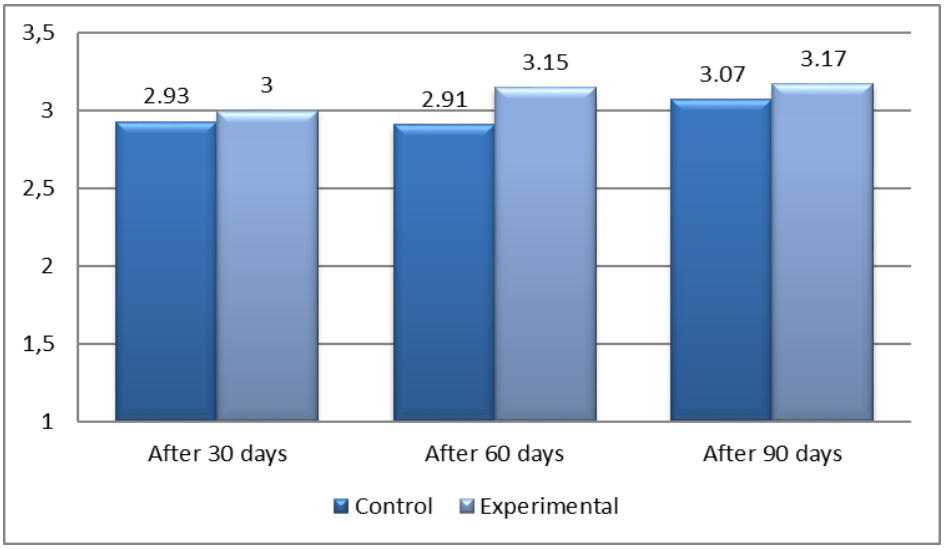

Figure 3. **Changes of milk protein content during the experimental period, %**

The study by Liponi et al. (2007) using peas in feed of lactating ewes showed a similar chemical composition of milk, but lower protein content compared with sheep fed with added soybean meal or bean fodder. As it can be observed from the data of Figure 3, the milk protein amount of control and experimental cows increased during the experimental period. During the entire experimental period, the milk protein amount in milk of the control group cows increased by 0.14% ($P<0.05$), and in the experimental group by 0.17% ($P>0.05$). After the first month of the experiment, the amount of protein in milk of the experimental group was bigger by 0.77%, after the second month by 0.24%, after the third month by 0.10% ($P<0.05$), compared with the control group. Thus, an assumption that adding extruded peas into the ration had a positive influence upon the protein amount in milk can be made and agrees with data of other authors. The low milk protein amount of the control group cows can be explained for full-fat extruded soybean adding into the cows' ration, and a lot of fat containing feeds increase milk fat amount, though reduce milk protein amount (Santos, 2002).

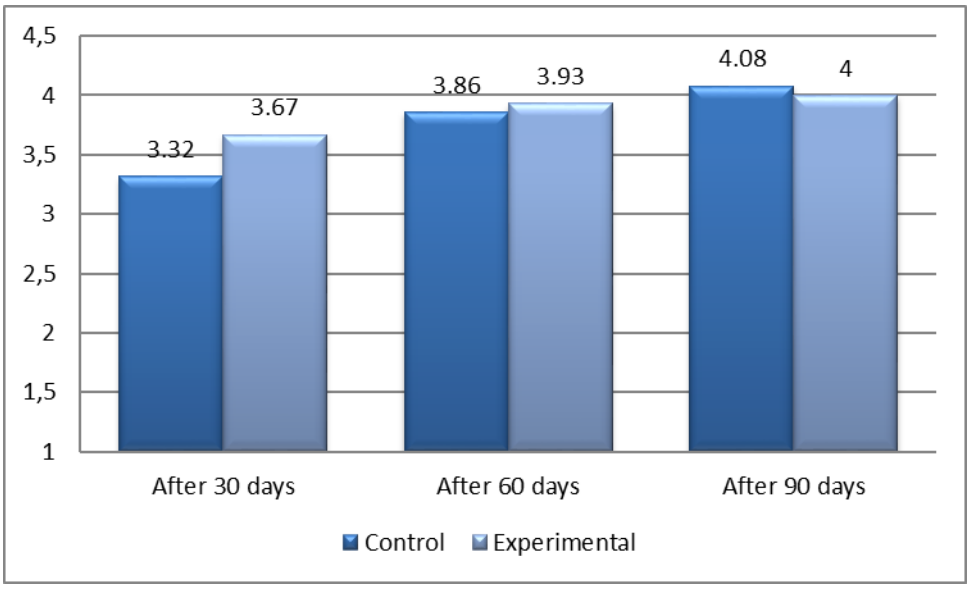

Figure 4. **Changes of milk fat content during the experimental period, %**

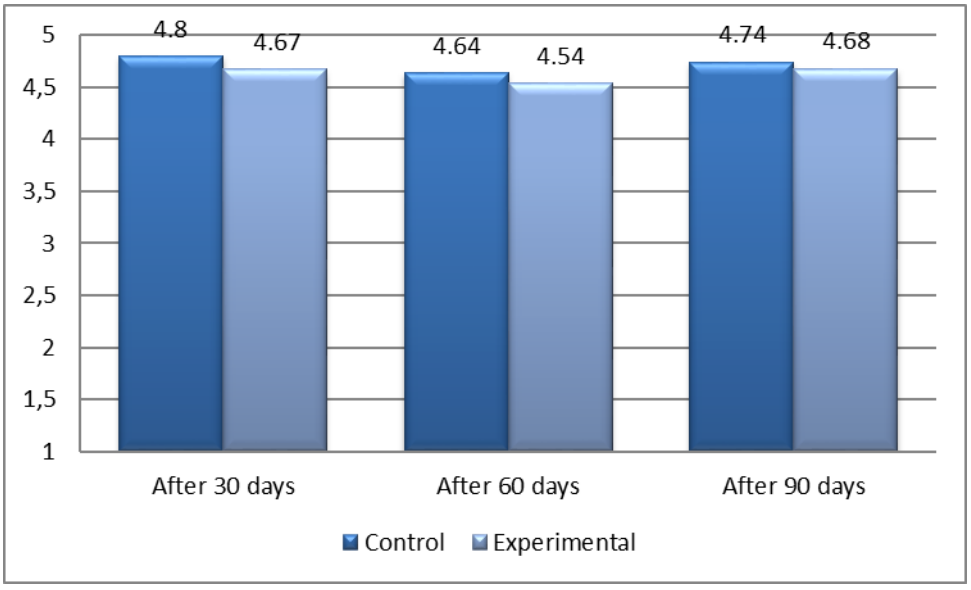

Figure 5. **Changes of lactose content during the experimental period, %**

Corbett et al. (1995) stated that milk fat percent was significantly higher for early- and mid-lactation cows fed the pea supplement, compared with a control group fed diet supplemented with canola and soybean. As it can be observed from the data of our investigation presented in Figure 4, the fat content in milk of both control and experimental cows groups increased during the entire experimental period; therefore, extruded peas had a positive influence not only on the milk protein amount, but also on the fat amount. After the first month of the

experiment, the milk fat amount of the experimental group cows was by 0.35% higher compared with the control group (P>0.05). After the second month of the experiment, the milk fat of the control group cows was only by 0.07% lower compared with the experimental group (P>0.05). At the end of the experiment, the milk fat of the experimental group cows was by 0.08% lower compared with the control group cows (P>0.05). During the entire experimental period, the control group cows' milk fat increased by 0.76%, and that of the experimental group cows by 0.33% (P>0.05).

After the first month of the research, the concentration of lactose in the experimental group cows' milk was by 0.13% lower compared with the control group (P>0.05). After the second month of the experiment, the concentration of lactose in the experimental group cows' milk was by 0.10% lower (P>0.05), compared with the control group cows' milk. At the end of the research, the concentration of lactose in the experimental group cows' milk was lower by 0.6% (P>0.05), compared with the control group.

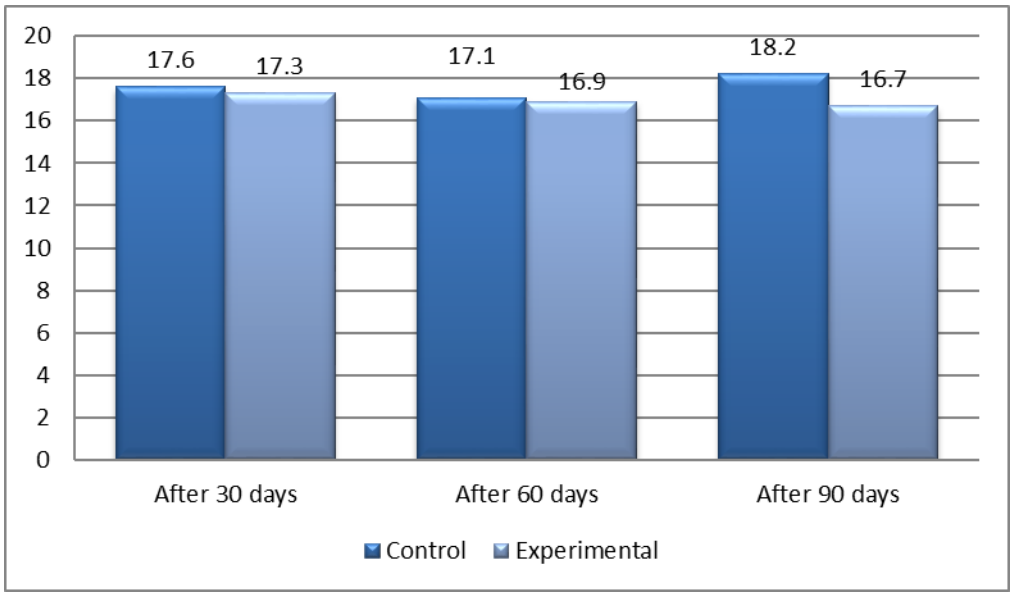

Figure 6. **Changes of urea content during the experimental period, mg**

Table 3. **Milk sensory parameters during the experimental period**

Parameter	After 30 days				After 60 days				After 90 days			
	Control		Experimental		Control		Experimental		Control		Experimental	
Overall odour	11.50	a	10.80	a	8.9	a	8.7	a	12.5	a	12.5	a
Pasteurisation odour	8.25	b	6.36	a	5.7	a	5.9	a	9.9	a	9.4	a
Natural milk odour	7.20	a	8.50	a	8.4	a	8.8	a	10.3	a	10.7	a
Atypical odour	1.00	a	1.00	a	1.1	a	1.7	a	1.0	a	1.5	a
Mouthcoating	8.80	b	6.25	a	7.2	a	6.4	a	7.5	a	7.4	a
Overall taste	12.10	a	10.90	a	11.0	a	10.1	a	12.2	a	12.4	a
Richness of the taste	11.88	a	10.10	a	10.9	a	10.8	a	11.7	a	10.7	a
Acid taste	1.70	a	1.70	a	1.3	a	1.6	a	1.1	a	1.2	a
Sweet taste	8.30	a	7.70	a	7.7	a	7.8	a	8.2	a	7.8	a
Pasteurised milk taste	6.90	a	6.88	a	7.3	a	6.9	a	8.0	a	7.8	a
Natural milk taste	9.60	a	9.80	a	6.9	a	7.3	a	10.6	a	10.6	a
Nonfresh milk taste	1.10	a	1.20	a	1.4	a	1.5	a	1.2	a	1.2	a
Atypical taste	1.10	a	1.50	a	2.8	b	3.1	b	1.0	a	1.9	b
Aftertaste	7.30	a	7.00	a	8.1	a	7.4	a	8.1	a	81	a
a, b – Means in the same row with no common superscript differ significantly (P<0.05)												

In other research studies, the use of 150 g/kg flaked pea (Volpelli et al., 2009) increased both blood and milk urea. During the experimental period, the amount of urea in milk, both in the control and the experimental group, differed non-significantly, though during the entire experimental period the control group cows' milk had a higher amount of urea in milk compared with the experimental group (P>0.05). These results agree with Vander Pol et al.'s (2008) experiment results that

concentration of milk urea nitrogen was also not affected by treatment.

Milk sensory properties. After the first month of the research, the results of milk sensory parameters showed that the milk samples did not differ by odour intensity, and every sample had an apparent milk specific odour. The milk samples were pasteurised by the same conditions. Applied feeds did not have a negative influence on the milk's odour, and there was no lateral, atypical odour. The milk samples of the experimental group cows (whose ration was supplemented with extruded peas and soybeans) had a more intense sense of mouthcoating. The samples of both groups had equal richness of taste.

After the second month of feeding, the results of sensory milk evaluation (Table 3) showed that the milk samples did not differ by odour intensity, and every sample had an apparent milk specific odour. All the samples were pasteurised by the same conditions; therefore, all the samples were distinguished by specific pasteurised milk's odour. Applied feeds did not have a negative influence on milk's odour, and there was no lateral, atypical odour. The milk samples of both groups had an intense overall taste, distinguished by sweet and natural milk taste. Intensity of sensory parameters of all the samples was identical, but the milk samples of the experimental group cows had a light, non-specific bitter and dry alike milk savour.

At the end of the research, the results of sensory milk evaluation (Table 3) showed that the milk samples did not differ by odour intensity, and every sample had an apparent milk specific odour. All the samples were distinguished by specific pasteurised milk's odour. Applied feeds did not have a negative influence on the milk's odour, and there was no lateral, atypical odour. Intensity of sensory parameters of all the samples was identical, but the milk samples of the experimental group cows after the second month of feeding had a light, non-specific bitter and dry alike milk savour. Vander Pol et al. (2008) stated that panel evaluation of milk from the dairy cows' diet with peas indicated no differences in the organoleptic characteristics of milk, compared with a control group fed soya, but our investigation showed that extruded soybean replacement with extruded peas had milk savour.

Conclusions

The results of this study showed that a part of extruded soybeans replacement with peas (*Pisum sativum*) in dairy cows' rations had a negative effect on milk yield, but increased milk fat and protein content. During the experimental period, the amount of urea and lactose in milk, both in the control and the experimental group, differed non-significantly.

The results of milk sensory properties showed that a part of extruded soybeans replacement with peas (*Pisum sativum*) in dairy cows' rations did not have a negative influence on milk sensory parameters. The milk samples of both groups (control and experimental) did not differ by odour intensity, and every sample had an apparent milk's specific odour. After 2 and 3 months of feeding, the milk samples of the experimental cows fed extruded peas and soybeans had a light, non-specific bitter and dry alike milk savour.

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Received 28 June 2016
Accepted 05 July 2016