

The Comparison Effects of Bolus and Dietary Supplements on Production, Milk Compositions and Udder Immune System of Holstein Dairy Cattle

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Abstract: The aim of this study was to compare the effects of bolus and dietary supplements on production, fat, protein and SNF of milk and the evaluation of the udder immune system by SCC of Holstein dairy cattle. In this study 2 groups containing 30 cattle were selected with an average of milk production 30 ± 2 kg and the same of the parity and days in milk. Both supplements were the same in composition. Dietary supplement was used in control group as TMR and bolus (2 bolus/cow) were used in the treatment group for 6 months. Milk sample was collected 1 week later from the beginning, 3 and 6 months after the examination for analyzed SCC, milk production, percent of fat, protein and SNF of milk. Results indicated that the treatment group lead to a significant increase of milk production compared to the control group and fat and SNF milk were higher than the control group but it wasn't significant. Also, between the two groups no significant differences were observed on SCC and milk protein at total sampling. It was concluded that bolus supplement had the same effects with dietary supplement in dairy cattle.

Key words: Bolus, dietary, milk, immune, dairy cattle, Iran

INTRODUCTION

Milk is one of the essential foods representing an important part of the human diet. It is an excellent source of protein and calcium and also of many vitamins and trace elements such as zinc, selenium and iodine. The composition of cow's milk is of great importance for the dairy industry. It is fundamental for the value of milk and affects its nutritional value as well as its processability. Factors influencing the composition of milk are internal factors e.g., the breed of cow and external factors such as type of feed, seasonal changes, milking frequency and milking systems (Swensson and Lindmark-Mansson, 2007). Change in the composition of milk have been associated with a number of factors including stage of lactation, environmental condition, genetic make-up of the cow, fever and disease and amount and composition of the feed. Some of the most dramatic changes in milk composition have been attributed to bacterial infections of udder. Mastitis has depressed milk yield, altered the amount and composition of milk proteins, decreased lactose, raised pH and altered the mineral composition of milk (Wegner and Stull, 1978).

Trace minerals and vitamins have a direct effect on the function of the immune system and milk composition

therefore could have a direct effect on the ability of a cow to combat mastitis. In the relation, it indicated Vit E+Se, Vit A, Cu and Zn that the whole affected mastitis incidence and milk compositions. In the relationship to the effects of diet Vit E+Se on phagocytes ability, lymphocytes response and high resistance to disease, extent researches has been done. These compositions were resulted in the increased performance of smooth muscles and decrease of bacterial entrance into teats ducts on post milking. Minerals such as Zn, Mg, Cu and Co play important roles at proteins synthesis, vitamins metabolism, connective tissue formation and increase performance of immune system and this minerals have numerous effects on cow's performance such as reproduction, production and safety of hooves. Cows that were feeding to amino acids and Mg indicated reduction of SCC and high milk yield. Other research has shown relationships between vitamin A and B-carotene with mastitis that there were resulted to decrease of new infection in early dry period or decline of SCC in during of 2-8 weeks lactation. Therefore, to pay attention to vitamins and minerals roles in cow's diet, they should be provided for suitable interest of cows. In this direction, addition of vitamins and minerals to diet has problems such as high expense, weight loss and lack of use by

cows (Andrieu, 2008; Cortinhas *et al.*, 2010). On the other hand, bolus supplements have advantage such as reduction of costs, time and staffs and also it has slow and regular releasing at a defined time. However, the aim of this study is to compare the effects of bolus supplements and dietary supplements on production, milk compositions (fat, protein and SNF) and so udder immune system was evaluated by the counting of somatic cells of Holstein dairy cattle.

MATERIALS AND METHODS

Animals: In this study, numbers of 60 Holstein cows were selected with a mean milk production 30±2 kg and the same parity and days in milk. The cows were divided to two groups of control (30 cows) and treatment (30 cows). Also, the management and environmental condition was the same.

Study design: According to NRC, nutritional requirements of cows were estimated as well as the regulation of diet for control and treatment groups. In the treatment group of two bolus supplements were used (All Trace Cattle, Agrimin; UK) in below formulation: In the control group vitamin and mineral supplements were used (Roshd Daneh, Iran) on base to NRC as TMR with diet for 6 months and there were the same to bolus composition (Table 1).

The milk samples were collected 1 week later, 3 and 6 months later from the beginning of the experiment as the amount of 10 mL milk samples were estimated the milk composition such as percent of fat, protein, Solid Non-Fat (SNF) with the use of MilkoScan 4000 (Combifoss, Denmark) and milk Somatic Cell Count (SCC) to assess mastitis (udder immune system) in the laboratory by fossomatic 5000 (Combifoss, Denmark).

Statistical analysis: The data was recorded in the computer software Excel and the statistical package SAS was used for the analysis which was based on a completely randomized design. Average treatments were compared by LSD multiple range test at 5% level.

Table 1: Composition of each bolus supplement

Bolus composition	Rate of releasing material/day in two bolus	Amount of materials in each bolus
Copper	136.5 mg	16.379
Cobalt	2.0 mg	236.000
Selenium	2.1 mg	251.000
Magnesium	69.4 mg	8.326
Zinc	111.5 mg	13.382
Iodide	4.1 mg	497.000
Vitamin A	4580.0 IU	549.408
Vitamin D ₃	916.0 IU	109.881
Vitamin E	9.0 IU	1.099

RESULTS AND DISCUSSION

All of the vitamins and minerals which exist in bolus have beneficial effects on milk composition and are needed for milk yield. Table 2 shows that treatment group was statically significant compared to control group in milk production at 1 week after the beginning of examination but it wasn't significant at 3 and 6 months after the beginning of the examination.

On the other hand, the percent of milk fat and SNF was higher in treatment group than control group but it wasn't statistically significant. Also, the percent of milk protein wasn't statistically significant in the treatment and control groups 1 week, 3 and 6 months after the beginning of the examination.

Figure 1 shows that bolus supplement wasn't significantly different in SCC compared to dietary supplement at the 1 week, 3 and 6 months after the examination.

The result shows that the treatment group was statistically significant difference compared to the control group in milk production at 1 week after the beginning of the examination. Also, the level of milk production was higher in first sampling than second and third sampling. On the other hand, the rate of SCC was lower in first sampling than second and third sampling but it wasn't statistically significant between the control and treatment

Table 2: The comparison effects of bolus supplement and dietary supplements on milk composition

Periods ¹	Groups ²	Milk (kg)	Fat (%)	Protein (%)	SNF (%)
1 week later	Treatment	35.6 ^a	3.9 ^a	3.2 ^a	15.1 ^a
	Control	32.9 ^b	3.5 ^a	3.2 ^a	13.3 ^a
3 month later	Treatment	32.5 ^a	3.8 ^a	3.1 ^a	14.2 ^a
	Control	32.1 ^a	3.3 ^a	3.2 ^a	13.9 ^a
6 month later	Treatment	31.6 ^a	3.7 ^a	3.0 ^a	14.5 ^a
	Control	30.3 ^a	3.1 ^a	3.3 ^a	13.4 ^a

^{a-b}Means within a row with different superscripts differ (p<0.05); ¹Time of sampling after examination; ²Control: dietary supplement, treatment: bolus supplement

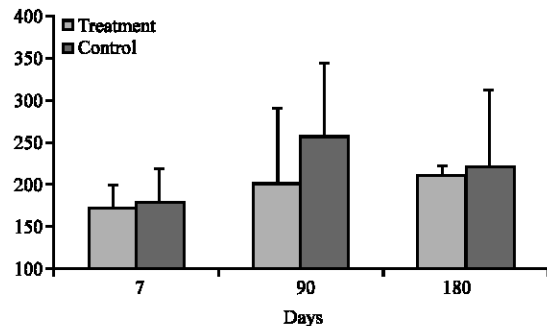


Fig. 1: Comparison effects of bolus supplement and dietary supplements on Somatic Cell Count (SCC)

groups in total sampling. This result may be due to the sudden releasing of bolus compositions which released greater amounts at the 1st week after examination and resulted in increased milk production and reduced SCC. However, the reason for higher milk yield in the first sampling in comparison with the second and third sampling which was due to lactation of peak in postpartum.

In this regard, copper could have prevented the oxidation of unsaturated fatty acids which are highly oxidative, consequently leading to the elevation of milk VFAs content and milk production (O'Rourke, 2009). Also, copper had effects on mammary gland health and fewer quarters infected and as follows increase milk production (Weiss, 2002). An additional approach to possible preventive measures is to supplement intakes of selenium and vitamin E beyond the generally accepted dietary requirements. Both have complementary functions as antioxidants to minimize cellular damage. Selenium by enhancing glutathione peroxidase activity reduces peroxide levels and vitamin E accelerates their removal from cellular membranes. Together they enhance both the phagocyte and macrophage function of cells and improve the immune response. An extensive review has been given of the effects of dietary selenium and vitamin E on phagocyte function, lymphocyte responses and enhanced immunity to disease. The entry of mastitis-promoting bacteria to the udder via the streak canal may be reduced and its rapid closure after milking enhanced by the improved function of the smooth-muscle lining under the influence of both adequate selenium and vitamin E. It is apparent that if increased dietary intakes of selenium and vitamin E are to be effective, they should be given from the start of the dry period so that any protective effects may be maximized at the time of parturition and in the 1st week of lactation.

One mammary gland of each cow was challenged with *E. coli* and infections were established in all the udders. Atrophy and agalactia and reductions in milk yield are significantly greater in the Se depleted cows. Se depleted cows also had higher bacterial counts in their milk and the duration of infection was longer and Somatic Cell Counts (SCC) increased significantly more rapidly. Neutrophils from cows given vitamin E had a significantly increased intracellular kill of both *Staph. aureus* and *E. coli*. Neutrophils from cows supplemented with dietary Se also had a significantly increased intracellular kill of *Staph. aureus* and tended to have an increased kill of *E. coli*. Dietary Se supplementation had no effect on the phagocytotic capacity of the neutrophils but

neutrophils from Se depleted cows killed significantly fewer of the ingested bacteria. Researches indicated a single Se injection before calving reduced the severity and duration of clinical cases of mastitis. On the other hand, Se resulted to SCC and it lead to reduction of alveolar epithelial cells that those are involved increasing milk production (Hemingway, 1999). In this regard, zinc has biological roles that are characterized by catalytic, structural and regulatory functions. The metabolic action of these systems includes carbohydrate and energy metabolism, protein synthesis, nucleic acid metabolism, epithelial tissue integrity, cell repair and division, vitamin A transport and utilization and vitamin E absorption. Zinc is also required for maintenance of skin integrity, stabilization of membranes and activation of the cell mediated immune system (Kellogg *et al.*, 2004). However, zinc is an essential trace element involved in the catalytic, structural and regulatory processes of keratinisation and in general protein metabolism; consequently teat canal keratin production is dependent on Zn status. Nutrition has been clearly shown to influence immune cell function in lactating dairy cows. Recent studies discussed how energy and protein status, Se, vitamin E, B-carotene, Cu and Zn can enhance the function of several immune cells including leucocytes, lymphocytes and neutrophils (Andrieu, 2008). Together stress, a reduction in immune response and breakdown in skin integrity may deteriorate the natural defense mechanisms of the mammary gland. Low zinc status leads to low yield and quality milk with high Somatic Cell Count (SCC) and increased incidence of mastitis (Kellogg *et al.*, 2004).

In this context, to date most research on rumen modification has emphasised benefits in animal productivity through improved ruminal fibre degradation and protein utilisation or reduced greenhouse gases. However, milk characteristics such as flavour and lipid profile can also be influenced. Some of the macro and micronutrients important for milk composition can affect and be affected by their passage through the rumen and their subsequent release and transformation caused by interaction with the microbial pool. For instance, rumen microbes respond rapidly to dietary Co to synthesize vitamin B₁₂ (cobalamin) required by microbes for methane, acetate and methionine synthesis. A Co/Vitamin B₁₂ deficiency leads to succinate accumulation in rumen fluid as a result of inhibition of propionate metabolism with a concomitant shift in microbial populations favouring succinate-utilising species. Stable and sustainable changes to the rumen environment have been difficult to achieve. It is possible now to improve the concentration

or consistency of nutrients in milk such as Ca, Se, I, Fe, vitamin B₁₂ and folate by using on-farm methods. Bringing these enhanced milks to market will require the initiative and collaboration of scientists, veterinarians, primary producers and processors to create the appropriate niche supply and value chains (Knowles *et al.*, 2006).

On the other hand, vitamin A is not a strong antioxidant but it is extensively involved in many aspects of immune function. The vitamin A plus B-carotene treatment reduced mean SCC during 2-8 weeks of lactation (85,000 cells mL⁻¹ compared with 225,000 and 125,000 mL⁻¹ for low and high vitamin A treatments). Also, vitamin A leads to cell repair and vitamin A leads to faster healing cell and reduce to cell connections pathogens and thus reduce the SCC and will increase milk production (Weiss, 2002).

Results of study were indicated that treatment groups have higher rate of milk fat than control group. This result may be due to the availability of desirable vitamins or mineral in the rumen which were obtained by supplements bolus. On the other hand, High levels of SNF could be due to the impact of vitamin D3 in supplements bolus that directly absorbed from the rumen and it is increased calcium of milk. Also as noted, minerals and vitamins found in supplements bolus lead to reduce milk SCC and decrease udder infection and subsequent increase in milk quality. However, milk composition hadn't significantly changed in both control and treatment groups in any sampling. It was indicated that using bolus supplements could replace dietary supplements and they have a favorable impact on production and composition of milk and the udder immune system. Thus, it has the same value to dietary supplements.

CONCLUSION

Overall concluded is that due to the lack of difference in the impact bolus supplements with dietary supplements convention, these supplements can replace an appropriate spatial diet supplements considering the reducing cost of supplements, non-throwing materials, labor reduction costs and continuously intake minerals and vitamins.

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