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Comparison of Compound Feed and Sunflower Expeller as a Supplement to Autumn Pasture for the Dairy Cows

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Abstract

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Twenty dairy cows divided in two equal groups, 10 cows each, were used in short term Latin square experiment to test two type of supplements. All cows grazed the same natural hilly pasture containing 9% crude protein in dry matter during experimental period, lasting from 18 August to 23 September in 2006. The first supplement was 6 kg of compound feed with 15% crude protein, and the second one was 5 kg of sunflower expeller with 26% crude protein. The cows supplemented with sunflower expeller during grazing on a low protein natural pasture had higher milk yield, compared to cows receiving as a supplement compound feed. There was tendency of increasing fat percentage of milk, and significant ($P<0.05$) higher percentage of protein in milk of the cows supplemented with sunflower expeller, than those receiving compound feed. Urea content of milk was higher in cows supplemented by sunflower expeller. There were not significant differences in fatty acid profile of milk fat depending on type of supplementation. However trends exist for increase of long chain fatty acids and conjugated linolic acid in milk of cows receiving sunflower expeller.

Key words: dairy cows, low protein pasture, supplementation, sunflower expeller, compound feed, milk yield, milk composition, fatty acid profile
Abbreviations: CF – Compound Feed; SE – Sunflower Expeller; CP – Crude Protein; MF – Milk Fat; FA – Fatty Acids; DM – Dry Matter; FUM – Feed Units for Milk; BCS –Body Condition Score; CLA – Conjugated Linolic Acid

Introduction

The content of CP of natural pastures in our country is comparatively low (Cheshmedjiev and Djarova, 1984; Todorova, 1998) and the main reason for this is the presence of small amount of legumes in the sward (Todorova, 1998; Todorova and

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Chourkova, 1998; Mishinev and Popov, 2000; Todorov, 2001; Ali, 2006). Summer high temperature also influences negatively composition and digestibility of grasses (Fales, 1986; Buxton and Fales, 1994).

Detailed five years analysis of economic results of 18 farms was made by one of the authors of this article (Ali, 2006). In those farms dairy cows and beef cattle had been kept in pasture conditions in the region of Central Balkan Mountains. Productivity level of animals and the economic results in the farms, using grain or CF with 15% CP for supplementation, were unsatisfactory. Considerably better results were gained in the farms in which rich in protein feeds were used as supplement to pasture. The author concluded that the protein level in the supplement, while cattle were grazed in the studied region of the country was of determining importance for the production and economic results (Ali, 2006). As far as this conclusion was based on observations in different farms the effect of other not control factors was also possible. However, this so important economic conclusion should be confirmed in totally equal conditions of rearing animals.

The aim of this experiment was to study effect of replacing compound feed with sunflower expeller as supplements to autumn pasture on milk yield and composition in dairy cows.

Materials and Methods

Animals and scheme of experiment. The experiment was conducted with two groups, 10 cows each, using Latin square scheme. In both groups two cows were from Holstein Frisian breed crosses and the rest were crosses of the Brown Cattle breed. The cows were assigned into different groups according to their age, live weight, date of calving, level of milk production, protein and fat content of the milk at the beginning of experiment. The BCS in five score system was evaluated (Todorov et al., 1999) at the beginning and at the end of the experiment.

In the barn cows from both groups were held tied and fed individually. From 8.30 in the morning till 6 in the afternoon they grazed on natural hilly pastures situated near to the farm (maximal distance 4.5 km). The pastures contained mainly grasses and only 5.6% legumes. Pasture availability during the experimental period from 18 August to 23 September in 2006 was insufficient to meet the requirements for maintenance and milk production. After the rainfalls in summer and autumn some new growth of grass was observed.

Cows were machine milked in bucked two times daily in the morning and in the evening after returning to the barn. The milk production was controlled individually at each milking for the whole experiment.

The effect of supplementation with two types of concentrates was studied: 6 kg compound feed (CF) containing 15% CP and 5 kg sunflower expeller (SE) containing 26% CP. Both feeds were given twice daily in the morning and in the evening. The compound feed provided daily intake of 6.36 feed units for milk (FUM) and 906 g CP, and the sunflower expeller – 5.4 FUM and 1295 g CP.

Cows receiving SE were additionally supplemented with vitamins and minerals premix. The premix provided daily 60 000 IU vitamin A, 12 500 IU vitamin D, 400 mg Irons, 400 mg Magnesium, 500 mg Manganese, 60 mg Copper, 500 mg Zinc, 4 mg Cobalt, 4.5 mg Iodine and 1.5 mg Selenium. Quantity of vitamins and trace minerals in the premix is approximately equal to intake of vitamins and trace elements by the compound feed. The scheme of the trial is shown in Table 1.

Before experimental period animals grazed on the same pasture and were offered the same amount (6 kg) of CF. Chemical composition of pasture grasses and two supplements are presented in Table 2.

Analytical and statistical methods. Analysis of feeds was carried out according to the Weende-method as the description of Krusteva et al. (1983). Milk composition was determined by Milcoscan 103 (ElectroInstr, Koldak, Danmark). Milk fat was extracted with mix of diethyl and petrol ether, and methylated by sodium methylate according to Hartman and Lago (1979) and fatty acids was separated on gas chromatograph Pay Unicam 304 with flame ionizing detector, hand injection system and glass column. Temperature of injection was 210 ^{0}C, of detector 250 ^{0}C, in column 80 ^{0}C and after 2 min. increased by 10 ^{0}C/min. until 190 ^{0}C and

Table 1

Scheme of the experiment, periods and type of supplementation

Experimental periods and duration	Group I	Group II
Preliminary period, 3 days	CF*	CF
Transition period, 7 days	SE**	CF
First experimental period, 11 days	SE	CF
Transition period, 7 days	CF	SE
Second experimental period, 11 days	CF	SE
Transition period, 7 days	CF	CF
Closing period, 3 days	CF	CF

*CF - 6 kg compound feed

**SE - 5 kg sunflower expeller

Table 2

Chemical composition of pasture grass and supplements

Indices, %	Pasture grass		Compound feed	Sunflower expeller
	Period I	Period II		
Moisture	66.10	63.00	11.90	10.20
Dry matter composition:				
Crude protein	9.05	9.34	17.14	28.84
Crude fat	2.21	2.02	3.83	13.66
Crude fiber	27.78	27.51	7.30	29.45
Nitrogen free extracts	52.86	53.29	67.77	21.17
Ash	8.10	7.84	3.96	6.88
Calcium	0.73	0.70	0.71	0.34
Phosphorus	0.24	0.22	0.59	0.66

elusion of linolenic acid. External standard was used for determination of the quantity of separate fatty acids using integrating device Mega (Carlo Erba). Urea in milk was determined according to the method of Angelov et al. (1999). The significance between the average values of different indices was determined with t-test, using the software Statistica (2001).

Results and Discussion

Milk production during the first trial period was significantly higher of cows supplemented with 5 kg sunflower expeller (SE) in comparison with cows supplemented with 6 kg compound feed (CF) (Table 3). Milk yield of both groups was equal during the preliminary period so the established difference was due to the supplementation.

In the second trial period, after exchange of supplements, again the cows consumed SE had higher milk yield, than those fed with CF. However, during this period the difference was lower (0.56 kg/daily, versus 1.27 kg/daily during first period of the trial) and was insignificant (P>0.05).

After summarizing data for same diet in the two experimental periods average milk yield is higher by 0.92 kg for cows supplemented with SE, compare to those receiving CF (Table 4).

The smaller reaction of cows to the supplementation of SE in the second pe-

Table 3

Average daily milk yield of experimental groups, kg

Period of experiment	Group I		Group II	
	Supliment	Milk yield	Supliment	Milk yield
Preliminary period	CF#	9.23	CF	9.29
Transition period	SE##	9.20	CF	8.74
First experimental period	SE	8.88	CF	7.61*
Transition period	CF	7.97	SE	7.39
Second experimental period	CF	7.31	SE	7.87

\# 6 kg compound feed with 15% CP

\## 5 kg sunflower expeller + premix

* Difference between groups is significant (P<0.05)

Table 4

Effect of supplementation on average daily milk yield, kg

Period of experiment	Sunflower expeller	Compound feed
First experimental period	8.88	7.61*
Second experimental period	7.87	7.31
Average of two periods	8.38	7.46*
Percent of suflower expeller	100	89

* Difference between two supplements is significant (P<0.05)

riod can be explained with the stage of lactation of cows. Applying the two supplements to the same group of cows during the trial contributed to avoid the possible side effects on productivity.

The positive effect of supplementation with SE can be explained firstly with the increased level of protein in the diet, compare to supplementation with CF. The increased consumption of pasture grass when giving SE was also of considerable importance. This was established in the same experiment by Todorov and Ali (2007).

The average milk yield of cows was relatively low – from 7.5 to 9 kg. However, it was nearly the same as the average per cow and year (3166 kg), for the cows kept predominantly on pastures, in this region (Ali, 2006). Another reason for the low milk yield was the late stage of lactation – average for the two groups 187 days after calving.

Daily milk yield throughout the observation period is presented in Figure 1. Tendency of decreasing of milk yield was observed which was typical for progress of the lactation. Certain increase of milk yield was observed in the first group when CF was replaced with SE and to some extent in the second group and deviation from the normal lactation curve was observed.

Milk composition for the groups by periods was shown in Table 5. Tendency of increase of milk fat content was observed while pasture was supplemented with SE. The reason for this effect can be explained with several facts. First, the animals consumed more grass aiming to compensate the less energy in the supplement feed (5.4 FUM/daily, versus 6.36 FUM/daily when CF where given). Furthermore, it was determined that the intake of SE leaded to increase of grass digestibility (Todorov and Ali, 2007). Higher forage intake in general lead to increase of fat content in milk (Sutton, 1989). Secondly, the higher content of fat in SE in comparison with CF probably had also affected the level of milk fats. It is well known that small increase of fat in the ration lead to transfer of more fatty acids from food to milk (Palmquist and Jenkins, 1980; Storry, 1981; Palmquist, 1984; Banks et al., 1984; Sutton, 1989). In this experiment cows consumed 613 g fats with SE, and 202 g fats with CF. Average for the two trials, a significant increase ($P<0.05$) was found in the content of the protein and dry matter of milk when the supple-

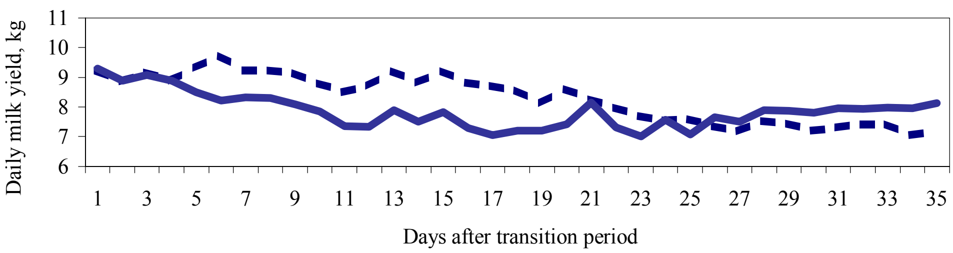

Fig. 1. Dynamic of milk yield during experimental period. Broken line is for I group received from 1 to18 day sunflower expeller, and from 19 to 35 day compound feed. Solid line is for II group received from 1 to 18 day compound feed, and from 19 to 35 day sunflower expeller

Table 5

Average chemical composition of milk by groups and experimental periods, %

Groups	Period of experiment	Supplement	Dry matter	Protein	Fat	Lactose
I	Preliminary period	CF#	12.13	3.34	3.54	4.65
	Transition period	SE##	12.09	3.36	3.44	4.72
	First experimental period	SE	12.34	3.47	3.61	4.67
	Transition period	CF	12.08	3.38	3.45	4.62
	Second experimental period	CF	12.09	3.47	3.47	4.55
	Closind period	CF	12.40	3.44	3.58	4.77
II	Preliminary period	CF	12.19	3.23	3.55	4.80
	Transition period	CF	12.21	3.23	3.61*	4.78
	First experimental period	CF	12.38	3.33*	3.72	4.74
	Transition period	SE	12.38*	3.35	3.79*	4.64
	Second experimental period	SE	12.50*	3.54	3.76*	4.62
	Closind period	CF	12.60*	3.58*	3.67	4.77

6 kg compound feed, ## 5 kg sunflower expeller

* Difference between group I and group II during the same period of the experiment is significant (P<0.05)

Table 6

Effect of two types of supplements on milk composition (average data of the two experimental periods)

Constituent of milk	Sunflower expeller	Compound feed
Dry matter, %	12.42	12.24*
Protein, %	3.51	3.40*
Fat, %	3.69	3.60
Lactose, %	4.65	4.65
Urea in milk, mg/dl	17.78	13.71*

*Difference between two supplements is significant (P<0.05)

mentation with CF was changed with SE (Table 6). There is some increase of fat content of milk from cows receiving SE, but significance is low (P= 0.07).

Urea in the milk of the cows supplemented with SE was significantly (P<0.05) higher compared to the levels in the milk of animals receiving CF (Table 6). This may be explained with higher protein content in the diet of cows supplemented with SE.

Fatty acids composition of milk fat was similar in cows supplemented with both types of concentrate (Table 7). Trend of increase of long chain fatty acids at the expense of short and medium chain fatty

Table 7

Fatty acids in milk as percent of total quantity #

Fatty acids	Supplementation with sunflower expeller			Supplementation with compound feed		
	Experiment I	Experiment II	Average	Experiment I	Experiment II	Average
C4	3.65	3.70	3.67	4.06	3.70	3.88
C6	3.00	3.11	3.05	3.12	3.03	3.07
C7	0.10	0.13	0.12	0.14	0.15	0.14
C8	1.79	1.84	1.82	1.82	2.00	1.91
C9	0.16	0.14	0.15	0.15	0.17	0.16
C10	3.05	2.87	2.96	3.17	3.08	3.13
C10:1	0.16	0.13	0.15	0.15	0.13	0.14
C12	3.07	2.96	3.01	3.30	2.86	3.08
C14	9.10	9.18	9.14	9.37	9.15	9.26
C14:1	0.26	0.36	0.31	0.28	0.32	0.30
C14:2	0.15	0.17	0.16	0.21	0.19	0.20
C15ai*	0.29	0.36	0.32	0.37	0.33	0.35
C15	0.56	0.64	0.60	0.55	0.47	0.51
C16i**	0.15	0.09	0.12	0.11	0.12	0.12
C16	31.42	27.60	29.51	31.15	28.43	29.80
C16:1	0.47	0.31	0.39	0.35	0.35	0.35
C16:2	0.27	0.24	0.26	0.27	0.21	0.24
C17ai	0.25	0.21	0.23	0.29	0.20	0.24
C18	9.15	9.59	9.37	8.69	8.25	8.47
C18:1	27.22	29.55	28.39	26.32	30.31	28.32
C18:2	2.65	3.24	2.95	2.79	3.56	3.17
C18:3	1.42	1.75	1.58	1.49	1.29	1.39
CLA	0.69	0.65	0.67	0.57	0.48	0.52

*anteiso ;**iso ; CLA -conjugated linolic acid

Difference between two suplements are not significant (P>0.05)

acids was observed when the cows were supplemented with SE (Table 8).This can be explained with the intake of more fats (Khorasani et al., 1991; Peterson et al., 2002; Kay et al., 2004).

The content of CLA was higher when cows were supplemented with SE in comparison with supplementation with CF. Difference is close to significance (P= 0.08). This is in conformity with the observed by Peterson et al. (2002) and Kay et al. (2004) increase of CLA when plant fats were supplemented to the diet.

Body condition score (BCS) was improved in all animals over the observation period (Table 9) but it was impossible to

Table 8
Percentage of fatty acids of the different groups #

Group of fatty acids	Supplementation with sunflower expeller			Supplementation with compound feed		
	Experi-ment I	Experi-ment II	Average	Experi-ment I	Experi-ment II	Average
Short chain	11.91	11.92	11.92	12.61	12.26	12.43
Medium chain	46.96	43.30	45.13	47.53	43.85	45.70
Long chain	41.13	44.78	42.95	39.86	43.89	41.87
Saturated	66.71	63.60	65.14	67.57	63.16	65.37
Nonsaturated	33.29	36.40	34.86	32.43	36.84	34.63
Branshed chain	1.66	1.84	1.75	2.05	1.87	1.96
Conjugated linolic acid	0.69	0.65	0.67	0.57	0.48	0.52

Differences between two suplements are not significant ($P > 0.05$)

Table 9
Changes in body condition score (BCS) during the experiment

Indices	Group I	Group II
BCS at the beginning of the preliminary period	2.74	2.78
BCS at the end of the closing period	2.88	2.90
Difference	0.14	0.12

find any substantial between groups differences.

Improving of the BCS showed that the energy intake is sufficient. On the other hand cows were in second period of lactation and it was expected their body reserves to be restored. The intake and digestibility of pasture are presented in another paper. (Todorov and Ali, 2007) and showed that energy intake was above the requirements for maintenance, lactation and pregnancy.

Conclusions

Supplementation of late summer and autumn natural pasture with 9% crude protein in DM with sunflower expeller (26% crude protein) lead to the increase of milk production with 11% in comparison with supplement of compound feed (15% crude protein). The ration with sunflower expeller is better balanced with protein and lead to significant increase ($P< 0.05$) of protein in milk. There is tendency for increase in milk fat content when pasture was supplemented by high fat sunflower expeller.

Fatty acids profile was not substantially influenced by the type of supplement. There is a trend conjugated linolic acid and long chain fatty acids to increase when high fat sunflower expeller supplementation was applied.

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