Journal of Aquaculture Feed Science and Nutrition 10 (1-6): 1-7, 2018
ISSN: 2070-1667

Effect of Supplementary Zinc and Manganese Methionine Chelateson Productive and Reproductive Performance of Dairy Friesian Cows

[1]W.A. Riad, [1]Ghada S. El-Esawy, [1]A.M.A. Mohy El-Dein, [2]M.F.E. Ali and [1]H.M.A. Gaafar
[1]Institute of Animal Production Research, Agriculture Research Center, Dokki, Giza, Egypt
[2]Department of Animal Production, Faculty of Agriculture, Kafrelsheikh University, Kafr El Sheikh, Egypt

Abstract: Twenty lactating Friesian cows with average live body weight of 500 kg and at 2-4 season of lactation were used after calving and divided into four similar groups (5 each) assigned randomly to four treatments. Cows were fed the basal ration consisted of 40% Concentrate Feed Mixture (CFM), 40% Fresh Berseem (FB) and 20% Rice Straw (RS), on Dry Matter (DM) basis. The 1st group was unsupplemented and served as control (T_1) while 2nd-4th groups were supplemented with Zinc methionine (Zinpro) and Manganese methionine (Manpro) at 100 mg Zn/head/day (T_2), 100 mg Mn/head/day (T_3) and 50 mg Zn+50 mg Mn/head/day (T_4), respectively. Results indicated that the digestibility of all nutrients as well as nutritive values increased significantly ($p<0.05$) with zinc and manganese methionine supplemented treatments than control. Average daily intake was higher markedly ($p<0.05$) in T_2 compared to T_1. Total Volatile Fatty Acids (TVFA's) concentration increased significantly ($p<0.05$), however, ammonia nitrogen (NH_3-N) decreased significantly ($p<0.05$) with chelated zinc and manganese supplements. Plasma total protein and globulin concentrations increased significantly ($p<0.05$), however, AST and ALT enzymes activity decreased significantly ($p<0.05$) with chelated zinc and manganese supplements. Also, actual milk and 4% Fat Corrected Milk (FCM) yield and the contents of fat, protein, lactose, solids not fat and total solids in milk were increased significantly ($p<0.05$), however, somatic cell count decreased significantly ($p<0.05$) with chelated zinc and manganese supplements. Chelated zinc and manganese supplements improved feed conversion ratio. Average daily feed cost of cows in T2 was significantly higher ($p<0.05$) than that of T_1. Whereas, feed cost per 1 kg 4% FCM decreased significantly ($p<0.05$), however, the output of daily 4% FCM and net revenue increased significantly ($p<0.05$) with chelated zinc and manganese supplements. Chelated zinc and manganese supplements improved decreased days to first estrus and service, service period, days open, calving interval and number of service per conception and increased conception rate ($p<0.05$). In conclusion, chelated zinc and manganese supplements for dairy Friesian cows improved digestibility, feed intake, rumen fermentation activity, some blood plasma parameters, milk yield and composition, feed conversion ratio and economic efficiency as well as postpartum reproductive traits.

Key words: Chelated zinc and manganese, lactating Friesian cows, digestibility, milk yield and composition, feed and economic efficiency, reproductive traits

INTRODUCTION

The nutritional support of high yielding cows depends not only on precisely balanced basic nutrients but also on minerals which contents in feeds vary in particular years and depend on soil type and harvest time (Brzoeska *et al*., 2003). The important factor that affects both the absorption and utilization of trace elements in the metabolic pathways is their chemical form. Minerals and vitamins deficiencies may result in delayed onset of estrus, repeat breeding and infertility (Underwood and Suttle, 1999).

To avoid deficiency of trace minerals, mineral supplementation has been recommended as an important nutritional strategy to maintain production, reproduction and health of dairy cows (Spears, 1996), since, these are important in vital functions such as blood synthesis, structure of hormones, vitamins synthesis, reproductive function, formation of enzymes and immune system integrity (NRC., 2001). Trace minerals are those that although essential for normal body functions, are required in a very small amount in feeding. This group includes cobalt, copper, iodine, iron, manganese, molybdenum, selenium, zinc and chromium (NRC., 2001).

Corresponding Author: W.A. Riad, Institute of Animal Production Research, Agriculture Research Center, Dokki, Giza, Egypt

As animal productivity increased in the last years there was an increase in the requirements and interest for more effective animal feeding strategies. This has led to the development of a specific area of study focused on the effects of the structure of minerals on their retention and relationship with health and performance of dairy cows (Nocek *et al*., 2006; Siciliano-Jones *et al*., 2008).

Trace minerals have been supplemented in the form of inorganic compounds such as sulfates. Sulfates are associated in normal conditions and dissociated when solubilized in water. Minerals dissociated in the reticulum-rumen, omasum and abomasum can interact with digestion compounds, becoming insoluble and indigestible and excreted in feces (McDonald *et al*., 1996; Spears and Weiss, 2003). Polyphenols and some specific carbohydrates can alter the mineral absorption process. In addition, some minerals have a mutual antagonism such as iron, manganese and cobalt (NRC., 2001).

In a meta-analytic study, demonstrated increase in fat and protein and milk yield and improved reproductive rates with organic source of trace minerals depending on the supplementation period, mineral source used, environmental conditions and requirement of animals (Rabiee *et al*., 2010). Research has demonstrated that specific amino acid complexes of trace minerals are more bioavailable (Paripatananont and Lovell, 1995) and have better retention (Nockels *et al*., 1993) than inorganic sources. In studies conducted by Strusinska *et al*. (2004), Zieminski *et al*. (2002) and Kinal *et al*. (2005) found that the use of chelates and amino acid complexes with Cu, Zn and Mn in dairy cow nutrition led to a decrease in milk somatic cell count after organic form application was noted.

The objective of this study was to investigate the effect of adding chelated zinc and manganese methionine on feed intake, digestibility coefficients, rumen fermentation activity, some blood plasma biochemical, milk yield and composition, feed conversion ratio, economic efficiency and postpartum reproductive traits.

MATERIALS AND METHODS

The current research was carried out at Sakha Animal Production Research Institute, Animal Production Research Institute (APRI), Agricultural Research Center, Ministry of Agriculture in Co-operation with Department of Animal Production, Faculty of Agriculture, Kafrelsheikh University, Egypt.

Experimental animals and treatments: The 20 lactating Friesian cows with average live body weight of 500 kg and at 2-4 season of lactation were used after calving and divided into four similar groups (5 each) assigned randomly to four treatments. Cows were fed the basal ration consisted of 40% Concentrate Feed Mixture (CFM), 40% Fresh Berseem (FB) and 20% Rice Straw (RS), on DM basis. The 1st group was unsupplemented and served as control (T_1) while 2nd-4th groups were supplemented with Zinc methionine (Zinpro) and manganese Methionine (Manpro) at 100 mg Zn/head/day (T_2), 100 mg Mn/head/day (T_3) and 50 mg Zn+50 mg Mn/head/day (T_4), respectively. Zinpro® (Zinc methionine complex) and Manpro® (Manganese methionine complex) are built on a unique, patented molecule that consists of one metal ion bound to one amino acid ion-called a metal specific amino acid complex and are a nutritional feed ingredient for animals that contains organic zinc and manganese produced by Zinpro Corporation, Minnesota, USA. The chemical composition of feedstuffs and basal ration are shown in Table 1.

Table 1: Chemical composition of feedstuffs and basal ration

		Composition of DM (%)					
Items	DM (%)	OM	CP	CF	EE	NFE	Ash
Concentrate feed mixture	91.30	95.72	16.80	12.38	2.77	63.77	4.28
Fresh berseem	17.27	87.41	15.92	27.65	2.59	41.25	12.59
Rice straw	90.14	82.78	3.20	35.91	2.24	41.63	17.02
Basal ration	61.46	89.81	13.73	23.19	2.59	50.30	10.19

Management procedure: Cows were fed to cover their recommend requirements according to NRC (2001) allowances for dairy cows and adjusted every week based on the average body weight of animals and milk production. Concentrate feed mixture were offered twice daily at 8 am and 4 pm, fresh berseem was offered daily at 10 am while rice straw was offered at 1pm. Fresh water was available for cows in build basin all the day round.

Digestibility trails: Digestibility trails were conducted during the feeding period using 3cows from each group to determine the digestibility coefficients and nutritive values of the experimental ration. Each digestibility trial consisted of 15 days as preliminary period followed by 7 days as collection period. Acid insoluble ash was used as a natural marker (Van Keulen and Young, 1977). Feces samples were taken from the rectum of each cow twice daily with 12 h interval during the collection period and composited for each cow. Samples of feedstuffs were taken at the beginning, middle and end of the collection period. Representative samples of feedstuffs and feces were dried in air oven at 60°C for 48 h, ground and chemically analyzed according to the methods of AOAC (1990). Nutrients digestibility coefficients were calculated from the equation stated by Schneider and Flatt (1975) as follows:

$$\text{DM digestibility\%} = 100 - \left(100 \times \frac{\text{AIA\% in feed}}{\text{AIA\% in feces}}\right)$$

$$\text{Nutrient digestibility\%} 100 - \left(100 \times \frac{\text{AIA\% in feed}}{\text{AIA\% in feces}} \times \frac{\text{Nutrient\% in feces}}{\text{Nutrient\% in feed}}\right)$$

where, AIA is acid insoluble ash.

Milk yield and samples: Cows were mechanically milked and daily milk yield was recorded individually and corrected for 4% Fat Content (FCM) using the formula of Gaines (1928) as follows: 4% FCM = 0.4×milk yield (kg)+15×fat yield (kg).

Milk samples from the consecutive evening and morning milkings were taken every week during the experimental period and mixed in proportion to milk yield. Composite milk samples were analyzed for fat, protein, lactose, Solids Not Fat (SNF) and Total Solids (TS), by Milko-Scan, Model 133 B. Ash was determined by difference.

Rumen liquor samples: Rumen liquor samples were taken once time from cows at 3 h after the morning feeding using stomach tube with draw pulse power of the automatic milking machine. Every sample was strained through double layers of cheesecloth and pH value was determined immediately using Orian 680 digital pH meter. Ammonia Nitrogen (NH_3-N) was determined using saturated solution of magnesium oxide distillation according to the method of AOAC (1990). The Total Volatile Fatty Acids (TVFA's) was determined by the steam distillation method described by Warner (1964).

Blood samples: Blood samples were taken from the jugular vein of cows at 3 h post-feeding in centrifuge tubes containing anticoagulant (EDTA). Then centrifuged for 15 min at 4000 rpm. to obtain plasma and kept in deep freezer until analysis. Blood plasma total protein, albumin, globulin (by difference), urea nitrogen, AST and ALT were determined calorimetrically using commercial diagnostic kits (test-combination-Pasteur lap.).

Feed conversion ratio: Feed conversion ratio was expressed as the amounts of DM, TDN and DCP required for producing 1 kg 4% FCM.

Economic evaluation: Economic evaluation parameters were average daily feed cost, feed cost per kg 4% FCM, output of average 4% FCM yield, net revenue and net revenue improvements.

Statistical analysis: The data were statistically analyzed using general linear model procedure adopted by IBM SPSS Statistics 22 for Windows (2014) for one-way ANOVA. Statistical significant effects were further analyzed and means were compared using Duncan's multiple range test. Statistical significant was determined at p = 0.05 (SPSS., 2014).

RESULTS AND DISCUSSION

Digestibility coefficients and nutritive values: The effect of zinc and manganese methionine supplements on nutrients digestibility coefficients and nutritive values in different treatments are presented in Table 2. Based on control ration, digestibility of OM, CP, CF, EE and NFE as well as nutritive values in terms of TDN and DCP increased significantly ($p<0.05$) with both zinc and manganese methionine supplements in T_2-T_4 with the best results in T_2 (zinc methionine). The improvement in digestibility coefficients could be attributed that zinc and manganese methionine can play indirect role to stimulate anaerobic fermentation of organic matter that improve the utilization efficiency of nutrients and direct role to improve digestion in abomasums. These results are in a good agreement with those obtained by Garg *et al.* (2008) who found that digestibility of DM, OM, CP, EE and NFE, DCP and TDN increased significantly ($p<0.05$) with zinc methionine supplement for lambs. Gaafar *et al.* (2011) stated that nutrients digestibility coefficients and nutritive values increased significantly ($p<0.05$) with zinc methionine supplement for lactating cows. El Ashry *et al.* (2012) reported that digestibility coefficients and nutritive value increased significantly ($p<0.05$) with combination of zinc, manganese and copper methionine chelates supplements for early lactation dairy cows.

Daily feed intake: Average daily feed intake by lactating cows as affected by zinc and manganese methionine supplements are presented in Table 3. Average daily feed

Table 2: Nutrients digestibility coefficients and nutritive values for different treatments

	Treatments				
Items	T_1	T_2	T_3	T_4	SEM
Digestibility coefficients (%)					
OM	67.39^b	69.68^a	69.41^a	69.50^a	0.22
CP	69.22^b	71.99^a	71.62^a	71.65^a	0.33
CF	66.29^b	68.69^a	68.38^a	68.66^a	0.83
EE	70.05^b	72.23^a	71.44^{ab}	71.30^{ab}	0.87
NFE	68.08^b	70.74^a	69.64^{ab}	70.41^a	0.47
Nutritive values (%)					
TDN	63.20^b	65.60^a	64.88^a	65.33^a	0.28
DCP	9.50^b	9.88^a	9.83^a	9.84^a	0.05

^{ab}Values in the same row with different superscripts differ significantly ($p<0.05$)

Table 3: Average daily feed intake by lactating cows in different treatments

Items	Treatments T_1	T_2	T_3	T_4	SEM
As fed basis (kg/day/head)					
Concentrate feed mixture	6.80	7.11	6.96	6.87	
Fresh berseem	35.92	37.57	36.78	36.29	
Rice straw	3.44	3.60	3.52	3.48	
Total	46.16	48.28	47.26	46.64	
On DM basis (kg/day/head)					
Total DM	15.51^b	16.22^a	15.88^{ab}	15.67^{ab}	0.14
TDN	9.80^b	10.64^a	10.30^{ab}	10.24^{ab}	0.11
CP	2.13^b	2.23^a	2.18^{ab}	2.15^{ab}	0.04
DCP	1.47^b	1.60^a	1.56^{ab}	1.54^{ab}	0.02

^{ab}Values in the same row with different superscripts differ significantly (p<0.05)

Table 4: Rumen fermentation activity and some blood plasma constituents for different treatments

Items	Treatments T_1	T_2	T_3	T_4	SEM
Rumen fermentation activity					
pH value	6.74	6.69	6.72	6.71	0.03
TVFA's (mEq/100 mL)	18.80^b	20.71^a	20.65^a	20.55^a	0.22
NH_3-N (mg/100 mL)	17.98^a	15.51^b	15.62^b	15.59^b	0.26
Blood plasma constituents					
Total protein (g/dL)	7.26^b	8.30^a	8.19^a	8.10^a	0.13
Albumin (g/dL)	3.95	4.20	4.12	4.10	0.09
Globulin (g/dL)	3.31^b	4.10^a	4.07^a	4.00^a	0.10
Creatinine (g/dL)	1.63	1.55	1.58	1.56	0.04
AST (U/L)	65.74^a	60.51^b	59.81^b	59.71^b	0.59
ALT (U/L)	30.80^a	25.79^b	26.31^b	26.12^b	0.49

^{ab}Values in the same row with different superscripts differ significantly (p<0.05)

intake in terms of DM, TDN, CP and DCP by lactating cows were higher markedly (p<0.05) with zinc methionine supplement in T_2 compared to T_1 (control) whereas in T_3 (manganese methionine) and T_4 (zinc and manganese methionine combination) were intermediate with insignificant differences. In this study, DM, TDN, CP and DCP intake are cover the recommended requirements of lactating cows producing 15-17 kg milk/day according to NRC (2001). These results are in accordance with those obtained by El Ashry *et al.* (2012) who reported that supplementation of organic metal had a significant increase in DM intake by lactating cows. Gaafar *et al.* (2011) found that the intake of TDN and DCP by lactating cows increased significantly with zinc methionine supplement.

Rumen liquor parameters: Data related to rumen liquor measurements as pH, ammonia-N and TVFA's concentrations are presented in Table 4. pH values seemed to be within in very narrow range being 6.69-6.74 without any significant differences among tested rations T_1 even T_4. There a slight decrease in pH value detected with increase the concentration of TVFA's. Whereas TVFA's concentration increased significantly (p<0.05) with zinc and manganese methionine supplements with the highest value in T_2 (20.71 mEq/100 mL). However, the concentration of NH_3-N decreased significantly (p<0.05) with zinc and manganese methionine supplements with the lowest value in T_2 (15.51 mg/100 mL). These results suggest that the anaerobic fermentation of protected amino acids was more efficient and faster yielding more TVFA's than that in control. The decreased ruminal NH_3-N concentration in supplemented treatments may be due to improve the rumen microbes activity utilizing NH_3-N to produce microbial protein. The pH values are within the normal range obtained by Van Soest (1982) who stated that the optimum pH value for growth of cellulytic microorganisms was 6.7±0.5 pH degree. Gaafar *et al.* (2011) found that pH value of rumen liquor was not significantly affected (p>0.05) while the concentrations of TVFA's increased significantly (p<0.05) and NH_3-N decreased significantly (p<0.05) with zinc methionine supplementation. El Ashry *et al.* (2012) indicated that rumen liquor pH values of sheep did not significantly differ among treatments. The NH_3-N were significantly (p<0.05) higher in inorganic metals than organic metals. Sheep in organic metals treatment had higher (p<0.05) total VFA concentrations than those in the inorganic metals. Jung *et al.* (2013) reported that ruminal fermentation patterns in lactating Holstein cows including pH, ammonia-N and VFA post-feeding were significantly altered when animals were supplemented with chelated minerals relative to the control (p<0.05).

Blood plasma biochemical: Results concerning the effect of chelated zinc and manganese supplements for lactating cows on some blood plasma parameters are shown in Table 4. In the present study, total protein and globulin concentrations in plasma were nearly similar for treatments supplemented with chelated zinc and manganese methionine (T_2-T_4) without significant differences (p>0.05) but were increased significantly (p<0.05) compared with control (T_1) and were within the normal range being 6-8.3 g/dL (Kaneko, 1989). While, plasma albumin and creatinine concentrations were insignificantly (p>0.05) differ among the different treatments. However, AST and ALT enzymes activity decreased significantly (p<0.05) treatments supplemented with chelated zinc and manganese methionine (T_2-T_4) compared to T_1. These results agreed with those obtained by Gaafar *et al.* (2011) who found that cows supplemented with zinc methionine showed the highest plasma total protein, albumin and globulin concentrations (p<0.05). Also, zinc methionine supplementation led to significant decrease (p<0.05) in the activity of AST and ALT.

Table 5: Average daily milk yield, milk composition and Somatic Cell Count (SCC) for different treatments

Items	Treatments				
	T_1	T_2	T_3	T_4	Mean
Average daily milk yield (kg/day)					
Actual milk	14.19^b	16.08^a	15.91^a	15.92^a	0.24
Increase (%)	100.00^b	113.32^a	112.12^a	112.19^a	0.74
4% FCM	13.45^b	15.60^a	15.31^a	15.35^a	0.23
Increase (%)	100.00^b	115.99^a	113.83^a	114.13^a	0.76
Milk composition (%)					
Fat	3.65^b	3.80^a	3.75^a	3.76^a	0.05
Protein	2.72^b	2.89^a	2.84^a	2.85^a	0.04
Lactose	4.32^b	4.46^a	4.42^a	4.43^a	0.03
Solids not fat	7.74^b	8.05^a	7.96^a	7.98^a	0.05
Total solids	11.39^b	11.85^a	11.71^a	11.74^a	0.07
SCC ($\times10^3$ cell/mL)	169.7^a	141.6^b	144.7^b	142.3^b	2.76

^{abc}Values in the same row with different superscripts differ significantly ($p<0.05$)

Table 6: Feed conversion ratio and economic efficiency for different groups

Items	Treatments				
	T_1	T_2	T_3	T_4	SEM
Feed conversion ratio					
DM kg/kg 4% FCM	1.15^a	1.04^b	1.04^b	1.02^b	0.09
TDN kg/kg 4% FCM	0.73^a	0.68^b	0.67^b	0.67^b	0.05
CP kg/kg 4% FCM	0.158^a	0.143^b	0.142^b	0.140^b	0.018
DCP kg/kg 4% FCM	0.109^a	0.103^b	0.102^b	0.100^b	0.011
Economic efficiency					
Feed cost (LE/day)*	46.34^b	48.47^a	47.45^{ab}	46.83^{ab}	0.23
Feed cost (LE)/kg 4% FCM	3.45^a	3.11^b	3.10^b	3.05^b	0.05
Output of 4% FCM (LE/day)*	60.53^b	70.20^a	68.90^a	69.08^a	0.27
Net revenue (LE/day)	14.19^b	21.73^a	21.45^a	22.25^a	0.17
Net revenue improvement (%)	100.00^b	153.14^a	151.16^a	156.80^a	0.35

^{ab}Values in the same row with different superscripts differ significantly ($p<0.05$). The prices of 1 kg were 5.00 LE for concentrate feed mixture, 0.31 LE for fresh berseem, 0.35 LE for rice straw, 160 LE for chelated zinc and manganese methionine and 4.50 LE for 4% FCM

Milk yield and composition: Data concerning milk yield and its composition are presented in Table 5. Actual milk yield and 4% Fat Corrected Milk (FCM) were increased significantly ($p<0.05$) in Zn and Mn methionine supplemented treatments (T_2-T_4) compared with control treatment (T_1). Actual milk yield increased by 13.32, 12.12 and 12.19% in T_2-T_4 compared toT_1, respectively. The corresponding values for 4% FCM were 15.99, 13.83 and 14.13%, respectively. Moreover, the contents of fat, protein, lactose, solids not fat and total solids in milk were increased significantly ($p<0.05$) in T_2-T_4 compared with T_1. However, somatic cell count decreased significantly ($p<0.05$) in chelated zinc and manganese treatments compared the control one. The increase in milk yield with zinc methionine supplementation might be due to one or more of the following reasons) higher nutrients digestibility (Table 2), feed intake (Table 3) and TVFA's concentration and lower ammonia nitrogen concentration in the rumen (Table 4) of animals given chelated zinc and manganese) apparent increase in the efficiency of nitrogen utilization as well as an increased conversion and availability of nutrients for milk synthesis (Iwanska *et al*., 1999). Methionine seems to be the most limiting for milk synthesis because it is heavily utilized by the mammary gland and are present in relatively low concentrations in plasma (Schwab *et al*., 1992). Noeek *et al*. (2006) reported an increased milk production in animals receiving diets containing organically complexed minerals and a mixture of inorganic and organically complexed minerals. Gaafar *et al*. (2011) observed significant increase ($p<0.05$) in the yield of actual milk and 4% and milk composition of cows supplemented with zinc methionine. The increase of milk fat with zinc and manganese methionine supplementation might be due to that methionine in particular might facilitate the transfer of blood lipids to milk by furnishing methyl group for synthesis of choline and phosphatidylcholine which represent an important link between methionine and lipid metabolism in ruminants (Seymour *et al*., 1990). Sobhanirad *et al*. (2010) and Gaafar *et al*. (2011) reported that somatic cell count was reduced by addition of Zn methionine complex to the diet this refer to that Zn methionine plays integral role in immune function by activating T-lymphocyte responsiveness, thus, impacting the effectiveness of somatic cells within the mammary gland.

Feed conversion ratio: Feed conversion ratio expressed as the amounts of DM, TDN, CP and DCP per 1 kg 4% FCM as affected by chelated ZN and Mn supplement are shown in Table 6. The amounts of DM, TDN, CP and DCP per 1 kg 4% FCM were significantly decreased ($p<0.05$) in chelated Zn and Mn treatments (T_2-T_4) compared to control (T_1).The amounts of DM, TDN, CP and DCP/1 kg 4% FCM in chelated Zn and Mn treatments (T_2-T_4) decreased by 9.57-11.30, 6.85-8.22, 9.49-11.39 and 5.50-8.26% compared to T_1, respectively. These results are in accordance with those obtained by Shakweer *et al*. (2010) who reported that zinc methionine supplements improved feed efficiency. Gaafar *et al*. (2011) showed that supplementation of zinc methionine improved feed conversion improved feed conversion, leding to reduce the quantities of DM, TDN and DCP required to produce one kg of 4% FCM ($p<0.05$).

Economic efficiency: The effect of chelated Zn and Mn supplements on economic efficiency is shown in Table 6. Average daily feed cost of cows in T_2 was significantly higher ($p<0.05$) than that of T_1 while in T_3 and T_4 was intermediate without significant differences reflecting the same trend with feed intake. However, feed cost per 1 kg 4% FCM decreased significantly ($p<0.05$) in chelated Zn and Mn treatments (T_2-T_4) compared to T_1. The output of daily 4% FCM and net revenue increased significantly ($p<0.05$) in chelated Zn and Mn treatments (T_2-T_4)

Table 7: Postpartum reproductive performance of cows in different treatments

	Treatments				
Items	T_1	T_2	T_3	T_4	SEM
First estrus (day)	38.8^{a}	30.3^{b}	32.1^{b}	30.9^{b}	1.05
First service (day)	64.5^{a}	47.8^{b}	53.9^{b}	52.1^{b}	2.001
Service period (day)	57.8^{a}	45.8^{b}	51.2^{ab}	48.6^{ab}	1.87
Days open (day)	122.3^{a}	93.6^{c}	105.1^{b}	100.7^{bc}	5.12
Calving interval (day)	407.4^{a}	380.2^{b}	388.9^{b}	386.7^{b}	6.09
No of service per conception	3.6^{a}	2.1^{b}	2.4^{b}	2.6^{b}	0.19
Conception rate (%)	63.19^{b}	81.59^{a}	80.9^{a}	79.25^{a}	1.86

[ab]Values in the same row with different superscripts differ significantly ($p<0.05$)

compared to T_1. These results agreed with those obtained by Shakweer *et al*. (2010) who reported that feed cost per kg milk produced decreased while economic cash return was more pronounced with ration contained zinc methionine than control. Also, economic efficiency was improved with added zinc methionine compared to control group. Gaafar *et al*. (2011) found that average daily feed cost per kg of 4% FCM decreased and average income from milk production increased with zinc methionine supplementation ($p<0.05$).

Reproductive performance: Results in Table 7 showed significant differences ($p<0.05$) in postpartum reproductive performance among cows in different treatments. Days to first estrus and service, service period, days open, calving interval and number of service per conception decreased significantly ($p<0.05$) in chelated Zn and Mn treatments (T_2-T_4) compared to T_1. However, conception rate revealed the opposite trend, which increased significantly ($p<0.05$) in chelated Zn and Mn treatments (T_2-T_4) compared to T_1. These results are in agreement with those obtained by Hardcastle (1995) who found that days to first estrus were significantly lower ($p<0.05$) in the treatment group. Bosseboeuf *et al*. (2006) reported that mean services per conception was less in the Amino Acid Chelates (AAC) group compared with the Inorganic Metal salts (IM) group (1.50 vs. 1.90). In the IM group, 87% of the cows ultimately became pregnant compared with 96% in the AAC group ($p<0.05$).

CONCLUSION

From these results, it could be concluded that chelated zinc and manganese methionine supplement for dairy Friesian cows improved digestibility coefficients, feed intake, rumen fermentation activity, some blood plasma parameters, milk yield and composition, feed conversion ratio and economic efficiency as well as postpartum reproductive traits.

REFERENCES

AOAC., 1990. Official Methods of Analysis Association of Official Analytical Chemist. 15th Edn., AOAC., Arlington, Virginia.

Bosseboeuf, Y., A. Bourdonnais, H.D. Ashmead and S.D. Ashmead, 2006. The effect of Copper, Zinc and Manganese Amino Acid Chelates on dairy cow reproduction on eight farms: A field trial. Intl. J. Appl. Res. Vet. Med., 4: 313-319.

Brzoeska, F., W. Brzezinskiand and B. Brzoska, 2003. Mineral nutrients in feeding staffs, Part 1 fodder plants. Ann. Anim. Sci., 3: 115-126.

El Ashry, G.M., A.A.M. Hassan and S.M. Soliman, 2012. Effect of feeding a combination of Zinc, Manganese and Copper methionine chelates of early lactation high producing dairy cow. Food Nutr. Sci., 3: 1084-1091.

Gaafar, H.M.A., M.I. Bassiouni, M.F.E. Ali, A.A. Shitta and A.S.E. Shamas, 2011. Effect of Zinc methionine supplementation on productive performance of lactating Friesian cows. Spanish J. Rural Dev., 1: 53-62.

Gaines, W.L., 1928. The energy basis of measuring milk yield in dairy cows. MSc Thesis, University of Illinois Agricultural Experiment Station, Urbana-Champaign Campus, Chicago, Illinois.

Garg, A.K., V. Mudgal and R.S. Dass, 2008. Effect of organic zinc supplementation on growth, nutrient utilization and mineral profile in lambs. Anim. Feed Sci. Technol., 144: 82-96.

Hardcastle, B.J., 1995. The effects of feeding chelated metal proteinates on milk production and reproductive performance in holstein dairy cows. MSc Thesis, Utah State University, Logan, Utah.

Iwanska, S., D. Strusinka and B. Pysera, 1999. Effect of rumen protected methionine supplementation on early lactational responses of dairy cows fed a grass silage and cereals diet. Acta Vet. Hungarica Hungary, 47: 191-206.

Kaneko, J.J., 1989. Clinical Biochemistry of Domestic Animals. 4th Edn., Academic Press, New York, California, USA., Pages: 898.

Jung, K.J., Y.H. Ko, G.S. Bae, E.J. Kim and S.S. Lee et al., 2013. Effects of chelated Zinc or Copper on ruminal fermentation characteristics and milk production in lactating holstein cows. J. Anim. Vet. Adv., 12: 1048-1054.

Kinal, S., R. Bodarski, A. Korniewicz, J. Nicpon and M. Slupczynska, 2005. Application of organic forms of zinc, copper and manganese in the first three months of dairy cow lactation and their effect on the yield, composition and quality of milk. Bull. Vet. Inst. Pulawy, 49: 423-426.

McDonald, M., I. Mila and A. Scalbert, 1996. Precipitation of metal ions by plant polyphenol: Optimal conditions and origin of precipitation. J. Agric. Food Chem., 44: 599-606.

NRC., 2001. Nutrient Requirements of Dairy Cattle. 7th Edn., National Academies Press, Washington, DC., USA., ISBN: 0309069971, Pages: 381.

Nocek, J.E., M.T. Socha and D.J. Tomlinson, 2006. The effect of trace mineral fortification level and source on performance of dairy cattle. J. Dairy Sci., 89: 2679-2693.

Nockels, C.F., J. Debonis and J. Torrent, 1993. Stress induction affects copper and zinc balance in calves fed organic and inorganic copper and zinc sources. J. Anim. Sci., 71: 2539-2545.

Paripatananont, T. and R.T. Lovell, 1995. Chelated Zinc reduces the dietary Zinc requirement of channel catfish, Ictalurus punctatus. Aquacult., 133: 73-82.

Rabiee, A.R., I.J. Lean, M.A. Stevenson and M.T. Socha, 2010. Effects of feeding organic trace minerals on milk production and reproductive performance in lactating dairy cows: A meta-analysis. J. Dairy Sci., 93: 4239-4251.

SPSS., 2014. Statistical Package for the Social Science. SPSS, Inc., Chicago, Illinois, USA.

Schneider, B.H. and W.P. Flatt, 1975. The Evaluation of Feeds through Digestibility Experiment. University of Georgia Press, Athens, USA., Pages: 423.

Schwab, C.G., C.K. Bozak, N.L. Whitehouse and M.M.A. Mesbah, 1992. Amino acids limitation and flow to the duodenum at four stages of lactation 1, Sequence of lysine and methionine limitation1,2. J. Dairy Sci., 75: 3486-3502.

Seymour, W.M., C.E. Polan and J.H. Herbein, 1990. Effects of dietary protein degradability and casein or amino acid infusions on production and plasma amino acids in dairy cows. J. Dairy Sci., 73: 735-748.

Shakweer, I.M.E., A.A.M. El-Mekass and H.M. El-Nahas, 2010. Effect of two different sources of Zinc supplementation on productive performance of friesian dairy cows. Egypt. J. Anim. Prod., 47: 11-22.

Siciliano-Jones, J.L., M.T. Socha, D.J. Tomlinson and J.M. DeFrain, 2008. Effect of trace mineral source on lactation performance, claw integrity and fertility of dairy cattle. J. Dairy Sci., 91: 1985-1995.

Sobhanirad, S., D. Carlson and R.B. Kashani, 2010. Effect of zinc methionine or zinc sulfate supplementation on milk production and composition of milk in lactating dairy cows. Biol. Trace Elem. Res., 136: 48-54.

Spears, J.W. and W.P. Weiss, 2008. Role of antioxidants and trace elements in health and immunity of transition dairy cows. Vet. J., 176: 70-76.

Spears, J.W., 1996. Organic trace minerals in ruminant nutrition. Anim. Feed Sci. Technol., 58: 151-163.

Spears, J.W., 2003. Trace mineral bioavailability in ruminants. J. Nutr. Am. Soc. Nutr. Sci., 133: 1506S-1509S.

Strusinska, D., J. Mierzejewska and A. Skok, 2004. Concentration of mineral components, ß-carotene, vitamins A and E in cow colostrums and milk when using mineral-vitamin supplements. Medycyna Wet., 60: 202-206.

Underwood, E.J. and N.F. Suttle, 1999. The Mineral Nutrition of Livestock. 3rd Edn., CAB International, Wallingford, Oxon, UK., ISBN: 0851991289, Pages: 624.

Van Keulen, J. and B.A. Young, 1977. Evaluation of acid-insoluble ash as a natural marker in ruminant digestibility studies. J. Anim. Sci., 44: 282-287.

Van Soest, P.J., 1982. Nutritional Ecology of the Ruminant. Cornell University Press, Ithaca, New York., ISBN:9780801427725, Pages: 476.

Warner, A.C., 1964. Production of volatile fatty acids in the rumen: Methods of measurement. Nutr. Abstr. Rev., 34: 339-352.

Zieminski, R., A. Korniewicz, S. Kinal, M. Filipiec, A. Tomaszewski and M. Lenarska, 2002. Effect of chelates addition on colostrum quality and rearing results. Chem. Agric., 3: 319-322.