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A PILOT STUDY ON COPPER LEVEL AMONG DOMESTIC ANIMALS IN ISMAILIA GOVERNORATE

(With One Table)

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دراسة عن مستوى عنصر النحاس فى حيوانات الحقل بمحافظة الاسماعيلية

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نظرا لأهمية تأثير بقايا المعادن فى الأنسجة الحيوانية على صحة الحيوان وسلامة الأغذية ذات الأصل الحيوانى تم اجراء هذه الدراسة وذلك لتعيين نسبة عنصر النحاس فى الأبقار والجاموس والجمال والخراف والماعز فى محافظة الاسماعيلية – مصر باستخدام جهاز الامتصاص الذرى. تم جمع عدد ٣٠٣ عينة من الحيوانات المذبوحة بمجزر الاسماعيلية والتى يتراوح أعمارها بين ٦ و ٣٦ شهر وأظهرت النتائج أن متوسط تركيز عنصر النحاس فى عينات الكبده والكلاوى والعضلات والشعر ومصل الدم ٣١.٣٣ ، ١٠.٨٧، ٥.٥٥ ، ٧.٤٤ و ٠.٩ لعينات الجمال و ٢٧.٦١ ، ٦.٠١ ، ٤.١ ، ٧.٨٤ ، ٠.٧٩ لعينات الجاموس و ٢٥.١ ، ٥.٦١ ، ٤.٥٢ ، ٦.٩٢ و ٠.٧٨ لعينات الأبقار و ٣٧.٤٤ ، ٨.٠٨ ، ٧.٢٣٥ ، ١٠.٠٣ و ٠.٧٥ لعينات الخراف وأخيرا ٢٥.٢٣ ، ٣.٦٢ ، ٤.٧٥ ، ٦.٣٣ و ٠.٦٤ لعينات الماعز. وقد سجلت عينات الكبد أعلى نسبة لعنصر النحاس فى حين سجلت عينات الشعر أقل نسبة للعنصر فى جميع الحيوانات. كما أظهرت النتائج أن عينات الخراف سجلت أعلى نسبة للعنصر تليها عينات الجمال ثم الجاموس ثم الماعز وأخيرا الأبقار.

SUMMARY

Monitoring levels of mineral concentrations in animal tissues is important for assessing the effect of contamination on animal health and safety of animal origin products in human nutrition. This study evaluated the levels of copper in cattle, buffaloes, camels, sheep and goats reared in Ismailia Governorate, Egypt. Samples of 303 animals aged 6-36 months were collected from the Governorate slaughterhouse at slaughtering and analyzed after acid digestion using atomic absorption spectrophotometer (AAS). The mean concentrations obtained per wet weight (ppm) for liver, kidney, muscle, hair, serum were 31.33, 10.87, 5.55, 7.44 and 0.90 in camels; 27.61, 6.01, 4.10, 7.84, and 0.79 in

buffaloes ; 25.10, 5.61, 4.52, 6.92 and 0.78 in cows; 37.44, 8.08, 7.235, 10.03 and 0.75 in sheep and 25.23, 3.62, 4.75, 6.33 and 0.64 in goats. The highest concentration of copper was in liver while the lowest was in hair for all animals. The results indicated that sheep had the higher liver copper concentrations, followed by camels, buffaloes, goats and then cows.

Key words: *Copper, trace elements, domestic animals.*

INTRODUCTION

Copper is an essential trace element for human and animals. Its deficiency is known to cause anemia, diarrhea, bone disorders, neonatal ataxia, changes in hair and wool pigmentation, infertility, cardiovascular disorders, impaired glucose and lipid metabolism and a depressed immune system (Davis and Mertz, 1987). Copper is a key component of many enzyme systems which when impaired can directly or indirectly cause many of the symptoms of copper deficiency.

Because many of the copper deficiency symptoms are general in nature, a clear diagnostic tool that accurately reflects the copper status of the animal is needed. Although serum and plasma copper concentrations are often measured, blood levels may not show the deficiency until severe symptoms develop (Hemken *et al*., 1993). Liver copper concentration is probably the most sensitive indicator of changes in copper status and its determination is recommended when liver biopsies can be obtained. Ceruloplasmin concentrations and superoxide dismutase activity in the blood or red blood cells can be useful indicators of copper status.

Dietary copper requirements vary greatly among species. The recommended levels for one species may cause toxicity in another. For example, 10 ppm is the NRC recommended level for dairy cattle but under certain conditions 10 ppm can cause toxicity in sheep (Church and Pond 1988). By comparison, growing pigs are often fed 100 to 250 ppm of copper in the diet to improve growth. According to the National Research Council, poultry require approximately 8 ppm copper.

The daily copper requirement for different animals recorded in ppm as: swine 5-6; poultry 6-8; horses 9; dairy cattle 12-16; beef cattle 10 (4-15); sheep 7-11; and goats 10, other animals 0.4-7.3. While toxic level in total diet (ppm) as: swine >250; poultry 250-500; dairy cattle 40; beef cattle 100; sheep 25; goats 8-25. (Larry, 1994)

In the liver the adequate amount of copper is 25 to 100 ppm wet weight and in the bovine serum falls between 0.60 and 1.50 ppm wet weight (Puls, 1994).

In the present investigation we tried to give an indicator about copper level among cattle in Ismailia Governorate through EFARP (Egyptian Finnish Agriculture Research Project).

MATERIALS and METHODS

Three hundred and three Samples including blood for serum separation, liver, kidney, muscles, hair and wool were collected from cattle, buffaloes, camels, sheep and goats at Ismailia Governorate. These samples were collected when the animals were slaughtered; samples then transported immediately on ice to the laboratory and kept in deep freezer at -18 ^{o}C until digestion.

Blood serum samples were diluted with n-butanes: bidistilled water (6:94 v/v) and analyzed for copper by atomic absorption spectrophotometer model Aurora AI 1200 according to Meret and Henkin (1971).

Tissue samples, hair and wool were analyzed for copper after wet ashing by a mixture of nitric and perchloric acids on hot plate as descried by Valentine *et al.* (1987). One gram portion of sample was digested in 10 ml of nitric acid / perchloric acid 1:1. Digestion continued on hot plate until organic matter was destroyed and the solution evaporated to dryness. To each of digested sample, 15 ml of 6 N HCl was added and used for copper measurement

RESULTS

Table 1: Copper content (mean ± SE) in samples collected from apparently healthy animals at slaughtering.

Animal	Number of Animals	Cu content (ppm weight)				
		Liver	Kidney	Muscle	Hair	Serum
Camels	15	31.33±3.41	10.87±3.48	5.55±1.50	7.44±2.01	0.90±0.15
Buffaloes	125	27.61±2.88	6.01±0.51	4.10±0.30	7.84±0.48	0.79±0.05
Cows	98	25.10±3.00	5.61±0.43	4.52±0.37	6.92±0.90	0.78±0.08
Sheep	49	37.44±6.09	8.08±1.64	7.23±1.35	10.03±1.90	0.75±0.14
Goats	16	25.23±0.67	3.62±0.59	4.75±1.44	6.33±1.61	0.64±0.10

DISCUSSION

Copper is a component of several enzyme systems and the measurement of these could provide a more accurate measure of rate limiting factors associated with copper deficiency (Gay *et al.*, 1988)

Distribution of total body copper will vary with species, age and copper status, but it is generally higher in the tissues of liver, brain, kidneys, heart and hair. In ruminants, normal liver storage of copper can be very high as compared to other species, since liver (dry matter basis) normally contains approximately 100 and 400 ppm for mature cattle and sheep, respectively (Bull,1980)

Liver is the main storage organ of copper and is currently considered the tissue of choice for most accurate measurements of copper status (Claypool *et al.*, 1975). In this study liver copper concentrations (mean ± SE) in camels, buffaloes, cows, sheep and goats (Table, 1) are 31.33±3.41, 27.61±2.88, 25.10±3.00, 37.44±6.09 and 25.23±0.67 respectively.

The results indicate that local bread sheep had the higher liver copper concentrations, followed by camels, buffaloes, goats and then cows. Underwood (1977) found that normal copper concentrations of liver tissues will vary with species, age and the disease condition of the animal. Lazzaro (2007) recorded that copper accumulate in the liver of sheep more readily than other farm animals while, Phillippo and Graca (1983) described that cattle limiting hepatic storage sooner than sheep by means of biliary secretion. Moreover, Zervas *et al.* (1990) observed that goats retain less copper in their livers than sheep when exposed to excess, presumably because they share with cattle a propensity for billiary copper secretion.

While, the mean values of liver copper concentrations in local animals are above concentrations considered to be indicative for copper deficiency, copper concentration below 10 ppm wet tissue are found in 11.11% of camel, 14.44% of buffaloes, 32.86% of cows, 10.34% of sheep and 33.33% of goats.

In cattle, the adequate amount of liver copper is 25 to 100 ppm wet weight (Puls, 1994), and the amount suggestive of copper deficiency is below 10 ppm wet weight (Brockman, 1977 and Frslie *et al*., 1980).

Taucher *et al.* (1975) recorded copper concentration 22.2 ppm wet weight in Polish cattle, 8.8 ppm wet weight in Irish cattle and 22.2 ppm wet weight in Australian cattle. Youssef *et al*. (1988) reported mean copper concentration of 9.94 ± 0.28 ppm dry weight in the livers of

Egyptian buffaloes, also Mousa and Samaha (1993) reported copper concentration of 13.97±1.26, 26.4±3.36 and 71.28 ± 7.96 ppm wet weight in the livers of Egyptian buffaloes, cattle and sheep respectively.

Korsrud *et al*. (1985) recorded copper levels below 10 ppm in 29% of cattle livers in Canada and Frslie *et al*. (1980) reported a 9.6% incidence of low copper levels in cattle in Norway. The difference may reflect variation in soil and forage copper levels (Korsrud *et al.*, 1985). Copper concentrations in organs which do not store the element may be more helpful decreasing only when the phase of dysfunction is approached. With the kidney for example, it is accepted that an increase in copper concentrations in the cortex above 0.4 m mol / kg DM indicates the likelihood of toxicity because values are normally kept within narrow range of 0.2 to 0.3 m mol / kg DM (Suttle, 1986).

In the present study, kidney copper concentrations were 10.87±3.48, 6.01±0.51, 5.61±0.43, 8.08±1.64 and 3.62±0.59 for camels, buffaloes, cows, sheep and goats respectively. Similar results were previously reported in cattle by Korsrud *et al.* (1985) (5.4 ppm wet tissue) and Mousa and Samaha (1993) (6.51±1.2 ppm wet tissue). On the other hand higher concentrations of copper in kidneys were recorded by Henning *et al*. (1973) in cattle (17.1 ppm) and Mousa and Samaha (1993) in sheep (22.75± 3.47 ppm).

Muscle copper concentrations are 5.55±1.50, 4.10±0.30, 4.52±0.37, 7.23±1.35 and 4.75±1.44 ppm fresh weight in camels, buffaloes, cows, sheep and goats respectively. These values are in accordance with those recorded by Tanner *et al.* (1988) and Nasser (1995) in cows.

Blood is a more convenient tissue to collect from animals than most other tissues e.g. liver. Blood is easy to collect and blood analysis is the cheapest in total cost. Blood concentration only fall after there has been significant depletion of liver reserves (Gay *et al.*, 1988). However, as liver biopsy seldom is a practical option in commercial herds, blood tests usually are used for routine assessment of mineral status in live cattle (Philip and Rogers, 2001)

The normal serum copper concentration ranges from 0.6 to 1.5 ppm and serum copper concentration below 0.6 ppm may indicate copper deficiency in cattle and concentration below 0.5 ppm in lambs show copper deficiency symptoms (Beck, 1956).

The mean values of serum copper (Table, 1) are 0.9±0.15, 0.79±0.05, 0.78 ± 0.08, 0.75 ± 0.14 and 0.64±0.10 (ppm) for camels, buffalos, cows, sheep and goats, respectively. These values lie within the

safe adequate levels. In cattle, normal serum copper concentration ranges from 0.7 to 0.1 mg/L (Beck, 1956). Serum copper concentration <0.6 mg/L may indicate copper deficiency in cattle (Tanner *et al*., 1988).

Copper concentrations in hair and wool are 7.44 ± 2.01, 7.84 ± 0.48, 6.92±0.90, 10.03±1.90 and 6.33± 1.61 ppm for camels, buffaloes, cows, sheep and goats, respectively.

Hair analysis is of limited value for evaluation of copper status because of the potential for contamination (Gay *et al.*, 1988) and copper levels in hair samples are variable (Lazzaro, 2007).

A value of less than 5 mg copper / kg DM in a clean recently grown hair samples may indicate an increased risk of hypocuprosis in wool.

The results agreed with those recorded by Erdogan *et al*. (2003) and Kolacz *et al.* (1999) and in hair of healthy control goats by Unny *et al*. (2002).

Although there is variation in the copper level in different animal tissues examined in this study, there is no change in the organoleptic properties observed during examination of these samples.

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