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EFFECT OF ZINC SUPPLEMENTATION AS ZINC SULFATE OR ZINC METHIONINE ON FRIESIAN CALF PERFORMANCE

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SUMMARY

This study was conducted to investigate the effect of zinc sulfate and zinc methionine supplementation on the nutrient digestibility and nutritive values of feeds, ruminal and some blood parameters and productive performance of Friesian calves. Fifteen newly born suckling Friesian calves were chosen and divided into three similar groups (5 calves each) after being fed one week on colostrums. They were then fed on ration supplemented with 40 mg of Zn in the form of zinc sulfate or zinc methionine as were their dams during the last three months of pregnancy. The experiment consisted of two stages : 1- suckling period , during which animals of the three groups were fed either starter + berseem (Trifolium alexandrinum) hay + whole milk without zinc addition (control) ,the control ration + 40 mg/head/day of zinc sulfate(first tested group) or the control ration + 40 mg/head/day of zinc methionine (second tested group). 2- growing period, animals were fed on the following rations: The control group was fed concentrate feed mixture (CFM) + berseem hay + rice straw) without zinc supplementation ; the second group was fed on the control ration + 40mg/kg dry matter intake (DMI) of zinc sulfate ; And the the third group was fed on the control ration + 40mg/kg DMI of zinc methionine . Results indicated that zinc addition either as zinc sulfate or zinc methionine increased ($P<0.05$) the digestibility of all nutrients which were reflected on the nutritive values (as TDN and DCP) of diets in the suckling and growing period . Addition of zinc sulfate or zinc methionine reduced ammonia-N and increased both TVFA's and daily gain during suckling and growing periods of Friesian calves. Also, tested rations improved serum total protein and globulin, and reduced the concentrations of both albumin and urea concentration in blood plasma.

On the basis of the foregoing results it is feasible to supplement 40 mg Zn to the diet, preferably in the form of Zn methionine rather than Zn sulphate during the last three months of pregnancy and during both calf suckling and growing period to improve growth performance and feed utilization with better economical revenue.

Keywords: Friesian calves, zinc sulfate, zinc methionine, feed intake, digestibility, ruminal and blood parameters, growth performance

INTRODUCTION

Recently a compound containing organic Zn , zinc methionine , has been reported to increase rate of gain and improve feed efficiency. Zinc from zinc methionine and zinc oxide was metabolized differently after absorption in sheep (Spears and Samsell, 1984). There is little evidence in cattle that the trace elements supplemented as organic complexes are better absorbed than are inorganic elements based on apparent absorption, retention and blood concentrations (Nockels *et al.*, 1993). Amino acid-based organic trace minerals have low availability in the rumen (Galyean, 1996), whereas zinc from polysaccharide complex organic trace minerals may be more available to ruminal bacteria (Kennedy *et al.,* 1993). The inorganic forms of the mineral, the sulfate form seems to be the most available organic source tend to have equal or greater availability than sulfate forms (Wedekind *et al.,* 1992). Improved bioavailability of zinc methionine may stimulate weight gain and feed conversion ratio in cattle, it is assumed to have a positive effect on zinc status and carcass (Spears, 1989) and (Kessler *et al.,* 2003). Greene *et al.* (1988) reported no significant differences in growth rate and feed conversion in steers fed Zn oxide or Zn methionine in excess of requirement . Ward *et al* .(1993) and Witlenberg *et al*., (1990) found no differences between bioavailability of organic and inorganic minerals. Although many studies have shown that zinc deficiency affects the immune system in humans and laboratory animals, little research has been carried out to examine the relationship between zinc status and immune function in cattle (Spears, 2000). Also, zinc methionine addition to a zinc deficient diet tended to increase the antibody titers after vaccination in recently weaned and shipped steers (Spears, *et al.,* 1991). Spears (1989) found that when zinc deficient diet was fed, the apparent absorption of Zn from Zn methionine (ZnMet) or Zn oxide (ZnO) forms was similar, but Zn retention increased with ZnMet, suggesting different metabolism following absorption. Source of Zn may also affect ruminal fermentation in ruminants. Feeding high levels of Zn from Zn sulfate altered ruminal fermentation and protozoa numbers in steers (Froetschel *et al*., 1990). If organic Zn sources remain complexed or chelated in the ruminal environment , they may affect ruminal fermentation differently from inorganic Zn. Steers supplemented with Zn proteinate had higher ruminal soluble Zn concentration than those supplemented with Zn oxide (Spears and Kegely, 2002). The present study was conducted to determine the effects of zinc sulfate ($Znso_4$) and zinc methionine (ZnMet) during the last three months of pregnancy of Friesian dairy cows on birth weight of their calves and also, investigate the digestion coefficients, nutritive values, ruminal and blood parameters and productive performance of Friesian calves during suckling and growing period .

MATERIALS AND METHODS

This study was conducted in Karada Animal Production Research Station belonging to the Animal Production Research Institute, Agricultural Research Centre, Giza, Egypt. Fifteen pregnant Friesian cows at the last three months of pregnancy were chosen and divided into three similar groups (five animals in each) balanced for LBW and age. Cows were fed on the following tested rations : 1- Concentrate feed mixture (CFM) + berseem hay + rice straw) without zinc supplementation as control group. 2- The first tested group was fed the control ration + 40 mg zinc sulfate/kgDMI. 3- The second tested group was fed the control ration + 40 mg zinc methionine /kgDMI , according to the feed allowances of NRC (1989). After calving, calves were removed from their dams after having their colostrums during the first week .The experiment included two stages, first stage was represented as suckling period (105 days), during which the calves fed whole milk (315 kg per 105 days) , starter and berseem hay (3[ed] cut) as recommended by Ghoneim (1964). Calves of the first and second tested groups were fed rations, supplemented with 40mg zinc sulfate or 40mg zinc methionine as their dams, respectively. Calves were fed on the following tested rations: 1- The control group was fed starter + berseem hay without zinc supplementation. 2- The first tested group was fed the control ration + 40mg /calf/day of zinc sulfate. 3- The second tested group was fed the control ration + 40mg/calf/day of zinc methionine . During the second stage growing period (175 days) the corresponding calves were fed on the following tested rations : 1- The control group was fed concentrate feed mixture (CFM) + berseem hay + rice straw without zinc supplementation. 2- The first tested group was fed the control ration + 40mg/kg DMI of zinc sulfate. 3- The second tested group was fed the control ration + 40mg /kg DMI of zinc methionine according to the feed allowances of NRC (1989). Feed additives (zinc methionine which contained 80.5% methionine hydroxy analogue , 15.10% zinc sulfate) and were mixed manually with whole milk during suckling period and mixed manually with some ground amounts of CFM during growing period . Rations were offered twice daily at 8 a.m. and 4 p.m. and water was offered freely. The chemical composition of ingredients and the experimental rations (DM basis %) are shown in Table (1).

Table 1. Chemical composition of ingredients and the experimental rations (DM basis %)

Item	DM	OM	CP	EE	CF	Ash	NFE
Whole milk	12.82	94.15	26.44	30.27	0.00	5.85	37.44
*Starter	92.61	91.66	17.65	4.69	5.92	8.34	63.40
**CFM	90.40	90.22	16.20	2.99	13.10	9.78	57.9.3
Berseem hay (3[ed] cut)	90.39	86.84	14.82	2.39	28.75	13.16	40.79
Rice straw	92.18	85.00	3.10	1.76	36.12	15.00	44.02
Calculated experimental rations:							
Suckling period							
Control	91.64	89.55	16.41	3.68	15.92	10.45	53.54
Control+zinc sulfate	91.68	89.65	16.47	3.73	15.45	10.35	54.00
Control +zinc methionine	91.78	89.86	16.60	3.83	14.43	10.14	55.00
Growing period							
Control	90.90	88.10	12.27	2.53	22.56	11.90	50.74
Control+zinc sulfate	90.91	88.11	12.18	2.53	22.52	11.89	50.88
Control +zinc methionine	90.93	88.08	12.05	2.52	22.64	11.92	50.87

*****Starter composed of : 40% ground maize, 11% decorticated cotton seed meal, 16% linseed cake, 15% rice bran, 15% wheat bran, 2% lime stone, and 1% sodium chloride.

** Concentrate feed mixture contained : 42% undecorticated cotton seed meal ,10% wheat bran, 30% yellow corn, 10% rice bran,5% molasses ,2% limestone and 1% common salt.

Live body weight changes and feed intake were recorded biweekly. At the end of both suckling and growing periods , three calves from each group were chosen randomly to determine the nutrients digestibility of the experimental three rations using acid insoluble ash techniques (A.I.A.) according to Van Keulen and Young (1977). Proximate analysis of feedstuffs and faeces samples were carried out according to the methods of A.O.A.C (2000). At the end of the digestion trials, rumen liquor samples were collected by stomach tube three times at just before morning feeding, 3and 6 hrs after feeding. Samples were strained through four folds of cheese cloth then pH value was immediately determined using a digital pH meter. Ammonia-N was determined according to the modified Semi-micro Kijeldahl digestion method A.O.A.C. (2000). Total volatile fatty acids (TVFA's) were determined according to Eadie *et al.* (1967). At the end of the collection period in each digestibility trial, blood samples were taken from the jugular vein from each animal and allowed to flow into acid washed heparinzied tubes and it were centrifuged at 3000 r.p.m. for 15 min. to separate plasma and stored at -20 ^{o}C until analysis .Total protein and albumin were determined according to Weichselboum (1946) and Drupt (1974) respectively. Urea concentration was determined according to Fawcett and Scott (1960). Zinc was determined according to Makino *et al.,* (1982).

The obtained data were statistically analyzed by general linear , model using ANOVA procedures of SAS (1985).The significant differences among treatments were tested using Duncan’s multiple range test, (Duncan) (1955).

RESULTS AND DISCUSSION

Nutrients digestibility and Nutritive values of the experimental rations:

Data presented in table (2) indicated that the addition of zinc sulfate or zinc methionine to the ration of the Friesian calves significantly ($p<0.05$) increased nutrient digestibilities of all nutrients during suckling and growing periods, except for EE nutrient digestibility at suckling period. The improvement in apparent digestibility coefficients with zinc methionine supplementation may be due to the improve of their absorption in the abomasums (Valdes *et al*., 2000 and Salem, 2003). These results are in harmony with those obtained by Shakweer *et a*l. (2005), Shakweer and El-Nahas (2005) and Shakweer *et al.* (2006) who found that the addition of different levels of zinc methionine to the ration of Friesian dairy cows , suckling calves and growing Friesian calves increased the digestibilities of DM, OM,CP and CF compared with those of the control group. Mousa and El-Sheikh, (2004) found that the apparent digestibility of DM, OM,CP,CF,EE and NFE were slightly increased by different levels of zinc sulfate supplementation to the ration of lactating buffaloes and buffalo-calves. Durand and Kawashima, (1980) concluded that addition of 50 mg zinc/ kg DMI of rations would optimize microbial metabolism and consequently led to improve the digestibilities of DM, OM, CP, CF, EE and NFE. Nutritive values as TDN and DCP, were significantly ($P<0.05$) increased by both zinc sulfate and zinc methionine supplementation during suckling and growing periods (Table 2). Improved of TDN and DCP might be due to the higher digestibility values of all nutrients by addition of zinc sulfate or zinc methionine supplementation. These results are in accordance with Shakweer *et al.* (2005) , Shakweer and EL-Nahas (2005) and Shakweer *et al.* (2006) who found that TDN and DCP were significantly ($P<0.05$) increased by different levels of zinc methionine addition compared to that of the control group. Mousa and EL-Sheikh (2004) found that TDN and DCP were significantly ($P<0.05$) increased by zinc sulfate addition .

Table 2. Digestion coefficients and nutritive values of rations fed to suckling and growing Friesian calves and supplemented with zinc sulfate or zinc methionine

Item	Control	Experimental ration		SE
		Control+ 40mg / kg DMI Zinc sulfate	Control + 40mg / kg DMI Zinc methionine	
Suckling period				
Digestibility (%)				
DM	59.93[c]	62.77[b]	64.20[a]	1.26
OM	60.07[c]	65.49[b]	67.48[a]	2.22
CP	56.93[b]	58.81[b]	65.61[a]	2.64
CF	49.03[b]	51.28[b]	56.95[a]	2.36
EE	59.09[a]	62.45[a]	64.27[a]	1.52
NFE	65.81[c]	71.66[b]	75.06[a]	2.70
Nutritive values %				
TDN	57.49[c]	61.66[b]	65.62[a]	2.35
DCP	9.34[b]	9.69[b]	10.89[a]	0.47
Growing period				
Digestibility (%)				
DM	63.14[b]	66.03[a]	67.05[a]	1.17
OM	65.66[b]	68.89[a]	69.94[a]	1.29
CP	64.79[b]	68.59[a]	69.57[a]	1.46
CF	59.88[b]	62.05[a]	63.38[a]	1.02
EE	64.11[b]	67.34[a]	67.65[a]	1.13
NFE	70.81[b]	73.51[a]	74.23[a]	1.04
Nutritive values %				
TDN	61.42[b]	63.49[a]	64.31[a]	0.86
DCP	7.95[b]	8.35[ab]	8.38[a]	0.14

a,b: means in the same row followed by different superscripts are significantly different (P<0.05).

Rumen parameters :

The pH value was decreased (P<0.05) at zero time with zinc sulfate or zinc methionine supplementation compared to that of the control group without no significant differences (Table 3). At 3 and 6 hrs after feeding, the mean values of ruminal pH decreased in all groups with no significant differences . These results are in line with those obtained by Shakweer *et al.* (2005), Shakweer and EL-Nahas, (2005), Shakweer *et al.* (2006) and Robinson *et al.* (2002). However, Arelovich et al. (2000) reported that pH after feeding was linearly decreased at 2 hrs after feeding, but at 6 hrs, it was linearly increased (P<0.05) by adding zinc sulfate. Concerning ammonia-N values (Table 3) the data indicated that ammonia-N significantly (P<0.05) reduced with zinc sulfate and zinc methionine addition compared to that of the control group different times at zero, 3 and 6 hrs. These results are in line with those obtained by Skakweer *et al*. (2005), Shakweer and EL-Nahas , (2005) and Skakweer *et al*. (2006) Also, ruminal ammonia- N was linearly decreased (P<0.05) by adding zinc sulfate as found by Arelovich *et al.* (2000) .This might be due to that zinc sulfate depress urease activity directly or it might inhibit growth and reduce the population of ureolytic bacteria (Arelovich *et al.,* 2000) .

Table 3. The Effect of zinc sulfate or zinc methionine supplementation on ruminal pH, NH_3, TVFA's values (n=5/ group)

Item	Time	Control	Experimental rations: Control + 40 mg / kg DMI Zinc sulfate	Experimental rations: Control+ 40 mg / kg DMI Zinc methionine	SE
pH	0	7.02[a]	6.88[a]	6.64[a]	0.11
	3	6.42[a]	6.31[a]	6.26[a]	0.05
	6	5.81[a]	5.72[a]	5.61[a]	0.06
Ammonia-N (mg/100ml RL)	0	23.10[a]	19.80[b]	18.23[b]	1.44
	3	32.19[a]	28.97[b]	28.66[b]	1.13
	6	23.89[a]	17.07[b]	17.33[b]	2.23
TVFA's (meq/100ml RL)	0	5.91[a]	6.07[a]	6.81[a]	0.28
	3	7.06[c]	7.97[b]	9.26[a]	0.64
	6	6.58[a]	6.62[a]	6.93[a]	0.11

a,b.c: means in the same row followed by different superscripts are significantly different ($P<0.05$) .

On the other hand , the concentrations of TVFA's were increased with zinc sulfate or zinc methionine supplementation compared with those of the control group at all sampling time (zero time 3 and 6hrs).The differences were significant at 3hrs post feeding (table 3). This increase in TVFA's may be due to the increase of apparent digestibility of organic matter. These results are in accordance with Arelovich *et al.* (2000), Shakweer *et al.* (2005), Shakweer and EL-Nahas (2005) and Shakweer *et al.* (2006) who reported that the increase proportion of propionate in ruminal VFA’s leads to an increased energetic efficiency of ruminal fermentation which might explain the consistent benefits obtained from addition of chelated zinc.

Blood parameters :

The data in Table (4) showed that addition of zinc sulfate or zinc methionine had no significant effect on plasma total protein concentration. among all tested rations and control ration. The plasma albumin concentration was increased with zinc sulfate addition, while plasma globulin and zinc concentrations were increased with zinc methionine addition. However, urea concentration in blood plasma was decreased either with zinc sulfate or zinc methionine addition . These results are in line with those obtained by Shakweer *et al.* (2005) , Shakweer and EL-Nahas (2005) and Shakweer *et al.* (2006) who found normal concentrations of total protein, globulin and zinc with different levels of zinc methionine supplementation. Mousa and EL-Sheikh (2004) indicated that zinc sulfate addition increased total protein and globulin concentration , while it decreased albumin and urea concentration in blood serum of buffalo calves. The increase in plasma globulin by zinc supplementation might be a refection of the rise in total protein as reported by El-Masry and Habeeb (1989) and El-Masry and Yousef (1998). Also, Malcolm-Callis *et a*l. (2000) found that zinc addition at 30 mg/kgDMI for beef steers significantly increased serum globulin concentration .

Table 4. Effect of zinc sulfate or zinc methionine supplementation on some blood parameters (n= 5/ group)

Item	Control	Experimental rations		SE
		Control + 40 mg / kg DMI Zinc sulfate	Control + 40 mg / kg DMI Zinc methionine	
Total protein g/dl	7.57[a]	7.74[a]	7.81[a]	0.07
Albumin g/dl	4.28[ab]	4.64[a]	4.06[b]	0.17
Globulin g/dl	3.29[b]	3.10[ab]	3.75[a]	0.19
Urea mg/dl	33.90[a]	32.37[ab]	31.74[b]	0.64
Zinc mg/l	0.79[b]	0.86[ab]	0.90[a]	0.03

a,b: means in the same row followed by different superscripts are significantly different($P<0.05$) .

Growth performance:

Data in Table (5) revealed that zinc methionine addition at 40 mg /kg DMI for pregnant Friesian cows during the last three months of pregnancy significantly ($P<0.05$) increased birth body weight of calves compared to those of the zinc sulfate addition and control groups without addition. While, zinc sulfate addition for pregnant Friesian cows significantly ($P<0.05$) increased birth body weight compared to that control group without addition. In addition final body weight was higher ($P<0.05$) with supplemented zinc methionine compared to that of the zinc sulfate addition and that of control group of suckling period. On the other hand, the final body weight was higher ($P<0.05$) with supplemented zinc methionine compared to that of the zinc sulfate addition and control group of growing period. At suckling period the daily gain (g/h/d) of Friesian calves given zinc methionine supplementation were significantly ($P<0.05$) higher than those of the zinc sulfate addition and control groups. While, there was no significant difference in daily gain (g/h/d) of Friesian calves given zinc sulfate and control group. The daily gain (g/h/d) of growing Frisian calves that given zinc sulfate or zinc methionine supplementation were significantly ($P<0.05$) higher than that of the control group. While , there was no significant difference in daily body weight of growing Friesian calves given zinc sulfate or zinc methionine. This improve in growth performance due to zinc supplementation was not only due to its importance through acting as a component and activator to more than 200 metalloenzymes and hormones (Riordan and Vallee 1976), but also can improve acid – base balance as stated by Halhn and Baker (1988) and digestive enzymes activities (Izhboldina 1994). The present results are in agreement with those of Goetsch *et al.* (1990) who found that the daily gain was higher ($P<0.05$) with supplemented ration (4g daily of zinc /animal) than that without zinc supplementation by beef steers . Shakweer and EL-Nahas (2005) working on weaned Friesian calves found that the daily gain was higher ($P<0.05$) with supplemented 40mg zinc methionine than that of the control group. Shakweer , *et al*. (2006) found that the addition of different levels of zinc methionine increased daily gain for growing Friesian calves. Zeedan *et a*l. (2008) found that daily gain and body weight gain were significantly ($P<0.05$) higher with buffalo-calves when fed 40mg and 80 mg zinc methionine compared to that of control ration. Mousa and EL-Sheikh (2004) found that the addition of zinc at different concentrations increased daily gain of buffalo-calves. Greene *et al.* (1988) reported that there were no significant difference in growth rate and feed conversion of steers fed zinc oxide or zinc methionine in excess of requirements. Also, Kessler *et al*. (2003) found that zinc supplementation to fattening bulls in the form zinc oxide , zinc proteinate and zinc polysaccharide did not have a significant impact on growth performance and feed conversion .

Table 5. Growth performance of suckling and growing Friesian calves given zinc sulfate or zinc methionine (n= 5/ group)

Item	Control	Experimental rations: Control + 40 mg / kg DMI Zinc Sulfate	Experimental rations: Control + 40 mg / kg DMI Zinc methionine	SE
Suckling period				
Duration /days	105	105	105	-
Bith body weight, kg	30.67[c]	35.00[b]	41.67[a]	3.20
Final body weight, kg	94.67[c]	102.33[b]	131.33[a]	11.18
Total gain, kg	64.0[b]	67.33[b]	89.66[a]	8.07
Averag daily gain, g/head/day	609[b]	641[b]	854[a]	0.08
Average daily feed intake(as DM)				
Stater DM, g/head/day	1290	1350	1400	-
Berseem hay DM, g/head/day	890	910	950	-
Total DM intake, g/head/day	2180	2260	2350	-
Total TDN, g/head/day	1253.35	1393.44	1542.15	-
Total DCP, g/head/day	204.70	219.45	254.51	-
Feed efficiency				
Kg DM/kg,gain	3.58	3.53	2.75	-
Kg TDN/kg,gain	2.06	2.17	1.81	-
Kg DCP/kg,gain	0.34	0.34	0.30	-
Growing period				
Duration /days	175	175	175	-
Initial body weight, kg	94.67[b]	102.33[b]	131.33[a]	11.18
Final body weight, kg	280.67[c]	316.67[b]	351.67[a]	20.52
Total gain, kg	186[b]	214.34[a]	220.34[a]	10.60
Average daily gain, g/head/day	1.06[b]	1.22[a]	1.26[a]	0.06
Average daily feed intake(as DM)				
CFM DM, g/head/day	3373.33	3753.33	3039.33	-
Berseem hay DM, g/head/day	1700	1896.67	2183.33	-
Rice straw DM,g/head/day	2770	3230	2690	-
Total DM intake, g/head/day	7843.33	8880	8912.67	-
Total TDN, g/head/day	4837.24	5582.88	5677.60	-
Total DCP, g/head/day	573.35	678.47	693.64	-
Feed efficiency				
Kg DM/kg,gain	7.38	7.25	7.02	-
Kg TDN/kg,gain	4.55	4.56	4.48	-
Kg DCP/kg,gain	0.54	0.55	0.55	-

a,b.c: means in the same row followed by different superscripts are significantly different ($P<0.05$) .

Feed intake as kg DM, TDN and DCP/ head are shown in table (5). The highest intake was recorded with zinc methionine supplementation followed by zinc sulfate supplementation and then control group of suckling and growing Friesian calves. On the other hand, there was an improvement in feed conversion as kg DM, kg TDN and kg DCP/ kg gain by zinc sulfate or zinc methionine addition to the ration of suckling and growing Friesian calves. The best feed efficiency as kg DM, kg TDN and kg DCP required for each kg gain was obtained with zinc methionine followed by zinc sulfate supplementation, respectively for suckling and growing Friesian calves compared with that of the control group. The present results are in agreement with those of Malcolm- Callis *et al.* (2000) who found that feed efficiency was improved with supplementation of zinc. Also, Shakweer and EL-Nahas (2005) and Shakweer and *et al*. (2006) found that feed efficiency was increased with different levels of zinc methionine supplementation for weaning and growing Friesian calves. Mousa and El-Sheikh (2004) reported that feed intake and feed efficiency were increased with adding of 40mg zinc sulfate /kg DMI for buffalo-calves compared to that of the control group .

Table 6. Economic efficiency of suckling and growing Friesian calves fed on ration supplemented with zinc sulfate or zinc methionine

Item	**Control**	**Experimental rations**	
		Control + 40 mg / kg DMI	**Control + 40 mg / kg DMI**
Suckling period			
Daily feed intake (as fed),kg			
Whole milk	3	3	3
Starter	1.390	1.460	1.510
Berseem hay (3rd cut)	0.984	1.01	1.05
Total feed intake, kg/h/d	5.374	5.470	5.560
Zinc supplement , g/h/d	0.00	0.11	0.27
Total daily feed cost (L.E.)/h/d	8.27	8.43	8.57
Average daily gain, kg/h/d	0.610	0.641	0.854
Feed cost/kg gain (L.E.)	13.56	13.15	10.04
Price of daily gain (L.E.)	10.37	10.88	14.45
Economical return (L.E/h/d)	2.10	2.45	5.88
Economic efficiency(%)	1.25	1.29	1.69
Growing period			
Daily feed intake (as fed),kg			
Concentrate (CFM)	3.750	4.190	4.830
Berseem hay (3rd cut)	1.880	2.100	2.420
Rice straw	3	3.5	4
Total feed intake, kg/h/d	8.630	9.790	11.250
Zinc supplement , g/h/d	0.00	0.9768	2.7648
Total daily feed cost (L.E.)/h/d	7.74	8.69	10.09
Average daily gain, kg/h/d	1.060	1.220	1.260
Feed cost/kg gain (L.E.)	7.30	7.13	8.01
Price of daily gain (L.E.)	16.96	19.52	20.16
Economical return (L.E/h/d)	9.22	10.83	10.07
Economic efficiency(%)	2.19	2.25	2.00

Calculations were based on the following prices in Egyptian pounds (L.E.) per ton at 2007:concentrate feed mixture (CFM)= 1600 L.E./ton, Berseem hay=700 L.E./ton, Rice straw=140 L.E./ton, zinc sulfate=30 L.E./kg, zinc methionine =40 L.E./kg, the price of one kg of live body weight 17 L.E . and 16 L.E. for suckling and growing calves respectively.

$$\text{Economic efficiency (\%)} = \frac{\text{Price of daily gain (L.E)}}{\text{Average daily feed cost (L.E.)}}$$

Economic efficiency:

The results of economical evaluation (Table 6) showed that the feed cost/kg weight gain (L.E.) of control and zinc sulfate group were higher than that of zinc methionine supplementation during suckling period. The best economic efficiency was detected with zinc methionine addition to suckling calves. On the other hand, the feed cost/kg weight gain(L.E.) with zinc methionine addition was the highest, while the lowest values were obtained with zinc sulfate supplement of growing Friesian calves. The best economic efficiency was detected with zinc sulfate addition to growing calves.

CONCLUSION

On the basis of the foregoing results it is feasible to supplement 40 mg Zn to the diet, preferably in the form of Zn methionine rather than Zn sulphate during the last three months of pregnancy and during both suckling and growing periods since it improves growth performance and feed utilization with better economical revenue.

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تأثير إضافة كبريتات الزنك وزنك مثيونين على الأداء الإنتاجي للعجول الفريزيان

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أجريت هذه الدراسة بهدف دراسة تأثير إضافة كبريتات الزنك والزنك مثيونين على معاملات الهضم والقيمة الغذائية وبعض مقاييس الكرش والدم ومعدل النمو وتكاليف التغذية والكفاءة الاقتصادية.حيث استخدم فى هذه الدراسة خمسة عشرة عجل فريزيان مولودة من أبقار مغذاة من الشهر الثالث قبل الولادة على علائق مضاف اليها ٤٠ ملجم زنك مصدرة كبريتات الزنك او ٤٠ ملجم زنك مصدرة زنك مثيونين يوميا. وقسمت العجول الى ثلاثة مجاميع (٥ عجول فى كل مجموعة) وغذيت العجول خلال فترة الرضاعة على النحو التالى١- مجموعة الكنترول غذيت على البادىء +دريس برسيم + جانب كميات البن المقررة له بدون إضافة زنك ٢- المجموعة المختبرة الاولى غذيت على البادىء +دريس برسيم+ كميات اللبن المقررة له مضافة اليها ٤٠ ملجم زنك مصدرة كبريتات زنك/عجل/اليوم ٣- المجموعة المختيرة الثانية غذيت على البادئ +دريس برسيم + كميات اللبن المقررة له مضافة اليها ٤٠ ملجم زنك مصدرة زنك مثيونين/عجل/اليوم بينما غذيت العجول خلال فترة النمو على النحو التالي: ١- مجموعة الكنترول غذيت على علف مركز+دريس برسيم+ قش الأرز بدون أى إضافة زنك. ٢- المجموعة المختيرة الأولى غذيت على عليقة الكنترول +٤٠ ملجم زنك (كبريتات الزنك/كجم مادة جافة ماكولة.٣- المجموعة المختيرة الثانية غذيت على عليقة الكنترول +٤٠ ملجم زنك ميثيونين/كجم مادة جافة ماكولة. وكانت النتائج كالاتى: إضافة زنك المثيونين فى الثلاثة شهور الأخير ومن الحمل للأبقار ادى الى زيادة فى وزن الميلاد مقارنة باوزان الميلاد للمجموعة المضافة اليها كبريتات زنك ومجموعة الكنترول. كما أظهرت النتائج ان إضافة كبريتات الزنك وزنك مثيونين ادى الى تحسن فى معاملات الهضم والقيمة الغذائية للعليقة الماكولة مقارنة بمجموعة الكنترول. اما بالنسبة لمقاييس الكرش فقد أدت إضافة الزنك على صورة كبريتات او زنك مثيونين إلى انخفاض تركيز امونيا الكرش وزيادة تركيز الأحماض الدهنية , اما بالنسبة لمقاييس الدم فقد أدت الى ارتفاع ضئيل فى تركيز بروتين الدم والجلوبيولين بينما انخفض تركيز الالبيومين ويوريا الدم مقارنة بمجموعة الكنترول. إضافة الزنك بنسبة ٤٠ ملجم /كجم مادة جافة ماكولة للعجول فى صورة زنك مثيونين او كبريتات الزنك أدت إلى زيادة ملحوظة فى معدل النمو اليومى خلال فترتي الرضاعة والنمو مع انخفاض تكاليف التغذية مع ظهور أهمية الزنك المثيونين فى خفض التكلفة وزيادة الكفاءة الاقتصادية خلال فترة الرضاعة بينما كبريات الزنك كان تاثيرها افضل فى فترة النمو وعموما فان المجموعات المختبرة التى تغذت على علائق تحتوى على زنك كان ادائها افضل من مجموعة الكنترول

وتوصى الدراسة باضافة زنك المثيونين فى الثلاثة شهور الاخيرة من الحمل حيث تؤدى الى زيادة أفضل فى وزن الميلاد أفضل من إضافة كبريتات الزنك كما أن إضافة الزنك فى صورة كبريتات الزنك او زنك مثيونين تؤدى إلى زيادة معدلات النمو وتحسن الكفاءة التحويلية للعجول من الميلاد وخلال فترة الرضاعة والنمو مقارنة

بمجموعة الكنترول كما أن إضافة زنك المثيونين للعجول الرضيعة يعطى أفضل عائد اقتصادى من إضافة كبريتات الزنك بينما إضافة الكبريتات الزنك لعلائق العجول الفريزيان النامية أعطت أفضل عائد اقتصادى.