ELECTRONIC JOURNAL OF POLISH AGRICULTURAL UNIVERSITIES

2000
Volume 3
Issue 2
Series
ANIMAL HUSBANDRY

SZULC T. 2000. EFFECTIVENESS OF MINERAL-FAT (PMT) SUPPLEMENT IN FEEDING HIGH YIELD COWS IN THE FIRST STAGE OF LACTATION **Electronic Journal of Polish Agricultural Universities**, Animal Husbandry, Volume 3, Issue 2.
Available Online http://www.ejpau.media.pl

EFFECTIVENESS OF MINERAL-FAT (PMT) SUPPLEMENT IN FEEDING HIGH YIELD COWS IN THE FIRST STAGE OF LACTATION

Tadeusz Szulc
Department of Cattle Breeding and Milk Production, Agricultural University of Wrocław, Poland

ABSTRACT

From the second week after calving to the 120th day of lactation a mineral-fat (PMT) supplement was used in feeding high yield cows; group I - 1.1 kg, group II - 0.8 kg daily per animal. In the first four months of lactation, a statistically significant higher daily milk yield was noted from cows from the experiment groups as related to those from the control group (ca. 1.5 kg daily). In the group where the dose of the supplement was lower, the amount of lactose and fat in milk was significantly higher (0.29%). This resulted in a higher FCM milk yield (ca. 2.60 kg daily). No significant influence of PMT on other milk components, its technological parameters, content of fatty acids nor the biochemical parameters of the serum of the cows was noted. The analysis of yield and the

PRINT

parameters of milk and blood indicates that the amount of PMT in the daily feed doses should not exceed 0.8 kg per animal.

Key words: milk cows, mineral-fat (PMT) supplement, lactation, feeding

INTRODUCTION

In feeding high yield cows, from the second week after calving to the 120^{th} day of lactation, PMT supplementation was used; group I - 1.1 kg, group II - 0.8 kg/cow/day. In the first four months of lactation, there was noted a statistically significant higher daily milk yield from cows in the experiment group as compared to the control group, reaching ca. 1.5 kg/day. In the group where the dosing of preparation was lower, there was a significant increase of lactose and fat content in milk (0.29 %). The yield of FCM milk in this group was 2.60 kg/day higher. No significant influence of PMT on the content of other components in milk was noted. Its technological parameters, fatty acids content and biochemical parameters of the serum of cows' blood were also not changed.

Most researchers who introduced fat additives to the feeding of high yield cows arrived at higher milk productivity and fat content noting at the same time lowered content of protein in milk (2, 17, 24, 28, 32). Ruminants used the fat added most effectively when it was in form of calcium or magnesium soaps (4, 5, 10). Most unsaturated fatty acids undergo lipolisis and hydrogenation in the rumen, which lowers their effectiveness

Overdosing of fats may bring about a lower number of protozoa and cellulolitic bacteria at a general increase of the number of bacteria in the rumen, which causes a lowered content of protein in milk (4, 12, 22, 29, 34) and lowered digestion of fibre (1, 16, 22). An increased content of stearic and oleic acids in milk of cows fed with fat additives was noticed (19, 25, 27).

An addition of bentonite and humocarbovite may increase the use of feed (7, 8, 21). Aluminosilicates present in bentonite play the role of moderators of the processes in the rumen and positively affect the digestive processes, whereas montmorillonite influences its buffering characteristics (26). While absorbing the surplus of ammonia in the rumen, bentonite causes a better use and retention of nitrogen (3, 7, 8). According to Mendel (21), bentonite may also positively influence the use of minerals and metabolism of some cations. Bentonite is supposed to influence the processes of bacterial synthesis of vitamins in the rumen. It was observed that bentonite improves the growth rate of fattening cattle, brings about higher milk production and fat content in milk (26).

The research was conducted in order to asses the changes in the yield, content and technological quality of milk from cows in the first 120 days of lactation receiving a mineral-fat supplement based on refined rape oil and bentonite and humocarbovite as carriers.

MATERIALS AND METHODS

The research was conducted on ncb milk cattle with an average milk yield of 6.000 kg per cow. The animals were selected based on analogues, depending on their yield in the 6^{th}-7^{th} day after calving. The difference between the yield in the groups was under 0.2 kg and was not statistically relevant. 55 cows were selected for the research and placed in three groups (table 1): I - with a daily PMT supplementation at 1.1 kg; II with a daily PMT supplementation at 0.8 kg; III - control group.

Table 1. Scheme of the experiment

Specification	Cow groups		
	I	II	III
Number of cows under investigation	17	19	19
Daily nutrition contents:			
- energy MJ NEL	70.1	70.1	70.1
- crude protein	1388	1388	1388
Daily PMT supplementation, kg	1.1	0.80	0.0

The research was conducted during the period of winter feeding based on the DLG norm (35). Maize silage, sugar beet top silage, crop decoction and grass hay constituted the base of feed doses. The feed composition was analysed by a lab (table 2).

Table 2. Feed chemical composition (%)

Specification	Dry matter	Crude protein	Ether extract	Crude fibre	Ashes	MJ NEL
Maize silage	23.77	2.19	0.70	4.35	3.22	1.36
Sugar beet top silage	14.66	2.74	0.60	2.66	3.77	0.97
Grass hay	84.16	10.54	2.67	22.11	6.2	4.59
Gram distillers soluble	8.5	1.7	0.6	0.9	0.4	0.41
Concentrate mixture	87.32	18.30	1.56	1.94	0.48	6.70

1 kg of nutritive fodder was used for every 2 litres over 11 kg per day

The doses of bulky feed were sufficient to cover the growth needs and guarantee a daily yield of milk of 11 kg. The bulky feed was administered to groups and the PMT supplement individually. The mineral-fat supplement was administered twice a day, from the 6th-7th to 120th day after calving, as a special additive not changing the regular doses of feed.

The mineral-fat supplement is a product consisting of waste plant fats mixed with bentonite acting as a carrier (80%), humocarbovite (20%) and Endox (antioxidant). The mixture consists of 22% of raw fat, 53% of ashes - including 50% of ashes insoluble in 10% HCl. Unsaturated fatty acids constitute the main part of the raw fat (75 - 80%) and from among saturated acids there is palmitic acid (20 - 25%). Among mineral components, silica constitutes 40%, aluminium oxide 7%, iron 0.03%, calcium 0.24%, sodium 0.22% and magnesium 0.38%. The content of toxic metals is within the norm of acceptable, maximum concentration.

For four consecutive months of lactation, the milk yield was controlled in all the cows, and the Milco Scan ASN Foos Elektric 133 B apparatus was used to measure the content of fat, protein, lactose and dry matter in milk samples. A thermolactodensimeter was used to determine the mass density; the Wolker formaldehyde method was used to measure casein content; a BRAN LUEBBE autoanalyser was used to measure urea content; a Fossomatic apparatus was used to define the number of somatic cells and a Dramiński apparatus was used to measure the current resistance of milk. An alcohol test was conducted to measure the thermostability of milk.

From 8 cows from each of the groups blood samples were taken once, between the 35th and 60th day after calving. A Kodak EKTACHEM DT 60 autoanalyser was used to mark the albumen, content of glucose, urea, cholesterol, ketone bodies, calcium, inorganic phosphorus and magnesium in serum. Milk samples were taken from the same cows and the content of fatty acids in milk fat was analysed through the gas chromatography method using a Packard apparatus and a Supelco supelcovax capillary column 10.30 x 0.53 x 1 mm.

The results obtained were statistically analysed; the mean values, standard deviation and relevance of differences between groups were calculated based on a single-agent variant analysis using a Duncan test.

RESULTS AND DISCUSSION

Statistically, the higher milk yield from experiment cows in the first months of lactation (table 3) supports the observation of other researchers and indicates a positive influence of fat supplementation on milk yield in the period of high milk productivity (1, 2, 17, 28, 31, 32). A mean difference in milk yield (almost 1.5 kg) and, especially FCM yield (1.53 and 2.60 kg) significantly exceeds the energetic value of fat administered (ca. 2 MJ NEL), which indicates a positive influence of bentonite in the supplement and an improved energy distribution in the animals. Zalewska et al. (33), Slonina et al. (26) arrived at a higher milk yield from cows receiving a bentonite additive. Dembiński et al. (7) proved additionally a positive effect of bentonite on the alimentary canal diseases of calves. Thus, a combination of post-refining fat wastes and bentonite proved beneficial for the productivity of milk cattle. A lower increase of yield in cows receiving 1.1 kg of supplement may indicate that the dose was too high. Abel et al. (1) and Szulc et al. (30), who used fat as an energy supplement and not as an energy substitute, arrived at a statistically significant increase of FCM milk yield and, at the same time, lower protein content in milk.

Table 3. Mean daily milk yield and chemical composition 1-4 months of lactation

Specification		Groups		
		I	II	III
Milk yield, kg	$\bar{x}$	25.51 b	25.60 b	24.01 a
	sd	4.63	5.09	4.97
Fat , %	$\bar{x}$	4.30 b	4.60 a	4.31 b
	sd	0.48	0.55	0.69
Protein, %	$\bar{x}$	3.25 a	3.40 b	3.40 b
	sd	0.25	0.25	0.29
Lactose, %	$\bar{x}$	4.87 a	4.97 b	4.85 a
	sd	0.29	0.23	0.28
Dry matter, %	$\bar{x}$	13.11 b	13.67 a	13.25 b
	sd	0.71	0.68	0.85

PRINT

Casein, %	$\bar{x}$	2.42 a	2.53 b	2.53 b
	sd	0.24	0.28	0.25
Milk yield FCM, kg	$\bar{x}$	26.57 b	27.64 a	25.04 b
	sd	4.78	5.93	5.53
Urea, mg/dl	$\bar{x}$	10.09	10.24	10.22
	sd	3.76	4.02	3.41
Zn, mg/l	$\bar{x}$		3.143	4.510
Cu, mg/l	$\bar{x}$		0.127	0.153
Se, mg/l	$\bar{x}$		0.010	0.010
Pb, mg/l	$\bar{x}$		0.043	0.022
Cd., mg/l	$\bar{x}$		0.010	0.010

ab - different superscripts within rows show significant differences at ($P \leq 0.05$).

The statistically higher fat content in milk from cows from Group II may have resulted from an accumulation of the positive effects of the fat providing high yield cows with concentrated energy and of bentonite. It may also have resulted from a direct inclusion of some of the long-chain fatty acids from the supplement to the fat of milk, which saved energy usually used for their creation (20, 23). Other researchers noted a low increase of fat content in milk when fat supplement was used (2, 17, 27), whereas Sklan et al. (28) did not observe any changes in fat content in milk from cows which received fat supplement with feed. Similar percentage of fat content in Group I and in Control Group indicates a lack of stimulating effect of the supplement when doses are higher.

The statistically lower percentage of protein in milk from cows from Group I indicates (as presented by many researchers; 1, 2, 4, 12, 19, 31, 32, 34) that an increased content of unsaturated fatty acids in the doses lowers the content of the protein of microorganisms. Wu and Huber (32) suggest that it may be due to a less economic use of aminoacids for the synthesis of the protein of milk in milk gland. When the doses of supplement were lower, the percentage of protein was not changed in relation to that of the control group.

The lower level of lactose in the control group may have resulted from a smaller amount of energy used for the production of every litre of milk. The statistically significant higher level of lactose in Group III may have resulted from a better use of energy and use of a part of glucose to produce lactose. The statistically significant higher content of dry matter in milk from cows from Group II ($P \leq 0.05$) resulted from a higher content of fat and lactose in milk from these cows.

Low content of urea and high content of fat in milk from cows from the experiment and control groups indicates a well-balanced energy/protein composition of the feed, which is proved by other researchers (6, 9, 13).

The content of toxic metals in milk was within the norms (table 3), which indicates that an addition of PMT did not result in an increased content of these metals apart from lead, whose increased content was not statistically significant. Similarly, Kreuzer et al. (18) did not observe an influence of the feed composition on the content of Zn, Fe, Cu and Mn in milk.

Higher thickness of milk from cows from Group II resulted from a higher content of protein and lactose (Table 4). A similar level of current resistance of milk from each of the quarters of the udders indicates good health of the milk glands of the cows under research. A significantly lower amount of somatic cells in milk from cows from Groups I and II indicates a higher immunity of the udders. Similarly, Jahreis et al. (11) showed that when fats are used, the content of vitamin E is higher and amount of somatic cells in milk is lower, which may indicate a health improvement of the milk glands.

Table 4. Physical traits, technological parameters and number of somatic cells in milk

Specification		Groups		
		I	II	III
Density, ° LD	$\bar{x}$	29.3	29.8	29.6
	sd	1.3	1.8	1.3
Thermostability	$\bar{x}$	6.53	6.02	6.31
	sd	2.3	2.2	2.7
Current resistance of milk:				
A - left head quarter	$\bar{x}$	302.8	303.6	314.9
	sd	47.5	23.3	40.2
B - right head quarter	$\bar{x}$	306.8	305.6	313.6
	sd	35.0	44.3	37.9
C - left hind quarter	$\bar{x}$	304.0	313.9	303.8
	sd	41.4	43.2	45.0
D - right hind quarter	$\bar{x}$	306.0	328.6	297.4
	sd	39.8	38.4	43.6
Number of somatic cells:				
<300.000, % of cows	$\bar{x}$	58.1	59.5	33.7
300.000 - 500.000, % of cows	$\bar{x}$	10.8	8.3	14.1
>500.000, % of cows	$\bar{x}$	31.1	32.2	52.2

The biochemical parameters of blood of the cows from all groups (Table 5) were within physiological norms (Kłopocki and Winnicka, 15). The content of calcium, phosphorus and magnesium in blood indicates their proper supply in feed. Rahnema et al. (24) show that a supply of fat in the form of soaps and plant fats lowers the absorption of Ca and Mg in the intestine, which may bring about a lowered level of these components in blood. This could be altered thanks to the presence of Ca and Mg in bentonite and humocarbovite. Most biochemical parameters of blood from the cows receiving higher doses of PMT were lower as related to the control group. Despite the lack of statistical significance of the differences, it may be assumed that a dose of 1.1 kg of PMT is too high for the cows.

The lack of statistically significant differences in the content of fatty acids in the fat from the milk from the cows under research may result from a considerable lipolisis and hydrogenation of the fatty acids from the supplement taking place in the rumen and their lowered transfer to milk.

Table 5. Biochemical blood metabolites in cows

Specification		Groups		
		I	II	III
Glucose	$\bar{x}$	2.78	2.85	2.85
	sd	0.44	0.31	0.14
Urea	$\bar{x}$	3.2	3.60	3.35
	sd	0.62	0.19	0.25
Total protein	$\bar{x}$	75.81	72.51	79.26
	sd	5.6	6.1	5.6
Calcium, mmol/l	$\bar{x}$	2.30	2.42	2.42
	sd	0.14	0.04	0.27
Phosphorus inorg., mmol/l	$\bar{x}$	2.12	2.11	2.18
	sd	0.47	0.36	0.29
Magnesium, mmol/l	$\bar{x}$	1.06	1.01	0.99
	sd	0.06	0.10	0.15
Total cholesterol, mmol/l	$\bar{x}$	5.00	5.31	5.90
	sd	1.1	1.0	0.8
Ketone, mmol	$\bar{x}$	277.5	314.8	321.8
	sd	65.1	115.9	97.3

ab - different superscripts within rows show significant differences at ($P \leq 0.05$).

The research indicates that the use of mineral-fat supplement in feeding milk cattle after calving significantly increases the yield of milk and its components in the first four months of lactation. The overall analysis shows that a maximum daily dose of the supplement used in feeding milk cows should not exceed 0.8 kg per cow.

PRINT

REFERENCES

1. Abel H., Mooren T., Meyer U., 1993 - Physiologische Grundlagen der Fettfütterung beim Wiederkäuer. Institut für Tierphysiologie und Tierernährung der Universität Göttingen (Mimeograph).
2. Bielak F., Wawrzyńczak S., Kraszewski J., Wawrzyński M., Kozłowski J., 1993 - A supplement of fodder fat Erafet to cow´s diet versus milk yield and composition, and selected blood components. Rocz. Nauk. Zoot., 20, 171 -181 (in Polish).
3. Britton R., A., Colling D., P., Klopfenstein T., J.,1978 - J. Anim. Sci., 46, 1738.
4. Brinkmann J.H.; Abel H.,1992 - Wirkungen verseiften, veresterter und freier Fettsäuren auf die Entwicklung der Mikrobenpopulation in kontinuierlichen Kulturen sowie auf die Nährstoffverdaulichkeit und Futterpartikelpassage bei Schafen. J. Anim. Physiol. Anim. Nutr., 68, 174-184.
5. Burgstaller G., Klein F., 1989 - Zum Einsatz von "kristallinem" Futterfett in der Anfangslaktation der Milchkuhe. Kraftfutter, 72, 306-308.
6. Ciszuk P.; Gebregziabher T., 1994 - Milk urea as an estimate of urine nitrogen of dairy cows and goats. Acta Agric. Scand, Sect. A, Anim. Sci., 44, 87-95.
7. Dembiński Z., Więckowski W., Saklińska A., 1985 - The use of Polish bentonite in treatment of alimentary canal diseases in newborn calves. Medycyna Wet., 6, 359 - 362.
8. Dembiński Z., 1985 - Bentonite in cattle feeding. Medycyna Wet., 3, 197 - 198.
9. Gustafsson A.H., Palmquist D.L., 1993 - Diurnal variation of rumen ammonia, serum urea, and milk urea in dairy cows at high and low yields. J. Dairy Sci., 76, 475-484.
10. Hermansen J.E., 1989 - Feed intake and milk yield and milk composition by replacing unprotected fat by Ca - soap for dairy cows., Anim. Feed. Sci. Technol., 22, 193-202.
11. Jahreis G., Richter G.H., 1993 - Flachowsky G.: Auswirkungen von Rapssaat in der Milchkuhfütterung auf den vitamin A und E gehalt des Milchfettes. (Mimeograph).
12. Jilg T., Aiple K.,P., Steingass H., 1988 - Fettsstoffwechsel und Wirkungen von Futterfetten beim Wiederkäuer. Übers. Tierernähr., 16, 109-152.
13. Kirchgessner M., Paulicki B.R., Kreuzer M., Kaufmann T., Roehrmoser G., Schwarz F.J., Roth-Maier D.A., 1986 - Urea content of dairy milk for diagnosig inadequate protein and energy supply. Z. Tierernähr. Tierphysiol. Futtermittelk., 53, 3, 154-155.
14. Klausmeyer T.H., Lynch G.L., Clark J.H., 1991 - Effects of calciumsalts of fatty acids and protein source on ruminal fermentation and nutrient flow to duodenum of cows. J. Dairy Sci., 74, 2206 - 2220.
15. Kłopocki T., Winnicka A., 1987 - Common values of basic laboratory tests. Warsaw Agric. Univ. Press., pp., 43.
16. Kowalczyk J., Orskov E.R., Robinson J.J., Stewart C.S., 1977 - Effect of fat supplementation on voluntary food intake and rumen metabolism in sheep. Brit. J. Nutr., 37, 251-257.
17. Kraszewski J., Wawrzyńczak S., Bielak F., 1993 - The usefulness of supplementing diets of highly productive cows whith Erafet (a fatty substance) in the shape of calcium and magnesium soaps. Rocz. Nauk. Zoot., 20, 183 - 191 (in Polish).
18. Kreuzer W., Kirchgessner M., 1990 - Zn, Fe, Cu und Mn in der Milch von Kùhen bei unterschiedlicher Rohproteinzufuhr. J. Anim. Physiol. A. Anim. Nutr., 63, 204-209.
19. Lebzien P., Daenicke R., Rohr K., 1992 - Untersuchungen über den Einfluß verseifter Pflanzenfettsäuren auf die Milchleistung und die Milchinhaltsstoffe., Landbauforschung Völkenrode, 42, 85-88.
20. Leibetseder J., 1996 - Modification of fat composition through animal feeding. PROANIMALI Conference Wrocław, (typescript), p. 8.
21. Mendel V., E., 1971 - J. Anim. Sci., 33, 891.
22. Ohajuruka D.A., Wu Z., Palmquist D.L., 1991 - Ruminal metabolism, fiber, and protein digestion by lactating cows fed calcium soap or animal - vegetable fat. J. Dairy Sci., 74, 2601-2609.
23. Palmquist D.L.; 1990. The strategic use of fat in dairy ration. Bull. Nat. Rend. Assoc. 784. 8-9.
24. Rahnema S., Wu Z., Ohajuruka O.A., Weiss W.P., Palmquist D.L., 1994 - Site of mineral absorption in lactating cows fed high-fat diets. J. Anim. Sci., 72, 229-235.
25. Rohr K., Lebzien P., Daenicke R., Engling F.P., 1993 - Zur Wirkung verseifter Pflanzenfettäuren in Verbindung mit geschütztem Protein bzw. mit Körnermais auf die Milchleistung und die Milchzusammensetzung bei Hohleistungskühen. J. Anim. Physiol. Anim. Nutr., 69, 251-259.
26. Slonina L., Lehocky J., Sokol J., Rosival I., Burdova O., 1973 - Vet. Med. Praga, 18, 465.
27. Strzetelski J., Ryś R., Stasiewicz T., Lipiarska E., Stankiewicz B., 1993 - Effect of heat-treated rapeseds included to concentrate mixtures on cow performance, milk fat composition and rumen fermentation. Rocz. Nauk. Zoot., 20, 107-121 (in Polish).

PRINT

28. Sklan D., Kaim M., Moallem U., Folman Y., 1994 - Effect of dietary calcium soaps on milk yield body weight reproductive hormones, and fertility in first parity and older cows. J. Dairy Sci., 77, 1652-1660.
29. Stern M.D., Varga G.A., Clark J.H., Firkins J.L., Huber J.T., Palmquist D.L., 1994 - Evaluation of chemical and physical properties of feeds that affect protein metabolism in the rumen. J. Dairy Sci., 77, 2762-2786.
30. Szulc T., Preś J., Dobicki A., 1995 - Effects of supplemental fat for high yielding dairy cows at first stage of lactation on milk yield and composition. J.Anim. a. Feed Sci., 4, 83 - 89.
31. Tomlinson A.P., Horn H.H., Wilcox C.J., Harris B., Van-Horn H.H., 1994 - Effects of undegradable protein and supplemental fat on milk yield and composition and physiological responses of cows. J. Anim. Sci., 77, 145-156.
32. Wu Z., Huber J.T., 1994 - Relationship between dietary fat supplementation and milk protein concentration in lactating cows: A review. Livest. Prod. Sci., 39., 141-155.
33. Zalewska E., Krasudzki J., Cąkała S., 1985 - Microelements - Cu, Zn, Fe, vitamin B 12 and carotenoids, hematological Hb and Ht indices and milk yield from cows fed bentonite supplemented feed. Medycyna Wet., 2, 122-125.
34. Zawadzki W., 1993 - The influence of some nonenventional feeds additives on the course of rumen fermentation in sheeps. Zesz. Nauk. AR Wroc. Rozpr. Habil., 112, ss. 76 (in Polish).
35. DLG, 1986 - Energie and Nährstofbedarf landwirtschaftlicher Nutztiere. Nr., 3 Milchkühe Aufzuchtrinder. Frankfurt (Main).

Submited:

Tadeusz Szulc
Department of Cattle Breeding and Milk Production
Agricultural University of Wrocław
5b Kożuchowska, 51-631 Wrocław
