EFFECT OF SUPPLEMENTARY CHELATED ZINC AND MANGANESE METHIONINE ON PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF FRIESIAN COWS

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Abstract

This study aimed to investigate the effect of adding chelated zinc or/and manganese methionine on productive and postpartum reproductive traits. Twenty lactating Friesian cows with an average live body weight of 500 kg and on 2-4 seasons of lactation were used after calving immediately and divided into four similar groups (5 each) and assigned randomly into four treatments of feeding trial. Cows were fed a basal ration that consisted of 40% concentrate feed mixture (CFM), 40% fresh berseem (FB) and 20% rice straw (RS), on dry matter basis. The 1st group was unsupplemented and served as control (T1), while 2nd, 3rd and 4th groups were supplemented (per/head/day) with zinc methionine (ZINPRO) 100 mg Zn (T2) or manganese methionine (MANPRO) 100 mg Mn (T3) and 50 mg Zn + 50 mg Mn (T4). Results indicated that the digestibility of all nutrients as well as feeding values increased significantly ($P<0.05$) with zinc and manganese methionine supplemented treatments than control.

Daily intake was significantly higher ($P<0.05$) in T2 compared to T1.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 in comparison with control (unsupplemented one).

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 and economical efficiency as well. Likewise, chelated zinc and manganese supplements improved all reproductive traits (first estrus and service, service period, days open, calving interval and number of service per conception and conception rate). In conclusion, chelated zinc and manganese supplements for dairy cows improved digestibility, feed intake, rumen fermentation activity, some blood parameters, milk yield and composition, feed conversion ratio and economic efficiency as well as reproductive traits.

Keywords: Chelated zinc and manganese, 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 its contents in feeds greatly vary in particular by far depending on soil type and harvest time (Brzóska, *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 negatively affected on reproductive performance of farm animals (Underwood and Suttle, 1999). To avoid deficiency of trace minerals, mineral supplementation has been recommended as an important nutritional strategy to maintain the highly production, reproduction, and good health conditions of dairy cows (Spears, 1996).

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).

Traditionally trace minerals have been supplemented into the diets of animals 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 (Spears, 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, Rabiee *et al.* (2010) demonstrated an increase in fat, protein, milk yield and improved reproductive rates with the organic source of trace minerals depending on the supplementation period, the mineral source used, environmental conditions, and requirement of animals. Research has been demonstrated that specific amino acid complexes of trace minerals are more bioavailable and have better retention than inorganic sources (Paripatananont and Lovell, 1995). In studies conducted by Kinal *et al.* (2005), the use of chelates amino acid complexes with Cu, Zn or Mn in dairy cow nutrition led to a decrease in milk somatic cell count after organic form application.

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

MATERIALS AND METHODS

The current work was carried out at Sakha Animal Production Research Station, Animal Production Research Institute (APRI), Agricultural Research Center, Ministry of Agriculture in jointly with the Department of Animal Production, Faculty of Agriculture, Kafr El-Sheikh University, Egypt.

Experimental animals and dietary treatments:

Twenty lactating Friesian cows with an average live body weight of about 500 kg and on 2-4 seasons of lactation were used after calving immediately in a feeding trial in which animals were divided into four similar groups (5 each), which assigned randomly into four treatments. Cows were fed a basal ration (BR) that consisted of 40% concentrate feed mixture (CFM), 40% fresh berseem (FB) and 20% rice straw (RS), on DM basis. Ration of the 1st group was unsupplemented and served as control (T1), while the tested rations were supplemented with zinc methionine (ZINPRO) at rate of 1oo mg Zn/head/day (T2) or manganese methionine (MANPRO) at the same rate 100 mg Mn/head/day (T3) and 50 mg Zn + 50 mg Mn/head/day (T4). 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. Chemical composition of the basal ration and its ingredients are shown in Table (1).

Table 1. Chemical composition of basal ration and its ingredients.

Item	DM %	Composition of DM %							
		OM	CP	CF	EE	NFE	Ash	Zn* (ppm)	Mn* (ppm)
CFM	91.30	95.72	16.80	12.38	2.77	63.77	4.28	42	49
FB	17.27	87.41	15.92	27.65	2.59	41.25	12.59	17	24
RS	90.14	82.78	3.20	35.91	2.24	41.63	17.02	22	32
BR (calculated)	61.46	89.81	13.73	23.19	2.59	50.30	10.19	28	35.6

* Bassiouni *etal.* (2013).

Management procedure:

Cows were fed to cover their requirements according to NRC (2001) allowances for dairy cows. Feeds were adjusted every week based on the average body weight of animals and milk production. Concentrate feed mixture was offered twice daily at 8 a.m. and 4 p.m., while the whole amount of fresh berseem was offered only at 10 a.m., and then rice straw was offered at 1p.m. Fresh water was available for cows all the day round.

Digestibility trails:

Digestibility trails were conducted during the feeding period using 3 cows from each group to determine the digestibility coefficients and feeding values of the experimental rations. Each digestibility trial consisted of 15 days as a preliminary period followed by 7 days as collection period. Acid insoluble ash (AIA) was used as a natural marker (Van Keulen and Young, 1977). Fecal samples were taken from the rectum of each cow twice daily at 12 hours interval during the collection period and composited for each cow. Samples of feeds were taken at the beginning, middle and end of the collection period. Representative samples of feeds and feces were dried in air oven at 60 ^{0}C for 48 hours, ground and chemically analyzed according to the methods of AOAC (1990). Nutrient digestibilities were calculated from the equation as follows:

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

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

Milk yield and composition:

Cows were mechanically milked and daily milk yield was recorded individually and corrected for 4% fat content (FCM) using the formula as follows:

4% FCM (kg) = 0.4 x milk yield (kg) +15 x fat yield (kg).

Milk samples from the consecutive evening and morning milking 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 (RL) samples were taken once from cows at 3 hours after 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. Concentration of ammonia nitrogen (NH_3-N) was determined in RL using a saturated solution of magnesium oxide distillation according to the method of AOAC (1990). Concentration of 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 each cow at 3 hours post-feeding in centrifuge tubes containing anticoagulant (EDTA), then centrifuged for 15 minutes at 4000 r.p.m. to obtain plasma and kept in the deep freezer until analysis. Concentration of total proteins, albumin, globulin (by difference) and urea nitrogen, as well as AST and ALT activity 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 estimated as daily feed cost, feed cost per kg 4% FCM, the output of 4% FCM yield, net revenue and net revenue improvements according to the prices of the first half of 2017.

Reproductive parameters:

Postpartum reproductive traits studied in this work were first estrus and service, service period, days open, calving interval, number of services per conception and conception rate during the first 120 days postpartum.

Statistical analysis:

Data were statistically analyzed using general linear model procedure adopted by IBM SPSS Statistics for Windows (2014) as one-way ANOVA. Statistical significant effects were further analyzed and means were compared using Duncan's multiple range test. Statistical significant was set at $P \leq 0.05$.

RESULTS AND DISCUSSION

Digestibility and feeding values:

Effect of zinc methionine and manganese methionine supplements on nutrient digestibilities and feeding values of different experimental rations are presented Table (2). Based on control ration, digestibility of OM, CP, CF, EE and NFE as well as feeding values in terms of TDN and DCP were increased significantly ($P<0.05$) with the two organic mineral supplements in T2, T3 and T4, being the best in T2 (zinc methionine). The observed improvement in digestibility coefficients might be attributed to that zinc and manganese methionine can play direct role to improve the digestive process in abomasum and an indirect role to stimulate anaerobic fermentation of organic matter and consequently improves the utilization of nutrients. These results are in 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. Moreover, Gaafar *et al.* (2011) stated that nutrient digestibilities and feeding values increased significantly ($P<0.05$) with zinc methionine supplement for lactating cows. Also more recently, El Ashry *et al.* (2012) reported that digestibility and feeding value increased significantly ($P<0.05$) with a combination of zinc, manganese and copper methionine chelates supplements for early lactation of dairy cows.

Table 2. Nutrients digestibility coefficients and feeding values for different treatments.

Item	Treatment				SEM
	T1	T2	T3	T4	
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
Feeding 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

a, b: Means in the same row with different superscripts differ significantly (P<0.05).

Daily Feed intake:

Daily feed intake by lactating cows as affected by zinc and manganese methionine supplements are presented in Table (3). The daily feed intakes as DM, TDN, CP and DCP were significantly higher (P<0.05) with zinc methionine supplement (T2) compared to those of control ration (T1), whereas those of T3 (manganese methionine) and T4 (zinc and manganese methionine combination) did not significant differences than the corresponding values of control ration. 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). The present 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. Also, Gaafar *et al*. (2011) found that feed intake as TDN and DCP by lactating cows increased significantly with zinc methionine supplement.

Table 3. Daily feed intake by lactating cows fed the different experimental rations.

Item	Treatment				SEM
	T1	T2	T3	T4	
Feed intake (as fed, kg/head):					
CFM	6.80	7.11	6.96	6.87	
FB	35.92	37.57	36.78	36.29	
RS	3.44	3.60	3.52	3.48	
Total	46.16	48.28	47.26	46.64	
Feed unit intake (kg/head):					
DMI	15.51^{b}	16.22^{a}	15.88^{ab}	15.67^{ab}	0.14
TDNI	9.80^{b}	10.64^{a}	10.30^{ab}	10.24^{ab}	0.11
CPI	2.13^{b}	2.23^{a}	2.18^{ab}	2.15^{ab}	0.04
DCPI	1.47^{b}	1.60^{a}	1.56^{ab}	1.54^{ab}	0.02

a, b: Means in the same row with different superscripts differ significantly (P<0.05).

Rumen liquor parameters:

Data related to rumen liquor parameters as pH value and concentration of ammonia-N and TVFA’s are presented in Table (4). Results showed that pH values seemed to be within anarrow range (6.69- 6.74) being insignificant differences among the experimental rations and correspondent pH value were slightly decreased with increasing the concentrations of TVFA’s among treatments. The TVFA’s concentration was higher significantly ($P<0.05$) with all tested rations than that of control one, with the highest value that associated with (T2). Inversely, the concentration of NH_3-N was lower significantly ($P<0.05$) with the three tested rations than that of control one that free of organic mineral supplement with the lowest value in T2 (15.51 mg/100 ml). These results may 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 improving the rumen microbial activity for utilizing NH_3-N and production of microbial protein. The pH values are within the normal range obtained by Van Soest (1982), who stated that the optimal pH value for the growth of cellulolytic microorganisms was 6.7±0.5 pH degree. In fully agreement with the present results, 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. Moreover, El Ashry *et al.* (2012) indicated that rumen liquor pH values of sheep did not significantly differ among metal treatments, while NH_3-N were significantly ($P<0.05$) higher in inorganic metal rations than that of organic metal one. They were added that sheep in organic metal treatment had higher ($P<0.05$) total VFA concentrations than those in the inorganic metal one. Jung *et al.* (2013) reported that ruminal fermentation patterns in lactating Holstein cows including pH value and ammonia-N and VFA post-feeding concentrations were significantly altered in animals supplemented with chelated minerals relative to the control ($P<0.05$).

Table 4. Ruminal fermentation parameters and some blood biochemicals for dietary treatments.

Item`	Treatment				SEM
	T1	T2	T3	T4	
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/d)	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

a, b: Means in the same row with different superscripts differ significantly ($P<0.05$).

Blood biochemicals:

Results concerning the effect of chelated zinc and manganese supplements for lactating cows on some blood plasma parameters are shown in Table (4). Total proteins and globulin concentrations in plasma were nearly similar among treatments supplemented with chelated zinc or manganese or their mixture (T2, T3 and T4), but the concentrations of these two items were significant higher with the three tested rations than those of control one that free from chelated mineral supplement. Eventually the obtained values mentioned above were within the normal range recorded by Kancko (1989). While plasma albumin and creatinine concentrations were insignificantly ($P>0.05$) differ among the different treatments. Activity of AST and ALT decreased significantly ($P<0.05$) with treatments supplemented with chelated zinc and manganese (T2, T3 and T4) as compared to T1. These results agreed with those obtained by Gaafar *et al.* (2011) who found that cows supplemented with zinc methionine showed the highest plasma total proteins, albumin and globulin concentrations ($P<0.05$). Also, zinc methionine supplementation led to a significant decrease ($P<0.05$) in the activity of AST and ALT.

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 (T2, T3 and T4) based on control ration values (T1). Actual milk yield increased by 13.32, 12.12 and 12.19% in T2, T3 and T4 as compared to T1, respectively. The corresponding increase 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 T2, T3 and T4 as compared with T1. Also, favorably somatic cell count was lower significantly ($P<0.05$) in chelated zinc and manganese treatments as compared with that of control one. Gaafar *et al*. (2011) observed significant increase ($P<0.05$) in milk yield and milk composition of cows ration supplemented with zinc methionine. The increase in milk yield with chelated mineral supplementation might be due to one or more of the following reasons: 1) 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 these organic form of the studied minerals; 2) 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) or 3) methionine seems to be the most limiting for milk synthesis because it is excessivelly utilized by the mammary gland and are present in relatively low concentrations in plasma (Schwab *et al*., 1992). Also, Nocek (2006) reported an increased milk production in animals receiving diets containing organically complexes minerals and also a mixture of inorganic and organically complex minerals. 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 phosphatidyl choline, which represent an important link between methionine and lipid metabolism in ruminants (Seymour *et al.*, 1990). In respect of somatic cell count, Sobhinard (2010) and Gaafar *et al.* (2011) reported that its concentration was reduced by addition of Zn methionine complex to the diet. This refers to that Zn methionine plays an integral role in immune function by activating T-lymphocyte responsiveness, thus impacting the effectiveness of somatic cells within the mammary gland.

Table 5. Daily milk yield, milk composition and somatic cell count (SCC) for different treatments.

Item	Treatment				SEM
	T1	T2	T3	T4	
Daily milk yield (kg/day):					
Actual milk	14.19^{b}	16.08^{a}	15.91^{a}	15.92^{a}	0.24
Increase%	100.00	113.32	112.12	112.19	
4% FCM	13.45^{b}	15.60^{a}	15.31^{a}	15.35^{a}	0.23
Increase%	100.00	115.99	113.83	114.13	
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 (x10^3 cell/ml)	169.7^{a}	141.6^{b}	144.7^{b}	142.3^{b}	2.76

a, b: Means in the same row with different superscripts differ significantly ($P<0.05$).

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 supplements are shown in Table (6). The amounts of DM, TDN, CP and DCP per 1 kg 4% FCM were significantly ($P<0.05$) decreased in chelated Zn and Mn treatments (T2-T4) as compared to those of control (T1). It is well know that zinc has been greatly essential for productive performance for farm animals, where it plays significant role in different enzymatic systems needed in nucleic acid metabolism, protein synthesis and carbohydrate metabolism (Chester, 1997). These results are in accordance with those obtained by Shakweer *et al.* (2010) who reported that zinc methionine supplements improved feed efficiency. Similarly, Gaafar *et al.* (2011) showed that supplementation of zinc methionine improved feed conversion leading to reduction in the quantities of DM, TDN and DCP required to produce one kg of 4% FCM ($P<0.05$).

Table 6. Feed conversion ratio and economic efficiency for different dietary treatments.

Item	Treatment				SEM
	T1	T2	T3	T4	
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:					
Daily 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

a, b: Values in the same row with different superscripts differ significantly (P<0.05).

* The prices of 1 kg were 5.00 LE for CFM, 0.31 LE for FB, 0.35 LE for RS, 160 LE for chelated zinc and manganese methionine and 4.50 LE for 4% FCM according to the prices of the first half of 2017.

Economic efficiency:

The effect of chelated Zn and Mn and their mixture supplements on economic efficiency is shown in Table (6). Daily feed cost for cows in T2 was significantly (P<0.05) higher than that of T1, while the values of T3 and T4 were insignificant different with control ration. While, the feed cost per 1 kg 4% FCM was decreased significantly (P<0.05) in chelated Zn and Mn treatments (T2-T4) as compared to that of T1. The output of daily 4% FCM and net revenue increased significantly (P<0.05) in chelated Zn and Mn treatments (T2-T4) compared to T1. 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 containing zinc methionine than control. Also, economic efficiency was improved with added zinc methionine as compared to control. 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). Generally, much more needs to be learning about the selectivity of chelating agents with minerals, the most effective kind and quantity, their mode of action, and their behavior with different livestock species and with varying diets. Dietary requirements for minerals may be greatly reduced by the addition of chelating to animal diets, but generally it is more economical to use higher levels of inorganic mineral source than the more expensive mineral chelates and complexes (McDowell, 1992).

Reproductive performance:

Results in Table (7) showed significant (P<0.05) differences in postpartum reproductive parameters among cows in different treatments. Days to first estrus and service, service period, days open, calving interval and the number of services per conception decreased significantly (P<0.05) in chelated Zn and Mn treatments (T2-T4) as compared to T1. However, conception rate revealed an opposite trend. These results are in agreement with those obtained by Hardcastle (1995) who found that interval to the first estrus was significantly shorter (P<0.05) in chelated metal proteinates supplemented group. Bosseboeuf *et al.* (2006) reported that mean number of services per conception was less in the amino acid chelates (AAC) group compared with the inorganic metal salts (IM) group (1.5 vs. 1.9 service). In the IM group, 87% of the cows ultimately became pregnant compared with 96% in the AAC group (P < 0.05).

Table 7. Postpartum reproductive parameters of cows in different dietary treatments.

Item	Treatment				SEM
	T1	T2	T3	T4	
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 services 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

a, b: Values in the same row with different superscripts differ significantly (P<0.05).

CONCLUSION

It could be concluded that supplementation of chelated zinc or manganese methionine or their mixture in cows rations led to an improvement the digestibility coefficients, feed intake, rumen fermentation activity, some blood parameters, milk yield and its composition, feed conversion ratio and economic efficiency as well as reproductive traits.

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تأثير اضافة مخلبيات الزنك والمنجنيز ميثيونين على الأداء الانتاجى والتناسلى للأبقار الفريزيان الحلابة

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أجرى هذا البحث لدراسة تأثير اضافة الزنك والمنجنيز مثيونين على الأداء الانتاجى وقياسات التناسل بعد الولادة للأبقارالفريزيان. استخدم فى هذه الدراسة ٢٠ بقرة فريزيان حلابة متوسط وزنها ٥٠٠ كجم فى مواسم الحليب من الثانى الى الرابع قسمت عشوائيا بعد الولادة مباشرة الى ٤ مجموعات متماثلة (٥ أبقار بكل مجموعة). غذيت الأبقار على العليقة الأساسية التى تتكون على أساس المادة الجافة من ٤٠% مخلوط علف مركز + ٤٠% برسيم + ٢٠% قش أرز. لم تعطى المجموعة الأولى أى اضافة واعتبرت المقارنة (ت١)، بينما أضيف الزنك أوالمنجنيز ميثيونين الى المجموعات الثانية، الثالثة، بمعدل ١٠٠ ملجم زنك/رأس/يوم (ت٢)، ١٠٠ ملجم منجنيز/رأس/يوم (ت٣)، أما المجموعة الرابعة أعطيت مخلوط من الزنك والمنجنيز المخلبى بمعدل ٥٠ ملجم زنك + ٥٠ ملجم منجنيز/رأس/يوم (ت٤).

أظهرت النتائج حدوث زيادة معنوية فى معاملات هضم كل من المادة العضوية، البروتين الخام، الألياف الخام، المستخلص الايثيرى، المستخلص الخالى من الأزوت وكذلك محتوى كل من المركبات الكلية المهضومة، البروتين الخام المهضوم مع اضافة الزنك والمنجنيز ميثيونين فى المعاملات (ت ٢-٤) عن المقارنة (ت١).

زيادة المأكول من المادة الجافة، المركبات الكلية المهضومة، البروتين الخام، البروتين الخام المهضوم معنويا فى ت٢ عنه فى ت١، بينما كانت ت٣، ت٤ وسطية بينهم بدون اختلافات معنوية. كانت قيمة درجة حموضة الكرش متماثلة تقريبا للمجموعات المختلفة بدون اختلافات معنوية. زيادة تركيز الأحماض الدهنية الطيارة معنويا، بينما قل تركيز نيتروجين الأمونيا معنويا مع اضافة الزنك والمنجنيز ميثيونين مقارنة بالكنترول.

زيادة تركيز البروتينات الكلية والجلوبيولين فى البلازما معنويا، بينما قل نشاط أنزيمات الكبد (AST & ALT) معنويات فى المعاملات ت٢، ت٣، ت٤ عنه فى ت١. فضلا عن ذلك لم يختلف تركيز الألبيومين والكرياتينين فى البلازما بين المعاملات المختلفة.

حدوث زيادة معنوية فى انتاج اللبن الفعلي، اللبن المعدل ٤% دهن، محتوى كل من الدهن، البروتين، اللاكتوز، الجوامد الصلبة اللادهنية، الجوامد الصلبة الكلية في اللبن، بينما قل عدد الخلايا الجسدية في اللبن معنويا في المعاملات ت٢، ت٣، ت٤ بالمقارنة بالمعاملة ت١.

تحسنت الكفاءة التحويلية للغذاء وكذلك مقاييس الكفاءة الاقتصادية معنويا فى المعاملات ت٢، ت٣، ت٤ مقارنة بمعاملة الكنترول الخالية من العناصر المعدنية المخلبية موضع الدراسة،

أيضا اضافة العناصر المعدنية لكل من الزنك والمنجنيز المخلبى (المرتبط مع المثيونين) حسنت معنويا كل مقاييس الأداء التناسلي التي شملتها الدراسة.

نستخلص من هذه الدراسة أن اضافة شيلات الزنك والمنجنيز ميثيونين لعلائق الأبقار الحلابة أدى الى تحسن معاملات الهضم، الغذاء المأكول، نشاط تخمرات الكرش، بعض قياسات الدم، انتاج اللبن وتركيبه، معدل التحويل الغذائي، الكفاءة الاقتصادية وكذلك الصفات التناسلية بعد الولادة.