MINERAL SUPPLEMENTATION IN TUNISIAN SMALLHOLDER DAIRY FARMS

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Abstract

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The aim of the experiment was to determine the effects of supplementation of di-calcium-phosphate in the form of blocks in late pregnancy (2 months before calving), on production and reproduction parameters of dairy cattle in smallholder farms. The experiment covered 63 animals in 20 smallholder farms, divided into control and supplemented groups. Results showed that mineral supplementation had a significant effect on calf weight, milk fat content and reproduction parameters. Calves born to cattle supplemented with di-calcium-phosphate were heavier by 1.67 kg than those in the control group. Similarly, the average milk fat content in the supplemented group was 5.6 g/L ($P < 0.01$) higher than in the control group. Inter-calving interval was lower by 38 days ($P < 0.05$) in the mineral supplemented cows compared to the control group. The body condition score of the cows and the milk quantity and quality (protein and density) were higher in the supplemented group than in the control group but the effect was not significant ($P > 0.05$).

1. INTRODUCTION

In many smallholder dairy farms in Tunisia, the ration is imbalanced and in many instances deficient in calcium and phosphorus. The poor reproductive performance such as inter-calving interval and the lower content and quality of fat in milk in these dairy herds are thought to be related to these mineral deficiencies.

To overcome these deficiencies in the organised and large farms, animals are supplemented with a local source of di-calcium phosphate in the form of a powder. This was initially added to the forage at the time of feeding. However, this source was unpalatable and some minerals were wasted. To overcome this non-palatability, it was later added to the concentrate feed, which was completely consumed. Although cattle were supplemented with the same quantity [1, 2] their production was different. Since the supplementation was calculated based on the most deficient animal, other cows were often over supplemented.

In the smallholder farms, di-calcium phosphate supplementation in the form of a block was a possible solution because it was more palatable (mixed with salt) and reduced wastage. The animals licked and regulated their mineral requirements as well.

2. MATERIALS AND METHODS

2.1. Animals

Sixty-three crossbred cows (80% Holstein × local breed) aged between 3–6 years and maintained under similar management conditions, and belonging to 20 farmers were used in this study. The average body weights were 588 and 563 kg for control (32 cows from 10 farmers) and supplemented animals (31 cows from 10 farmers), respectively. The supplemented group received di-calcium phosphate for one year, starting from late pregnancy (2 months before calving).

2.2. Feeding

The composition of the diet was different in the different farms and consisted of forages such as oat hay, wheat straw, alfalfa, berseem and sorghum and a concentrate such as barley, soybean or commercial concentrate available in the market. However, in all selected farms the diets were 10–15% deficient in both calcium and phosphorus.

The supplementation ration consisted of di-calcium phosphate mixed with salt in the form of a block (Table I) while the control ration consisted of 1% salt mixed with the concentrate.

The mineral blocks were prepared in a factory in the form of 5 kg cylindrical blocks. Salt was added to increase the palatability of the block. Blocks were distributed once every 2 months. The animals licked the blocks to satisfy their needs. The average daily block intake was 83 g/animal. The nutritive values of the feeds used in the farms are given in Table II.

TABLE I. QUANTITY OF CALCIUM AND PHOSPHORUS IN THE MINERAL BLOCK

	Calcium	Phosphorus	Salt	Ca:P ratio
As a percentage (%)	8.4	8.4	83.2	1: 1.003
g/5 kg block	420	421.5	4158.5	1: 1.003

TABLE II. NUTRITIONAL VALUE OF FEEDS (g/kg DM)

	NET ENERGY UFL	DIGESTIBLE PROTEIN		MINERALS	
		PDIN	PDIE	Ca	P
Berseem	0.88	150	125	1.28	0.39
Alfalfa	0.66	113	81	0.97	0.40
Sorghum	0.87	53	67	0.38	0.26
Hay oat	0.44	39	50	0.41	0.30
Straw wheat	0.40	18	34	0.30	0.31
Concentrate	0.89	111	91	1.95	0.58
Barley	0.97	88	98	0.22	0.41
Soya	1.02	303	213	0.63	0.76
Hulls wheat	0.71	111	100	0.30	1.01

1 UFL = 1700 kcal Net Energy Lactation.
PDIN = Intestinal digestible protein permitted by nitrogen.
PDIE = Intestinal digestible protein permitted by energy.

2.3. Measure of production and reproduction parameters

All cows were weighed every month using a weigh band. The calves were weighed using a spring balance. The body condition score (BCS) was estimated using the 1–9 scale. Milk production was measured daily in the farm but milk fat and protein were analysed in the laboratory [3].

Reproductive hormone progesterone was measured using the FAO/IAEA Self-coating RIA kits. Milk progesterone profiles constructed from twice weekly sampling were used to monitor ovarian activity in post partum cattle. The milk samples were taken and stored at 4°C in the farm and later, analysed in the laboratory. Cows were examined for uterine involution one month after calving. Forty-five days after insemination, a pregnancy diagnosis was carried out by rectal palpation of the uterus to confirm pregnancy.

2.4. Economics of feeding the mineral block

Block intake was determined every 60 days. Cost of production was calculated as:

B = Y–X,

where

B = benefit

Y = improvement in production and reproduction

X = cost of daily intake of minerals.

2.5. Statistical analysis

The statistical analysis was carried out using SAS procedure. Comparison of paired groups was tested with paired difference test, performed using the non-parametric test. The GLM procedure was used to analyse the data.

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3. RESULTS

The supplementation of lactating dairy cattle with di-calcium phosphate in the form of a mineral block improved calf weight gain by 1.67 kg, which was significantly different from the weight gain of calves in the control group. Calcium and phosphorus supplementation significantly increased the milk fat content of milk although there was no effect on the quantity of milk produced.

Mineral supplementation improved all reproduction parameters. Conception by first AI was significantly higher in the supplemented group as compared to the non-supplemented group (36.8 vs 25%, respectively). Similarly, supplemented group required less number of services/conception, had a lower calving to conception AI period and a lower inter-calving interval.

4. DISCUSSION

The mineral supplementation had a significant effect on dairy cattle production and reproduction. Ca and P are required for the utilisation of energy and protein, without which protein and energy would not be properly used. When given a nutritionally balanced diet, calves developed a large muscle mass, grew well and increased the mineral content of the bones [4 –9].

The availability of calcium and phosphorus improved the fat content in milk. This was achieved by the better utilisation of forages, due to the adequate presence of calcium improving the buffering capacity of the rumen. The increase in fat content in milk could have been due to the production of a higher ruminal molar percentage of acetic and butyric acids due to the fermentation of fibre [10].

The reproductive performance was considerably improved by mineral supplementation. It is known that a deficiency in phosphorus decreases the energy production and is associated with poor fertility, apparent dysfunction of the ovaries causing inhibition and depression or irregularity of oestrus [11–13]. Supplementation with di-calcium phosphate improved the reproduction potential and reduced the inter-calving interval [14].

The cost of 5 kg mineral block was US$ 2.00. The average block intake was 117 g/day, amounting to US$ 0.017/day. The benefit from the increased fat content was US$ 0.010/L. Since the average milk production was 14 litres per day, the benefit due to mineral supplementation was US$ 0.14. It has been estimated that for each day of delay in the pregnancy of a cow a farmer loser US$ 2.00. Thus, the reduction in inter-calving interval due to mineral supplementation benefited the farmer by an estimated US$ 38. The average daily gain by the farmer was calculated as:

0.140 + 38/365–0.017 = US$ 0.331. This amounted to the price of 1.5 L of milk.

TABLE III. MEAN (± SE) PRODUCTION AND REPRODUCTION PARAMETERS FOR CONTROL AND SUPPLEMENTED GROUPS

Parameters	Control group	Supplemented group
Production parameters		
BCS	3.15 ± 0.22 (n=243)	3.27 ± 0.37 (n=280)
Calf weight (kg)	37.1 ± 1.6^a (n=243)	38.7 ± 1.8^b (n=30)
Milk production (L)	13.6 ± 1.0 (n=243)	14.5 ± 0.8 (n=280)
Milk density (g/L)	1029.1 ± 0.6 (n=186)	1029.3 ± 0.5 (n=171)
Milk fat (g/L)	33.0 ± 2.0^a (n=243)	38.6 ± 2.5^b (n=280)
Milk protein (g/L)	28.9 ± 1.1 (n=243)	29.4 ± 1.3 (n=280)
Reproduction parameters		
1st AI success (%)	25.0 ± 2.1^a (n=8)	36.8 ± 3.1^b (n=11)
> 3rd AI success (%)	26.6 ± 3.1^a (n=8)	15.7 ± 1.0^b (n=5)
Services/conception	2.25 ± 0.11^a (n=31)	1.84 ± 0.12^b (n=30)
Calving to conception AI (d)	166 ± 4.5^a (n=31)	126 ± 6.2^b (n=30)
Calving interval (d)	436 ± 5.6^a (n=31)	398 ± 7.1^b (n=30)

AI: Artificial Insemination; SE: Standard Error; BCS: Body Condition Score; $^{a, b}$: different superscripts denote a significant difference at $P < 0.05$.

5. CONCLUSION

Supplementation with di-calcium phosphate improved milk production and reproductive performance in dairy cattle. The mineral should be incorporated along with common salt (NaCl) in order to increase palatability.

It is recommended that industrial scale production of the block should be undertaken and blocks distributed to smallholder farmers in areas where calcium and phosphorus deficiency is prevalent.

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REFERENCES

[1] GABBOUJ, C., Effet de la supplémentation en phosphate bicalcique chez la vache laitière en péripartum, Thèse Doc.Vét n°32, (1996).

[2] HAMDI, L., Supplementation phospho-calcique chez la vache laitière pendant un cycle de production, Thèse Doc.Vét n°30, (1997).

[3] AOAC International., Official methods of analysis, 16th Edition 3rd revision, Volume II, (1997).

[4] FALL, S.T., SAWADOGO, G., DIOP, M., Phosphates naturels et alimentation du bétail en zone Sahalienne: l'influence sur la santé et la naissance du zébu Gobra.(1999) Rev. Elev. Méd. Vét. pays trop **52** (2) 133–145.

[5] HERNANDEZ, J., CARLOS, A.R., JESSIE, B.E., Effect of oral administration of a calcium chloride gel on blood mineral concentrations, parturient disorders, reproductive performance and milk production of dairy cows with retained fœtal membranes, J.A.V.M.A., **1** (215) (1999) 72–76.

[6] NICOL, I.M., Quelques clés pour comprendre la nutrition de la vache laitière, G.T.V 3-B 525 (1996) 53–73.

[7] REKHIS, J., Complémentation minérale chez les ruminants, Training course for developing feed supplementation packages. FAO/IAEA, (AFRA), Morocco, (1997).

[8] RLEY, W., DOANE, R., Recent developments in the roles of vitamins and minerals in reproduction, J. Dairy. Sci. **72** (1989) 784–804.

[9] WARD, G., MARION, G.B., Influences of calcium intake and vitamin D supplementation on reproductive performances of dairy cows, J Dairy Sci. **54** (1971) 204–206.

[10] FORBES, J.M., How is feed intake controlled in ruminants. International Animal Nutrition congress Isparta, 4–6 Sept. Turkey, 22–35, (2000).

[11] ROBERTS, S.J., Veterinary obstetrics and genital diseases. 2nd Edition, Cornell University Press, Ithaca, New York (1971).

[12] PETERS, A.R., BALL, P.J.H., Reproduction in cattle. Blackwell Science, 2nd Edition, (1994).

[13] REKHIS, J., KOUKI, C.K., KHLIF, K., Supplementation par des blocs de phosphate bicalcique, intérêt chez la vache laitière dans les élevages fermiers, Colloque " lait, qualité et santé" ANMVT / M.V. com 11 (1999).

[14] GALYEAN, M.L., PERINO, J., DUFF, C., Interaction of cattle health-immunity and nutrition, J. Anim. Sci. **77** (1999) 1120–1134.