EFFECT OF EXTRUDED FIELD BEANS "FUEGO" (*Vicia Faba*) ON DAIRY COW'S PERFORMANCE AND MILK SENSORY PROPERTIES

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Abstract. The aim of our research was to determine effect of extruded fodder beans on dairy cows performance and milk sensory properties. For the experiment selected 24 Lithuanian Black-and-White cows with analogous characteristics and randomly allocated into 2 groups (control and experimental), 12 animals each. The experimental groups' cow's were fed a similar diet, but instead of 9 kg of compound feed with non-extruded field beans, the cows were given the same amount of compound feed with extruded beans, cow per day. All training and data collection sessions were held in the sensory analysis laboratory of Kaunas University of Technology Food institute established according to ISO 8589 requirements

The results of this study showed that a non-extruded beans replacement with extruded beans in dairy cow's diets, had possitive effect on milk yield. The results of milk sensory properties showed that non-extruded beans replacement with extruded beans 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.

Keywords: productivity, extruded beans, dairy cows, sensory properties

Introduction. Supplementation of pro-tein feeds in the diet of dairy cows is essential and the challenge of dairy nutrition is to establish minimal amount of protein required by high producing dairy cows (Huhtanen et al. 2011). High prices and consumers concerns has brought the attention to the use of more economical and ecological ways of producing home-grown protein feeds for animal feed market (Puhakka et al. 2016). Feed costs for the dairy cattle herd represent 50 to 60% of the total cost associated with the production of milk. In addition, properly implemented dairy cattle nutrition programs can improve milk production, health, and reproductive performance of dairy cows for both the milking herd. Any situation that causes cows to eat abnormally or limits feed intake may affect milk components and content, therefore we must to ensure the best quality rations (Grant and Ferraretto, 2017).

Protein is very important component of dairy cow nutrition, it effect their milk quality and productivity. The highest protein content of the feed material is found in the grain. According to Kononoff (2006), grain intake should be limited to a maximum of 10 to 15 kg per cow daily. Compared with the mistyards higher protein concentrations are in bean plants, that's why faba beans is a great source of protein for the cattle diet, but for the better result they should be heat treated (Masoero et al., 2006).

Processed grain by cracking, rolling, grinding, or possibly steam-flaking enhances rumen starch digestion, which improves milk yield and protein percentage (Vasupen et al., 2006). During extrusion, proteins are unfolded, realigned, hydrolyzed, and denatured, the resulting complexes forming matrices with the degree of expansion dependent on protein concentration. The sites for cross-linking among proteins and starches increase with an increase in protein concentration, which subsequently will affect the textural quality of extrudates (Onwulata at al., 2006). Protein concentration, moisture content, and the physical and mechanical parameters of the extruder significantly affect the physical and sensory qualities of extrudates (Li and Barry, 2013).

Many researches had been done in order to investigate peas and faba beans effects on dairy cows performance and milk composition (Martini et al., 2008; Tufarelli et al., 2012; Puhakka et al., 2016), but there haven't been done many researches in pursuance to investigate its effects on milk sensory profiles. **So the aim** of our research was to determine the influence of extruded faba beans on dairy cow's performance and milk sensory properties.

Material and methods

Dairy cows feeding trial. 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).

For the trial, 24 Lithuanian Black-and-White cows with analogous characteristics were selected. The animals selected were divided into 2 groups (control and experimental), 12 animals in each. Feeding trial was divided in two periods – preparatory (14 days) and experimental (90 days).

The cows of control group were fed a conventional diet consisting mainly of grass and corn silage, enriched compound feed with non-extruded fodder beans. The experimental groups' cow's were fed a similar diet, but instead of 9 kg of compound feed with non-extruded field beans, the cows were given the same amount of compound feed with extruded beans, cow per day. The composition of control and experimental group's compound feed's is provided in Table 1.

Table 1. **The composition of control and experimental group's compound feed's, their energy and nutritional values**

Feedstuff	Units	Group	
		Control	Experi-mental
Triticale	kg	237	237
Non-extruded field beans	kg	**167.9**	**-**
Extruded field beans	kg	**-**	**167.9**
Peas	kg	167.9	167.9
Wheat	kg	143.2	143.2
Extruded soya	kg	136.3	136.3
Oats	kg	98.8	98.8
Minerals	kg	27.8	27.8
Acid buffer	kg	9.9	9.9
Sodium dicarbonate	kg	8.8	8.8
Toxin's binder	kg	1.5	1.5
Fodder yeast's	kg	1	1
1 kg DM compound feed contains:			
Net energy for lactation (NEL)	MJ	7.27	7.28
Sugar	g	67	69
Starch	g	476	470
Crude lipids	g	47	47.1
Crude proteins	g	205	209
Crude fiber	g	36	36
Calcium	g	9.68	9.68
Phosphorus	g	6.59	6.59
Magnesium	g	5.34	5.34
Sodium	g	5.38	5.38

As we can see from Table 2, control and experimental group's compound feed's were analogical composition and the same nutritional value, only the field beans (untreated and extruded) used for their production differ.

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

Milk yield and sensory analysis. Milk yield was determined by control milking. A quantitative descriptive analysis (QDA) was carried out for the assessment of the sensory properties, and sensory profiles were created for each prepared beverage. Sensory assessors were staff of Kaunas University of Technology Food institute. A total group of 5 trained assessors (female, ages 20–60 years old) having work experience in evaluation of various food products not less than 20 hours and trained according ISO 8586 was used. All training and data collection sessions were held in the sensory analysis laboratory of Kaunas University of Technology Food institute established according to ISO 8589 requirements

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

Feedstuff	Units	Group	
		Control	Experi-mental
Perennial grass silage	kg	12.79	12.79
Compound feed with non-extruded beans	kg	9	-
Compound feed with extruded beans	kg	-	9
Maize grits	kg	1.5	1.5
Salt	kg	0.05	0.05
Maize silage	kg	16	16
Molasses	kg	0.25	0.25
Water	kg	5.4	5.4
Straw	kg	1	1
1 kg DM diet contains:			
Net energy for lactation (NEL)	MJ	6.79	6.79
Sugar	g	33	33
Starch	g	277	277
Crude lipids	g	36	36
Crude proteins	g	162	162
Crude fiber	g	131	131
Calcium	g	6.4	6.4
Phosphorus	g	4.31	4.31
Magnesium	g	2.66	2.66
Sodium	g	3.24	3.24

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

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

Milk samples for the chemical and sensory analysis were taken 3 times: after 1st month of the trial, after 2nd

month of the trial and at the end of the trial.

Statistical analysis. SPSS software, version 15.0 (Chicago, IL, USA, 2006) was used for the statistical analysis of the data. The Student's *t-test* was used to determine differences among the means. Differences were considered statistically reliable when $P < 0.05$.

Results and discussion

Dairy cows feeding trial results. The advance in altering milk composition by dietary manipulation come from significant contributions of the entire animal system, from practical studies on feeding systems to basic cellular work on mammary tissue metabolism (Bauman and Griinari, 2003).

Feeding management practices on the dairy farm can have a major impact on the levels of milk fat and protein concentration in milk. Nutritional strategies that optimize rumen function also maximize milk production and milk components (Tyasi and Tlabela, 2015).

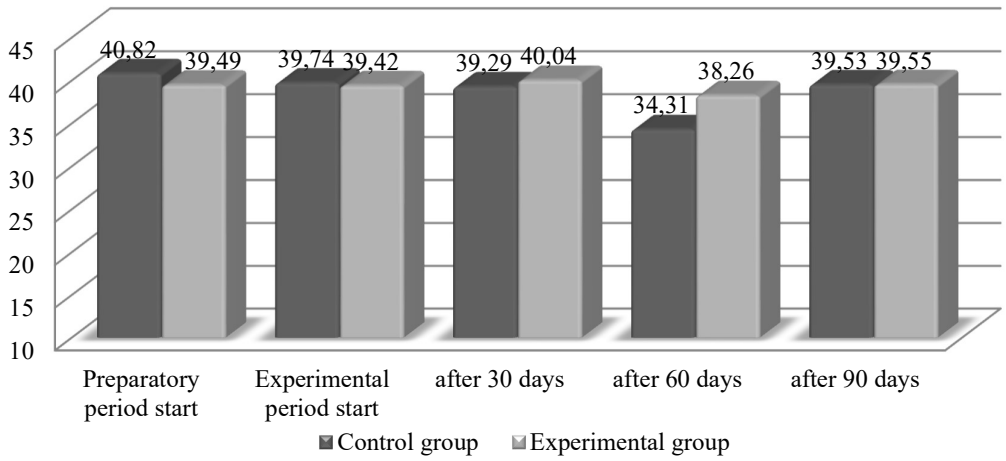

Fig. 1. **Analysis of basic milk during the preparation and experimental periods, *kg/d.***

Table 3. **Milk sensory parameters during experimental period after 30 days**

Parameter	**Control** (raw fodder beans)	**Experimental** (extruded fodder beans)	**P value**
Overall odour	12.33	11.83	0.418
Pasteurisation odour	8.50	8.75	0.823
Natural milk odour	10.42	10.00	0.657
Atypical odour	1.42	1.67	0.501
Mouthcoating	6.58	6.33	0.863
Overall taste	12.83	12.50	0.466
Richness of the taste	11.75	11.58	0.778
Acid taste	1.75	2.25	0.534
Sweet taste	9.50	8.92	0.624
Pasteurised milk taste	8.42	8.25	0.895
Natural milk taste	11.42	10.33	0.271
Nonfresh milk taste	1.02	1.13	0.781
Atypical taste	1.25	1.25	1.000
Aftertaste	9.58	8.83	0.464

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 we can see from Figure 1, non-extruded beans replacement with extruded beans in dairy cow's diets, had possitive effect on milk yield. During the first month of the trial, experimental group's cows gave 0.74 kg or 1,88 % higher amount of fat-correlated milk, during second month of the experiment – 3.96 kg or 11.54 % more, during third month of the trial difference between groups was statistically non-significant ($P < 0.05$).

During whole experimental period experimental group's cows fed with extruded beans supplement, the amount of fat-correlated milk was 136.9 kg or 3.46 % higher comparing to control group. ($P < 0.05$). Our data agreed well with data of other authors (Barletta et al., 2016).

Before recommending dietary modifications to breeders to modify milk composition, it has to be ascertained that such practices would not be detrimental to the sensory quality of dairy products (Chilliard and Ferlay, 2004). The results of milk sensory analysis using non-extruded fodder beans and extruded extruded beans in dairy cows' rations influence milk sensory parameters we can seen from Table 3 - 5.

30 days after the beginning of the experiment, the sensory analysis (Table 3) showed that there was no change in the composition of the feed during the feeding period. The odour and taste of all samples in all groups were clearly expressed, they did not feel any unusual taste or smell. The evaluator group did not indicate any sensory properties that could reduce the acceptability of the taste,

smell, or texture of milk. Milk samples from both groups were acceptable. Gruen (2007) studies have identified organic milk was the least liked among the samples, whereas conventional milk and milk from pasture-fed cows were rated similarly.

Table 4. **Milk sensory parameters during experimental period after 60 days**

Parameter	**Control** (raw fodder beans)	**Experimental** (extruded fodder beans)	**P value**
Overall odour	12.33	11.83	0.418
Pasteurisation odour	8.50	8.75	0.823
Natural milk odour	10.42	10.00	0.657
Atypical odour	1.42	1.67	0.501
Mouthcoating	6.58	6.33	0.863
Overall taste	12.83	12.50	0.466
Richness of the taste	11.75	11.58	0.778
Acid taste	1.75	2.25	0.534
Sweet taste	9.50	8.92	0.624
Pasteurised milk taste	8.42	8.25	0.895
Natural milk taste	11.42	10.33	0.271
Nonfresh milk taste	1.02	1.13	0.781
Atypical taste	1.25	1.25	1.000
Aftertaste	9.58	8.83	0.532

60 days after the beginning of the experiment, the sensory analysis (Table 4) showed that the odour and taste of all samples in both group were clearly expressed, they did not feel any unusual taste or smell. The odour, taste and texture of milk samples of all groups are assessed to be acceptable. While hay was part of the feed for all cows, as reported by Forss (1978) clover provides milk with a rather strong flavor while barley can be a source of off-flavors (Bassette and Fung, 1986).

During the feeding period after 90 days the experiment of sensory analysis (Table 5) showed that there was no changes in the composition of the feed. The savour and taste of all samples in both groups were clearly expressed, they did not feel any unusual taste or smell.

Mogensen et al. (2010) reported that milk from cows fed a diet containing toasted field beans and high content of maize had sour feed odour, a bitter taste and reduced fatty mouth-feel. In a comparision, milk from cows fed a high amount of maize and untreated field beans had a higher sugar sweet taste and fatty mouth-feel and lower astringent aftertaste and creamy flavour. During our investigation, the results of milk sensory parameters, whole experimental period, had shown that milk samples had no difference from each other by odour‘s intensity, every sample had an apparent milk‘s specific odour. Applied feeds had no negative influence on milk‘s odour, there were no lateral, atypical odour. Both groups milk samples had intense overall taste, it distinguished by having sweet and natural milk‘s taste. Sensory parameter‘s intensity of all samples was identical. Similar results were obtained by Kudlinskienė et al. (2017) that a part of extruded soybeans replacement with extruded beans in dairy cows rations had no negative influence on milk sensory parameters, but in this investigation we didn’t analyzed raw fodder beans effect on milk sensory properties.

Table 5. **Milk sensory parameters during experimental period after 90 days**

Parameter	**Control** (raw fodder beans)	**Experimental** (extruded fodder beans)	**P value**
Overall odour	12.17	12.08	0.876
Pasteurisation odour	9.08	8.83	0.791
Natural milk odour	10.00	10.00	1.000
Atypical odour	1.25	1.25	1.000
Mouthcoating	7.50	6.67	0.270
Overall taste	12.58	12.33	0.576
Richness of the taste	12.08	12.08	1.000
Acid taste	1.67	1.42	0.475
Sweet taste	9.33	10.00	0.328
Pasteurised milk taste	8.92	8.33	0.582
Natural milk taste	11.58	12.17	0.498
Nonfresh milk taste	1.08	1.00	0.328
Atypical taste	1.33	1.17	0.582
Aftertaste	8.67	8.75	0.498

Conclusions

Replacement of non-extruded field beans with extruded in dairy cows rations, had positive effect on milk yield. The results of milk sensory properties, shown that non-extruded beans replacement with extrudedin dairy cows rations, had no negative influense on milk sensory parameters. Both groups (control and experimental) milk samples had no difference from each other by odour‘s intensity, every sample had an apparent milk‘s specific odour.

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