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Effect of Mastitis on Trace Elements of Milk and Blood Serum in Friesian Dairy Cows

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Abstract: Milk and blood serum from forty five Friesian cows (15 healthy, 15 with subclinical mastitis and 15 with clinical mastitis) were used during the present study. Levels of micro minerals (Fe, Cu and Fe) were determined. The level of copper, iron and zinc in milk and blood serum of mastitis-infected cows (clinical and subclinical) and healthy cows were evaluated. When comparing healthy cows milk to those with subclinical mastitis, there was a significant decrease ($p<0.05$) in copper. Comparison between healthy and clinically infected cow's milk samples revealed a significant increase ($p<0.01$) in zinc. Comparison of clinical and subclinical mastitis revealed a significant increase of copper ($p<0.05$). Blood serum samples from subclinically and clinically mastitis-infected cows showed a significant decrease ($p<0.05$) for zinc only.

Key words: Trace element, mastitic milk, blood serum, Friesian dairy cows, Sudan

Introduction

Certain nutritionally important minerals (Ca, P, Na, K, Cu, Mn, Fe and Zn) in skim milk or in the whey may undergo significant change as a consequence of secretary disorders in the mammary glands and increased permeability of blood capillaries (Singh and Mathur, 1990). Mastitis infection was demonstrated to alter milk trace elements e.g. copper, zinc and iron (Middleton *et al.,* 2004). Similarly Verheijden *et al.* (1983) found that mastitic cow's milk contained slightly less zinc than those from healthy quarters. El Deeb and Hassan (1987) reported significantly higher levels of ash, copper and iron as a result of mastitis. Kozlowski (1978) obtained 78.8% more copper and 196.3% more iron from quarters of 75×10^5 cells/mL on an average than milk from healthy quarters (about 10×10^4 cells/mL). Mohamed *et al.* (1999) concluded that the changes in macrominerals levels in individual milk samples can be indictor of udder or quarter infection. Moreover Mohamed *et al.* (1999) concluded that the level some minerals (Ca, Na, K, Mg, P, Fe, Zn and Cu) in milk samples can be efficient procedure for monitoring abnormalities of bovine mammary glands.

Erskine and Bartllet (1993) found that experimental *E. coli* mastitis resulted in mean serum concentration of zinc, iron and copper of 28, 35 and 52% of prechallenge concentration. Moreover, they concluded that changes in trace elements might occur too late in the pathogenicity of infection.

The present study was aimed to determine the levels of trace elements (copper, zinc and iron) between healthy and mastitic (clinical and subclinical) cow's milk and blood serum.

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Materials and Methods

The present study was carried out on lactating dairy cows of the Arab Company for Agricultural Production and Processing (Dairy land) during 1992 in Khartoum, Sudan. According to the CMT scores, the cows were selected as clinically, subclinically mastitis- infected cows and mastitis free cows (15 samples each).

The method used for the determination of trace elements concentration in milk and blood serum were obtained from the atomic absorption spectrophotometer (2390 Perkin- Elmer, Germany). The procedures were described in the technical manual of the atomic absorption spectrophotometer. The different concentrations of metals (standard and samples) were measured at specific waves lengths (I. e., zinc 213.9, iron 248.7 and copper 324.8 nm). The data obtained, were then transferred from part per million (ppm) to mg/100 mL.

The data obtained were then analyzed according to Gill (1978) in the Randomized Complete Block Designs (RCBD), using co-variance analysis and t-test.

Results

Table 1 showed that copper decrease in subclinical mastitis milk initially and after three weeks (0.0621±0.034 VS. 0.0547±0.038 mg/100 mL, respectively). Similarly, the clinical milk samples increased, initially and after three weeks (0.0727±0.055 VS. 0.2040±0.260 mg/100 mL) compared with that from healthy cow's milk (0.0713±0.033 VS. 0.0807 ±0.021 mg/100 mL), respectively.

Zinc levels were reduced in healthy cow's milk samples after three weeks of the first collection (0.0046±0.002 VS. 0.0038±0.001 mg/100 mL), while the clinical mastitic milk samples showed increased levels (0.0057±0.001 VS. 0.0060±0.004 mg/100 mL). However there were no changes due to subclinical mastitis- infection (0.0047±0.001 VS. 0.0047±0.001 mg/100 mL).

Iron increased with severity of mastitis-infection (0.1100±0.085, 3.2001±11.841 and 0.192±0.208 mg/100 mL) for healthy cow's milk, subclinical and clinical mastitic milk, respectively. After three weeks, the level of iron in normal milk samples was increased to 0.164±0.097 mg/100 mL. However, there was a reduction in subclinical and clinical mastitic milk samples to about 0.1273±0.217 and 0.1400±0.057 mg/100 mL, respectively.

Table 1: Mean values of trace elements of the healthy cows milk, subclinical and clinical mastitic cow's milk, initially and after three weeks

	Healthy cow's milk (mg/100 mL)		Subclinical mastitic milk (mg/100 mL)		Clinical mastitic milk (mg/100 mL)	
Trace elements	R1	R2	R1	R2	R1	R2
Copper	0.0713±0.033	0.081±0.021	0.062±0.034	0.0547±0.038	0.0727±0.055	0.204±0.260
Zinc	0.0046±0.002	0.0038±0.001	0.0047±0.001	0.0047±0.001	0.0057±0.001	0.006±0.004
Iron	0.1100±0.085	0.164±0.097	3.2001±11.841	0.1273±0.217	0.192±0.208	0.1400±0.057

R1: mean values initially, R2: Mean values three weeks later

Table 2: Comparison of mean differences of trace elements of the healthy, subclinical and clinical mastitic milk, initially and after three weeks

	Healthy cow's milk (mg/100 mL)			Subclinical mastitic milk (mg/100 mL)			Clinical mastitic milk (mg/100 mL)		
Trace elements	Difference mean	Standard deviation	Standard error of mean	Difference mean	Standard deviation	Standard error of mean	Difference mean	Standard deviation	Standard error of mean
Copper	-0.0093	0.042	0.011	-0.0008	0.002	0.001	-0.0549	0.137	0.035
Zinc	0.0073	0.051	0.013	0.0000	0.001	0.000	3.0727	11.833	3.055
Iron	-0.1313	0.282	0.073	-0.0003	0.004	0.001	-0.5200	0.840	0.047

**: p<0.01, ***: p<0.001

Table 3: Comparison of mean differences of trace elements of the healthy cow's milk, subclinical and clinical mastitic cow's milk

	Healthy and subclinical masticmilk (mg/100 mL)			Healthy and clinical mastitic milk (mg/100 mL)			Subclinical and clinical mastitic milk (mg/100 mL)		
Trace elements	Difference mean	Standard deviation	Standard error of mean	Difference mean	Standard deviation	Standard error of mean	Difference mean	Standard deviation	Standard error of mean
Copper	-0.0177	0.026	0.007*	0.0623	0.126	0.033	0.0800	0.129	0.033**
Zinc	-0.0005	0.002	0.000	0.0016	0.002	0.001**	0.0012	0.002	0.001
Iron	1.5267	5.931	1.531	0.0290	0.144	0.037	1.4977	5.939	1.633

*: $p < 0.05$, **: $p < 0.01$

Table 4: Mean values of blood serum trace elements of healthy cow's, subclinical- and clinical- mastitic cows initially and after three weeks

	Healthy cow's blood serum (mg/100 mL)		Subclinically- infected blood serum (mg/100 mL)		Clinically- infected blood serum (mg/100 mL)	
Trace elements	R1	R2	R1	R2	R1	R2
Copper	0.0084± 0.003	0.0059± 0.001	0.0065± 0.002	0.0088± 0.002	0.0053± 0.002	0.007± 0.005
Zinc	0.0076± 0.003	0.0161± 0.010	0.015± 0.0040	0.0370± 0.037	0.0253± 0.009	0.096± 0.124
Iron	0.0100± 0.003	0.0081± 0.004	0.007± 0.0010	0.0089± 0.005	0.0071± 0.002	0.007± 0.004

R1: mean values initially, R2: Mean values three weeks later

Table 5: Mean differences of blood serum trace elements contents of the healthy, subclinical and clinical mastitic cows

	Healthy cow's blood serum (mg/100 mL)			Subclinical-infected blood serum (mg/100 mL)			Clinical-infected blood serum (mg/100 mL)		
Trace elements	Difference mean	Standard deviation	Standard error of mean	Difference mean	Standard deviation	Standard error of mean	Difference mean	Standard deviation	Standard error of mean
Copper	0.0025	0.003	0.001**	-0.001	0.003	0.001	-0.0017	0.005	0.001
Zinc	-0.0085	0.012	0.003**	-0.0221	0.037	0.009*	0.0707	0.124	0032*
Iron	0.00190	0.004	0.001	-0.0015	0.005	0.001	0.0005	0.0005	0.100

*: $p < 0.05$, **: $p < 0.01$

Table 2 revealed non significant differences for the trace elements between healthy cow's milk and those with subclinical and clinical mastitic milk, initially and after three weeks. However when comparing the healthy cow's milk to those of subclinical mastitis, the level of copper showed significant decrease ($p<0.05$). Comparison between subclinical and clinical mastitic milk revealed a significant increased of copper ($p<0.05$), while comparison between healthy cow's milk and clinical mastitic milk revealed highly significant increase of zinc ($p<0.01$) as shown in Table 3.

Blood serum trace elements level did not show noticeable changes due to mastitis-infection during the present investigation (Table 4).

Table 5 shows significant increase of copper ($p<0.01$) and significant decrease of zinc level ($p<0.01$) in healthy cow's blood serum samples. Zinc level also showed a significant decreased in subclinically-and clinically-infected blood serum samples ($p<0.05$).

Discussion

The slight increased mean values of zinc in clinical mastitic milk (Table 1), the significant increased ($p<0.05$) of clinical mastitic milk compared to healthy milk (Table 2) and subclinical and clinical- infected blood serum ($p<0.05$), were in agreement with Tallamy and Randolph (1970) and El Deeb and Hassan (1987), who obtained significantly more zinc in mastitic milk. However, the present result disagreed with Verheijden *et al*. (1983) that mastitic milk contained less zinc than healthy cow's milk.

The non significant increase in iron contents for both subclinical and clinical mastitis milk (Table 1 and 5) were similar to Kozlowski (1978). Similarly, Tallamy and Randolph (1970) and Buruiana *et al*. (1981) and El Deeb and Hassan (1987) obtained more iron in mastitic milk.

The non significant differences in copper content of clinical mastitic milk samples (Table 1 and 5), the significant decrease between healthy cow's milk and subclinical mastitic milk level of copper ($p<0.05$) and the significant decrease of copper level in subclinical compared to clinical mastitic milk ($p<0.05$) as shown in Table 3 were in agreement with Tallamy and Randolph (1970), El Deeb and Hassan (1987) and Kozlowski (1978).

Blood serum trace elements levels showed non significant levels (Table 4). This supported Erskine and Bartlett (1993) who found that the serum trace elements might occur too late in the pathogenesis of infection. The increase; as they reported; starts with the beginning of the decline phase of bacterial counts of milk. Fe and possibly Zn, sequestration during acute infections may be a mechanism to eliminate or to reduce pathogenic agents (Klasing, 1984).

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