EFFICIENCY OF CONCENTRATED FEED EXTRUSION IN DAIRY COWS FEEDING

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Abstract

The cows were allotted into two groups according to the analogue principle (n=2×50). Lactation dairy cows were included in the trial in the initial lactation phase with the average milk yield of 30.73 kg per day, fat content 3.92 % and 3.16 % protein content in milk. During the extrusion process, the protein content decreased, including all the amino acids, at the expense of hydrolysis of starch, but the amount of glucose in the grain increased. The extrusion process was powerful enough to almost completely, i.e., on 99.9 %, reduce the total quantity of bacteria in grain, to halve the number of mould and to completely destroy yeast bacteria populations in grain samples. Within 150 days of study, milk yield in the experimental group of cows was approximately 0.91 to 1.27 kg higher than that in the control group of cows. In addition, the difference in yield in favour of the experimental cows showed a tendency to increase.

Key words: dairy cows, extrusion grain, milk

INTRODUCTION

The quality of a full value feed is strongly influenced by the manufacturing technology-the physical factors of processing (pressure and temperature of granulation, extrusion, etc.). The extrusion process under the influence of high temperature (140 - 150 ^{0}C) and pressure (4 - 4.5 atm.) affects important physical and chemical changes in the structure of grain starch-to the decomposition of starch to sugars.

Consequently, starch becomes more easily digestible and more fully used in the animal body. In the extrusion process, food sanitation occurs to some extent - high temperatures kill mould colonies and weed germination is reduced [1, 3]. Grain extrusion and feeding extruded feed to animals on farms would enable to organize manufacturing of a full value feed on industrial principles, appropriately using all existing feed resources on the farm.

The aim of the study was to investigate the extrusion of concentrated feed in feeding of dairy cows.

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MATERIAL AND METHODS

Trials were carried out on the farm "Udri", Pale Parish, Limbazi Municipality. For the trial, two analogue (according to yield, lactation phase, live weight, fat content and protein content) groups of 50 animals of Latvian Brown cows were used in the study. The trial was carried out from 01 December 2009 to 08 April 2010, i.e., 150 days.

The average live weight of cows was 550 kg, the mean age was 2.0 lactations. The cows of high productivity in the initial phase of lactation were included in the experiment with the average yield of 30.73 kg per day, fat content 3.92 % and protein content 3.16%. The dairy cows were kept in the same rearing and feeding conditions. The differences between the trial and control group in feeding were that for the trial group of cows the feed was composed of extruded barley and wheat grains while for the control group of cows unprocessed grain was used. During the trial, the dairy cows received the total feed mix (TMR) which consisted, calculating per cow per day of: 35 kg grass + legume silage (80.46% by mass), kg of beer brewers grain (4.59% by mass), 2 kg of sugar-beet pulp (dried) (4.59% by mass) 0.5 kg of treacle (1.17% by mass) and 4 kg (9.19% by mass) of farm made concentrated feed, which was composed of wheat+ barley+ oats+ triticale

(70% of the concentrated feed mix), maize (4% of the concentrated feed mix), soybean meal (16% of the concentrated mix), soybean meal (4% of the concentrated feed mix), salt (1% of the concentrated feed mix), soda (0.5% of the concentrated feed mix), mono-calcium phosphate (1% of the concentrated feed mix), lime flour (1% of the concentrated feed mix), mineral premix (2.5% of the concentrated feed mix).

The chemical composition of the total feed mix and the feeding value according to the data of agronomical analyses available at the Latvia University of Agriculture (LLU) were as follows: dry matter 46.06 %, in turn, dry matter contained 14.15 % of crude protein, 5.89 % of total ash, 21.71 % of crude fibre, 39.71 % NDF, 24.10 % ADF, 0.71 % Ca, 0.48 % P, but quantity of the net energy for lactation (NEL) in 1 kg of the feed dry matter was 6.69 MJ. In addition to the total feed mix, depending on the productivity, the cows received industrially-made complete feed of 250 g concentrated feed per kg of milk yield.

A full value nutrition analyses were conducted by the accredited Scientific Laboratory of the Agronomical Analyses under the Latvia University of Agriculture and the Chemical Analyses Laboratory of Animal Biochemistry and Physiology of Institute of Biology under the Agency of Latvia University. Chemical analyses of the feed samples was carried out in accordance with the ISO 6498: 1998 standards, but the amount of amino acids in the feed samples were determined using the ion exchange method in accordance with the pattern of protein hydrolysis with 6N HCl in an inert atmosphere of the automatic amino acid analyzer T 339 (Microtechna Praha) - AOAC Official Method 985 28, but the amount of glucose – was analysed in accordance with the Nelsen modified method.

The microbiological testing of feed samples was carried out by the Scientific Laboratory of Biochemistry and Microbiology under the Scientific Institute of Biotechnology and Veterinary Medicine "Sigra". The biometric data was processed using by the computer program MC Excel.

RESULTS AND DISCUSSIONS

The increased temperature for starch hydrolysis increased the glucose content in extruded grain. Individual grain chemical composition ratios are somewhat contradictory. Thus, for instance, crude fibber in the grain had to be partially hydrolyzed and sugar (glucose) content – had to be increased under the effect of the increased temperature and pressure.

However, the analysis data do not show a reduced amount of crude fibber in the extruded grain, although, the amount of glucose in the grain, on dry weight basis has increased almost eightfold. This was mainly due to starch hydrolysis. The amount and composition changes of amino acids in the grain mixture resulting from the extrusion process are presented in Table 2.

From the data presented in the chart, it is evident that due to the extrusion process, the amount of all the amino acids in the feed grain decreased. For some amino acids (aspartic acid, alanine, leucine, tyrosine, phenylalanine), it has been somewhat lower, for others (glutamic acid, proline, isoleucine, arginine), the reduction has been already significant.

Table 1 The chemical modifications of grain mixture resulting from extrusion, on dry matter basis

Indices	Before extrusion	After extrusion
Dry matter, %	90.32	95.82
Crude protein, %	13.66	13.52
Total ash, %	2.08	2.33
Crude fat, %	1.87	1.40
Crude fibber, %	3.55	4.79
NDF, %	15.85	14.52
ADF, %	4.24	5.90
NEL, MJ kg^{-1}	8.27	8.14
Starch, %	63.71	60.70
Glucose, %	0.29	2.25
Ca, %	0.04	0.09
P, %	0.43	0.43

The decrease of the amino acid content in this case is due to high temperature and pressure during the grain extrusion resulting in amino acid denaturisation. The feed, including grain contamination with harmful microorganism cultures for animals, can lead to serious animal illnesses.

Table 2 Changes in the amino acid content in the extruded grain mixture resulting from extrusion, g 100 g^{-1}

Amino acids	Grain mixture (before extrusion)	Grain mixture (after extrusion)
Aspartic acid	0.55	0.53
Threonine	0.13	0.10
Serine	0.26	0.23
Glutamic acid	2.47	2.06
Proline	0.99	0.69
Glycine	0.37	0.32
Alanine	0.31	0.27
Valine	0.23	0.17
Methionine	0.23	0.17
Isoleucine	0.24	0.16
Leucine	0.53	0.52
Tyrosine	0.14	0.12
Phenylalanine	0.21	0.20
Histidine	0.35	0.29
Lysine	0.25	0.21
Arginine	0.75	0.50
Total amount of amino acids	8.01	6.54

Therefore, grain processing with high temperature during extrusion, can serve as food sanitation and health preservation [2, 4]. Modifications of microbiological contamination resulting from grain extrusion process are presented in Table 3.

Table 3 The microorganism counts in grain sample, *CFU g^{-1}

Type of microorganisms	Before extrusion	After extrusion
Bacteria, in total	2000 $x10^7$	3 $x10^4$
Mould	200 $x10^4$	100 $x10^4$
Yeast fungi	700 $x10^4$	Have not been identified

**CFU-colony forming units per gram.*

From the data presented in the chart it can be concluded that the extrusion process has been powerful enough to almost completely (99.9 %) reduce the total quantity of bacteria in the grain, to reduce by 50 % the number of mould and to completely destroy the yeast fungi populations in grain samples. The cow productivity changes characterize both milk yield and milk composition (milk fat and protein) changes. The changes in milk yield and milk quality indices between the two groups of cows are presented in Table 4 and Table 5.

Table 4 Cow productivity during the trials, on average kg **ECM (n=2×50)

Group	Before the trials	During the trials	After the trials	±, compared the beginning
Trial	31.15±1.36	30.96±0.68	28.99±0.52	-2.16
Control	30.24±0.81	30.00±0.61	27.72±0.55	-2.52
±, compared the control	+0.91	+0.96	+1.27	-0.36

**ECM - energy corrected milk

As the trials of 150 days showed that, the milk yield in the experimental group of cows was approximately 0.91 to 1.27 kg higher than that in the control group of cows ($p<0.05$). In addition, the difference in yield in favour of the trial cows showed a tendency to increase.

Although the daily milk yield for both groups of cows is lower under a normal course of lactation, this decrease for the trial group of cows was 0.36 kg milk per day slower ($p<0,05$).

Table 5 Changes in milk quality indices during the trials, % (n=2×50)

Group	Milk indices	Before the trials	During the trial	After the trials	±, compared the beginning
Trial	Fat	3.93	3.89	4.03	+0.10
	Protein	3.29	3.10	3.23	-0.06
Control	Fat	3.86	3.88	4.11	+0.25
	Protein	3.33	3.29	3.31	-0.02
±, compared the control					
Fat		-0.18	+0.07	+0.01	-0.08
Protein		-0.03	-0.04	-0.19	-0.08

There were no changes in the milk composition (milk fat and milk protein) observed. The economic efficiency is a key criterion for determining the benefit of one or another feed product fed out.

Table 6 Milk and feed costs for a cow during the trial of 150 days

Indices	Trial group	Control group	Compared the control
Milk obtained, kg	4624.7	4473.8	+151.9
Milk value, LVL	809.5	782.92	+26.58
Consumed feed value, LVL	297.00	279.00	+18.00
Benefit, LVL	512.50	503.92	+8.58

The milk sale and feed cost summary records for the trial that lasted 150 days show that the economic efficiency of extruded grain feeding has been positive. Each group of cows, which was fed with extruded grain, despite the relatively high extrusion cost, gave on average 8.58 LVL higher milk output than the cows in the control group.

CONCLUSIONS

1. During the extrusion period the protein amount decreased, including the content of all the amino acids at the expense of starch breakdown, and the amount of glucose in the grain increased.

2. During the trial, the experimental cows yielded from 0.91 to 1.27 kg more milk than the control group of cows. Feeding extruded grain to cows helped to better maintain the level of milk yield during lactation than in the control group of cows.

3. During the extrusion process, the total amount of bacteria and mould decreased in the grain, and the yeast fungi were completely destroyed.

4. The economic effectiveness extruded grain was positive. Each cow in the experimental group gave on average 8.58 LVL higher milk production than the cows in the control group.

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