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TRACE ELEMENT CONCENTRATIONS IN ILL-THRIFT CALVES IN RELATION TO THE ECOLOGY OF EL-KHARGA OASIS, THE NEW-VALLEY PROVINCE, EGYPT

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ABSTRACT

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Mineral imbalance in water and forages inhibit livestock production in tropical and subtropical parts of the world. This study aimed to determine trace element concentrations in blood serum of healthy and unthrifty calves and their relation with the surrounding environment including the trace element content in the soil, in addition to food and water allowed to these animals. A total of 20 yearling ill-thrift crossbred calves (group A) were chosen from El-thawra village (area A), where unthrifty calves occur. A similar number of healthy crossbred calves were chosen from El-Sabat area (area B) as a control group (group B). Results revealed that the area A soils have higher Fe and Mn ($P < 0.001$) and lower Cu and Zn ($P < 0.003$ and 0.004, respectively) than the area B. The area A forages have higher Fe and Mn ($P < 0.001$) and lower Cu and Zn ($P < 0.2$ and <0.001, respectively) than the area B. Both areas have higher Fe and Mn and lower Cu and Zn in water than the recommended levels. Values of serum Fe or Mn for both groups were within the published reference ranges. However, 10% and 55% of calves had lower Cu, and 15% and 60% had lower Zn in the groups B and A, respectively, than the reference ranges. On the other hand, blood serum of group B had significantly lower Cu ($P < 0.001$) and Zn ($P < 0.001$) than that of group A. It can be concluded that soil, forages and water in some localities in El-Kharga oasis are deficient in Cu and Zn and contain high concentrations of Fe and Mn. These mineral disturbances may directly affect the health of calves reared in these areas.

***Key words:** Ill-thrift calves, Trace element, El-kharga the New-valley province.*

INTRODUCTION

Mineral imbalance in water, soil and forages inhibit livestock production in tropical and subtropical parts of the world. One of the greatest challenges in pasture management is meeting the nutrient requirements of the ruminant due to variable forage quality. Previous research has shown that location and soil parent material were significant factors contributing to mineral uptake by forages (Suttle, 2010).

By the beginning of the 21st century, the plant life in the oases of Egypt has completely changed. About 500,000 acres are expected to be reclaimed and cultivated in the western desert after transferring the Nile water to these areas through the Toschka canal.

Relations between the geochemical nature of soils and their parent materials and the occurrence of nutritional deficiencies and excesses in grazing livestock have been documented since the 1960s and earlier (Miller and Stake, 1974). The scientists now have more advanced tools to facilitate the understanding of processes in the soil–plant–animal ecosystem that influence and control the supply of essential nutrient elements (Thornton, 2002).

For several decades, a major goal in the veterinary research has been to assess mineral status of animals, in which there are important practical problems (McDowell, 1997). Nowadays, mineral metabolism has reached a new importance and received a new stimulus with the development of instrumental tools and veterinary studies. It has been established that the status of these elements in animal body is the mirror image of the health, growth, productive and reproductive ability of livestock. The lack of adequate amounts of minerals is the major constraint limiting livestock production worldwide (Underwood and Suttle, 1998; Suttle, 2010).

McDowell (2003) concluded that the micronutrient deficiencies is the most commonly encountered in the field are of a marginal nature, often with non-specific ill thrift as the only sign of a disorder. Therefore, tests of blood and tissue are relied on to identify which micronutrient might be limiting productivity. For many of the micronutrients, biochemical changes in blood precede dysfunction, so monitoring of these changes provides early warning.

New-Valley is an arid inland tropical area. Soil nature is sandy limestone with low humus and low annual precipitation. Areas of such conditions are disturbed in mineral constituents and these minerals are readily leached from these soils by irrigation. Consequently, these possible disturbances in minerals in these soils may be directly reflected on mineral concentrations in the agricultural and local foods allowed to animals in this area (Khalil *et al.,* 2004). In turn these disturbances of minerals in soil and plant may be directly or indirectly affect the concentrations of these minerals in rearing animals and their health (Suttle, 2010).

Under these circumstances, however, mineral status of grazing ruminants is not well quantified under the local environment of the New-Valley region and the precise impacts of deficiencies are uncertain.

This study aimed to determine trace element concentrations in blood serum of healthy and unthrifty calves and their relation with the surrounding environment including the trace element content in the soil, in addition to food and water allowed to these animals.

MATERIALS and METHODS

Animals:
Crossbred calves (Friesian x Balady) in some localities in El-Kharga oasis are suffering from ill-thrift, poor growth, dullness and harsh coat. A total of 20 yearling ill-thrift crossbred calves (group A) were chosen from El-Thawra village (area A), where unthrifty calves occur. A similar number of healthy crossbred calves were chosen from El-Sabat area (area B) as a control group (group B). All calves were subjected to careful clinical and laboratory examination to judge their health status, and to ensure the absence of debilitating diseases or parasites.

Sampling:
Five soil samples at 20–30 cm depth were taken from pastures used for animal feeding in the studied areas. Samples were air-dried, ground, mixed and sieved. One gram from each sample was placed in a 125 ml conical flask and 20 ml of 0.005 M ammonium bicarbonate diethylene-triamine-penta-acetic acid (AB-DTPA) solution was added to it. After shaking the samples for 15 min, they were filtered through Whatman ashless filter paper. A clear supernatant was obtained by centrifuging for 20 min at 3000 rpm and stored in plastic bottles according to methods described by AOAC (1995).

Five samples from Barseem Hegazi (*Medicago sativa*), the main forage used for feeding of calves in these areas, were collected from the same points where soil samples were collected in the two areas. These samples were washed with 1% HCI, followed by four washes with distilled water to remove dust particles. These samples were then oven-dried at 70 ºC and ground to a powder, stored in clean, dry brown paper bags for further analysis (AOAC, 1995). The dried ground material (0.5 g) was digested in sulphuric acid and hydrogen peroxide according to the method of Wolf (1982).

Water was sampled directly from the well opening or the main water source in the studied areas to represent a non-soil contaminated sample. A clean, sterile one liter capacity bottles were used and crocked well after it were filled with water. These bottles were sent immediately to the laboratory for biochemical analysis according to methods described by AOAC (1995).

Blood was drawn from the jugular vein of all the selected calves in centrifuge tubes. The blood was allowed to coagulate and the harvested serum was stored at -20°C until processing.

Trace elements analysis:
Micro-nutrients (Fe, Cu, Zn and Mn) in soil, pasture and water were determined in the Regional Laboratory for Soil Analysis, New-Valley governorate, using atomic absorption spectrophotometer (GBC 932 AA) air-acetylene type according to manufacture instructions**.**

For determination of micro-minerals in serum, two mls of serum were digested with a 4 ml mixture of perchloric acid and nitric acid (1:1) using hot plates. After digestion, the volume was made up to 25 ml with bi-distilled water for determination of the micro-minerals (Fe, Cu, Zn and Mn) using atomic absorption spectrophotometer (GBC 932 AA) air-acetylene type according to manufacture instructions**.**

Statistical analysis:
Data were analyzed using the packaged SPSS program for windows version 10.0.1 (SPSS Inc., Chicago, IL.). Differences between groups were determined by the one way analysis of variance (ANOVA) followed student's t test. Data were presented as least squares means (LSM) and standard error of means (±SEM). Significance level was set at $P < 0.05$.

RESULTS

Extractable mineral concentrations of soils:
The mean values (ppm ± SE) of Fe, Cu, Zn and Mn concentrations in the area A, B soils are illustrated in table 1. The area A has significantly higher Fe and Mn (P < 0.001) and lower Cu and Zn (P < 0.003 and 0.004, respectively) than the area B.

Mineral concentrations of forage:
The mean values (ppm ± SE) of Fe, Cu, Zn and Mn concentrations in forages in the examined areas are shown in table 2. The area A forages have significantly higher Fe and Mn (P < 0.001) and lower Cu and Zn (P < 0.2 and <0.001, respectively) than the area B.

Mineral concentrations of water:
The values of trace elements in water in the studied areas are presented in table 3. Both areas have higher Fe and Mn and lower Cu and Zn than the recommended levels by Schlink *et al.* (2010).

Mineral concentrations in calves:
The mean values of concentrations of Fe, Cu, Zn and Mn concentrations in serum of calves are illustrated in table 4 and Fig 1. It was noticed also that none of the studied calves had lower values of serum Fe or Mn than the published reference range. However, 10% and 55% of calves had lower Cu, and 15% and 60% had lower Zn in the groups B and A, respectively, than the reference ranges. On the other hand, blood serum of group A had significantly lower Cu (P < 0.001) and Zn (P < 0.001) than that of group B.

Table 1: Extractable trace element concentrations (ppm) of soils (mean±SE).

Mineral	Area A	Area B	*P*-value	Reference range*
Fe	895.9±0.24	412.1±0.14	<0.001	1-10
Cu	0.11±0.02	0.19±0.05	0.003	0.20
Zn	0.71±0.09	0.91±0.09	0.004	1.0
Mn	2400.1±104.3	397.3±55.2	<0.001	300-1100

* Suttle (2010).

Table 2: Trace element concentrations (ppm) of forage (mean±SE).

Mineral	Area A	Area B	*P*-value	Reference range*
Fe	394±8.4	201.6±6.1	<0.001	50.0
Cu	3.09±0.76	4.67±0.81	<0.001	5.00
Zn	5.88±0.29	6.41±0.21	0.024	7-10
Mn	442.1±41.1	201.3±23.3	<0.001	86

*Suttle (2010).

Table 3: Trace element concentrations (ppm) in water.

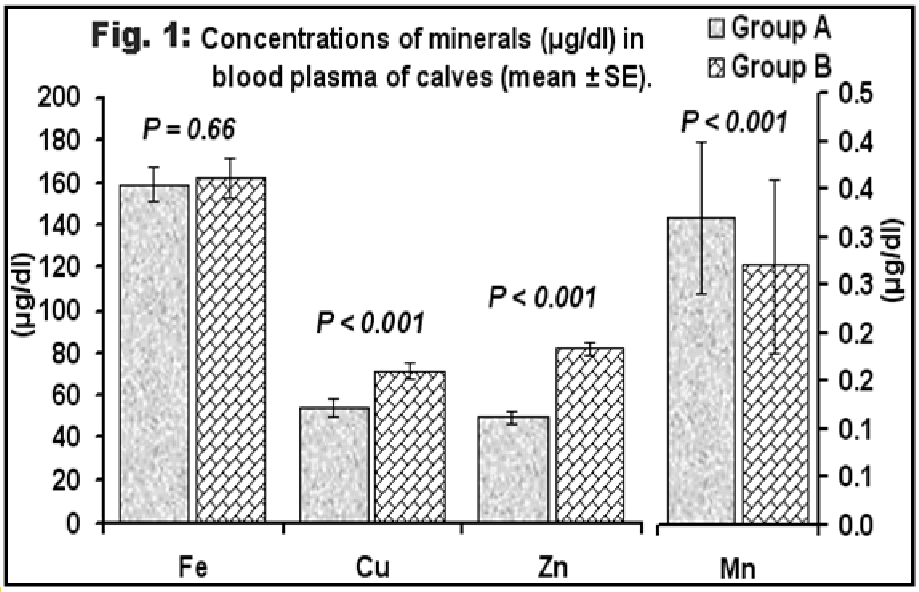
Mineral	Area A	Area B	Maximum level*
Fe	4.983	5.144	0.50
Cu	0.002	0.002	0.2
Zn	0.0039	0.0041	0.5
Mn	4.300	2.700	0.5

* Schlink *et al.* (2010)

Table 4: Concentrations of minerals (µg/dl) in blood plasma of calves (mean±SE).

	Group A		Group B		*P*-value	RR*
	Mean±SE	% of calves less than RR	Mean±SE	% of calves less than RR*		
Fe	159.2±8.5	00 %	162.5±9.6	00 %	0.066	70-230
Cu	54.1±4.2	55 %	71.41±3.8	10 %	0.001	>60
Zn	49.4±3.1	60 %	82.21±2.9	15 %	0.001	>60
Mn	0.32±0.08	00%	0.27±0.09	00%	0.001	0.15-0.28

* RR: Reference range according to Suttle (2010).



DISCUSSION

Micronutrient deficiencies most commonly encountered in the field are of a marginal nature, often with non-specific ill thrift as the only sign of a disorder. Therefore, studies on the geochemical nature of soils and their parent materials in addition to tests of animal's blood are relied on to identify which micronutrient might be limiting productivity. For many of the micronutrients, biochemical changes in blood precede dysfunction, so monitoring of these changes provides early warning (Suttle, 2010).

The soil of area A has a significantly higher Fe and Mn (P < 0.001) and a lower Cu and Zn (P < 0.03 and 0.004, respectively) than the area B. In addition, the concentrations of Fe and Mn are higher than the recommended levels cited by Thornton (2002) and Suttle (2010). Furthermore, Cu contents is lower than the critical levels cited by Suttle (2010). Our results in this respect concur with the findings of Khalifa *et al.* (1996), Abdel Aziz (1998) and Khalil *et al.* (2004). Mehana and Abdul Wahid (2002) found that most of the reclaimed areas, which planned to be cultivated in Egypt, are sandy soils with alkaline pH.

Area A forages has higher concentrations of Fe and Mn than the forages of area B, and both areas has higher Fe and Mn than the recommended levels cited by Thornton (2002) and Suttle (2010). On the other hand, Area A forages has lower concentrations of Cu and Zn than the forages of area B, and both area has lower Cu and Zn than the recommended levels cited by Thornton (2002) and Suttle (2010).

Mineral concentrations in water in the studied areas have the same trend of that of the soil and forage. Fe and Mn content in water are higher than the permissible levels cited by Schlink *et al.* (2010) and WHO (2011). Mn content in water of the area A is higher than the area B.

The physiologic effects of the essential mineral elements depend on the level of intake. There is a range of intake, the so-called safe and adequate range, which provides optimal function. At intakes progressively below this range there is graded decrease in function until overt signs of deficiency appear (McDowell, 1997).

In the present study, trace element concentrations in the soil, forages and water directly reflected on their concentrations in the serum of calves grazing on these areas. Both plasma Fe and Mn were within the normal reference ranges cited by Thornton (2002) and Suttle (2010). However, 55 % and 60 % of calves of group A had lower Cu and Zn, respectively, than the reference range compared with 10 % and 15 %, in calves of group B, respectively. kerr (2002) reported that forage mineral composition can have a significant effect on animal performance and health, as they are often not in balance with the nutrient requirements of the animals. Hypocuprosis and hypozencosis are the major causes of anorexia, growth retardation, anemia and harsh coat in calves (Suttle, 2010).

Manganese and iron excess in the diet can trap sulphate in the rumen and impair Cu and Zn metabolism by binding of sulfide ions (S^{2-}) to soluble Fe from rumen producing iron sulfide (FeS), preventing Cu to bind to S^{2-}, hindering thus the absorption of this element, binding of Cu to insoluble iron compounds, and by the utilization of nonspecific transporters of multiple metals by soluble Fe, thereafter preventing the Cu and Zn to bind to this carries and be absorbed (Hansen *et al.*, 2006; Hansen and Spears, 2008 and Hansen *et al.*, 2009). In pastures containing 140–200 mg Mn kg^{-1} DM, the growth rate is significantly depressed and reduction in plasma iron was evident despite the fact that the pastures contained 1100–2200 mg Fe kg^{-1} DM (Suttle, 2010).

It can be concluded that soil, forages and water in some localities in El-Kharga oasis are deficient in Cu and Zn and contain high concentrations of Fe and Mn. These mineral disturbances may directly affect their concentrations in animal tissues and impair the health of calves reared in these areas.

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تركيز العناصر النادرة في العجول الهزيلة وعلاقتها ببيئة الواحات الخارجة - محافظة الوادي الجديد

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اختلال توازن المعادن في المياه والحشائش يؤثر على الإنتاج الحيواني في المناطق الاستوائية وشبه الاستوائية من العالم. هدفت هذه الدراسة إلى تحديد تركيز العناصر النادرة في مصل دم العجول السليمة والهزيلة وعلاقتها بتركيز تلك المعادن في البيئة المحيطة بما في ذلك محتوى العناصر النادرة في التربة، بالإضافة إلى الغذاء والماء المتاح لهذه الحيوانات. وقد تم اختيار ٢٠ من العجول الهجين الهزيلة عمره سنة تقريبا (المجموعة A) من قرية الثورة (منطقة A)، حيث توجد العجول الهزيلة. وقد تم اختيار عدد مماثل من العجول الهجين السليمة من منطقة السبط (منطقة B) كمجموعة ضابطة (المجموعة B). أوضحت النتائج أن تربة والحشائش في المنطقة A أعلى في تركيز الحديد والمنغنيز وأقل في تركيز النحاس والزنك من المنطقة B. وأظهرت النتائج أيضا أن المياه في كلتا المنطقتين تحتوى على نسبة أعلى في تركيز الحديد والمنغنيز وعلى نسبة أقل في تركيز النحاس والزنك من المستويات الموصى بها. كانت قيم الحديد أو المنغنيز في مصل المجموعتين من العجول ضمن نطاق المرجعية المنشورة. ومع ذلك، كان ١٠٪ و ٥٥٪ من العجول تحتوى على تركيز منخفض من النحاس ، و ١٥٪ و ٦٠٪ تحتوى على تركيز منخفض من الزنك عن النطاقات المرجعية في المجموعة B و A على التوالي. من ناحية أخرى، كان مصل الدم في المجموعة A أقل في محتوى النحاس والزنك عن المجموعة B. يمكن أن نخلص إلى أن التربة واالحشائش والمياه في بعض المناطق في واحة الخارجة تعاني من نقص في النحاس والزنك وتحتوي على تركيزات عالية من الحديد والمنجنيز. هذه الاضطرابات المعدنية قد تؤثر بشكل مباشر على صحة العجول المرباة في هذه المناطق.