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A COMPARATIVE STUDY ON ZINC LEVELS BETWEEN BUFFALO AND CATTLE EDIBLE TISSUES IN ASSIUT CITY, EGYPT

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ABSTRACT

A total of 168 samples of livers, kidneys and muscles (part of the diaphragm) of both buffalo and cattle were screened in the period from October 2007 to September 2008. The samples were subjected to preparation & for measurement the level of zinc by using Atomic Absorption/Flaming Emission Spectrophotometer. Buffalo organs showed variations in their zinc content. Concentrations of zinc in buffalo livers were 11.89 ± 2.03 as a mean with a range varied from 8.0 to 16.0 µg/g wet weight. While the concentration of zinc in kidneys of buffalo varied from 11.00 to 22.00 with a mean value of 14.06 ± 3.24 µg/g wet weight, respectively. Moreover, the concentrations of zinc in muscles were 18.07 ± 6.39, 12.21 and 35.0 µg/g wet weight, respectively as a mean, minimum and maximum. On the other hand, concentrations of zinc in cattle livers, the levels varied from 8.78 to 40.0 with a mean value of 13.19 ± 6.40 µg/g wet weight. While in kidneys the concentrations were 10.23, 30.0 and 14.60 ± 4.30 µg/g wet weight, respectively as a minimum, maximum and mean. Moreover, the mean zinc concentrations in cattle muscles was 17.25 ± 5.77 with a range of 11.43 – 35.00 µg/g wet weight. In conclusion, 3% - 28% of the examined samples of both cattle and buffalo were higher than the results obtained by Egyptian Organization Standardization and Quality Control (2008), muscles samples have high concentrations of zinc than livers and kidneys. However, it is still not toxic to human because zinc daily requirement is about 15 mg/day which is never found in the daily serving of meat group of food.

Keywords: *Zinc toxicity in cattle***,** *Zinc toxicity in buffaloes, Egypt.*

INTRODUCTION

Zinc is relatively nontoxic to birds and mammals. Rats, pig, poultry, sheep, cattle and man exhibit considerable tolerance to high Zn intakes, the extent of the tolerance depending greatly on the nature of the diet. Particularly its content of calcium, copper, iron and cadmium, with which it interacts in the process of absorption and utilization. For this reason, studies of minimum toxic levels of dietary zinc are only meaningful when the status of the diet and the animal with respect to these interacting elements is known and defined (Underwood, 1977). Zinc is necessary for living organisms at low concentration to maintain normal development and maintenance of human physiology, but the high-level exposure to these element causes human health risks (Nriagu *et al.*, 2009). Acute adverse effects of high zinc intake include nausea, vomiting, loss of appetite, abdominal cramps, diarrhea and headache (Institute of Medicine, Food and Nutrition Board, 2001).

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Numerous data shows that increased Zn supply may reduce Cd absorption and accumulation and prevent or reduce the adverse actions of Cd, whereas Zn deficiency can intensify Cd accumulation and toxicity. (Brzoska and Moniuszko-Jakoniuk 2001). Therefore, the current study investigated zinc concentrations in the muscles (part of the diaphragm), livers and kidneys of cattle and buffalo which are slaughtered in Assiut city by using of Atomic Absorption/Flaming Emission Spectrophotometer (Shimadzu model AA 630-02) and assessed the human risk of this metal.

MATERIAL AND METHODS

1- Collection of samples:

A total of 168 samples of liver (part of caudate lobe), kidney and muscles (part of diaphragm) were collected from 23 male cattle and 33 male buffaloes 2-3 years old (livers, kidneys and muscles specimens from each species) slaughtered in Assiut abattoirs. Each sample was about 50 grams weight and was individually placed in polyethylene bags and labeled with the date, kind, age and sex of each animal. The collected samples were immediately taken to the laboratory in an ice box where they were kept deeply frozen at -20°C until preparation, digestion and analysis.

2- Preparation of equipments:
All glass utensils were thoroughly cleaned with water and then dipped in glass jars containing mixture of hydrochloric acid 25% and nitric acid 10% in ratio of 1:1 and leftover night. After that all utensils and instruments were thoroughly washed by distilled water and dried.

3- Preparation of N/10 Hydrochloric acid:
According to A.O.A.C. (1975) 8.9 ml conc. Hydrochloric acid were added to one liter of distilled water. The prepared stock solution of N/10 Hcl was preserved for dilution of the digested samples.

4- Laboratory Technique

4.1 Digestion procedure.
The applied technique recommended by Fahmy (1971) was followed. In a clean dry Kjeldhal flask of 250-300 ml capacity, one gram of wet sample, 5 ml of 50% sulphuric acid and 5 ml of concentrated nitric acid were added. The flasks were heated gently over a low flame of a minor-burner until clear fumes of nitric and sulphuric acids appeared, where the flame was turned off and the flasks were allowed to cool. On reheating the dark brown liquid formed in the flask is gradually disappeared. Complete digestion is indicated by colorlessness of the liquid. Stronger heating was continued for sometimes to drive off most of the nitric acid in the flask.

To hasten digestion, it was found better to use only 3 ml of the concentrated acid initially and then the other 2 ml were added after cooling.

4.2 Filtration.
10 ml Hcl N/10 were dissolved in 90 ml distilled water in volumetric glass cylinder to obtain 100 ml. About 50 ml of the prepared solution were added to the digested particles previously heated and cooled in a glass flask. The mixture was agitated well for thorough mixing.

The obtained mixture was filtrated through a glass funnel containing filter paper, where the filtrate was collected in a glass cylinder. The remainder 100 ml of the prepared solution were added also to the digested flask to dissolve any other digest particles which may be still adhered on the flask wall, and the mixture was thoroughly agitated, then filtrated.

The obtained filtrate for every sample was put in two special vials each of 50 ml capacity, stoppered and preserved at room temperature. Every laboratory technique was done in duplicate for each sample.

4.3 Estimation of zinc.
The previously digested and filtrated samples were prepared for measurement the level of zinc in each sample in Biochemistry Department, Faculty of Medicine, Assiut University, by using the Atomic Absorption/Flaming Emission Spectrophotometer (Shimadzu model AA 630-02), using an air acetylene flame and hallow cathode lamp.

$$C = \frac{R}{S} \times \text{conc. of standard} \times \text{dilution}$$

C = concentration of heavy metal µg/g wet weight.
R = reading of element conc. on digital scale of Atomic Absorption Spectrometry (AAS).
S = Reading of standard.
Zinc: The wave length was adjusted to 213.9 n.m. and the used lamp current was 10 mA.

5 - Statistical analysis.
Data was represented as (Mean ± SD).
T-test was used to compare between any two groups with normal data.
Mann-Whitney Rank Sum test was used to compare between any two groups with skewed data.

RESULTS

Table 1: Comparisons (Mean ± SD, range) between concentrations of Zinc (µg/g wet weight) in the examined buffaloes and cattle.

Kind of animal	**Buffalo**			**Cattle**		
	Liver*	**Kidney***	**Muscle***	**Liver****	**Kidney****	**Muscle****
Zinc	11.89±2.03 8.00-16.00	14.06±3.24 11.00-22.00	18.07±6.39 12.21-35.00	13.19±6.40 8.78-40.00	14.60±4.30 10.23-30.00	17.25±5.77 11.43-35.00

* No. of samples= 33 ** No. of samples= 23

Table 2: Differences of Zinc concentrations (µg/g wet weight) in livers, kidneys and muscles of buffaloes and cattle.

	Site			Significance		
Metal	**Liver**	**Kidney**	**Muscle**	**Liver v Kidney**	**Liver v Muscle**	**Kidney v Muscle**
Cattle	13.19±6.40 8.78-40.00	14.60±4.30 10.23-30.00	17.25±5.77 11.43-35.00	*	***	*
Buffalo	11.89±2.03 8.00-16.00	14.06±3.24 11.00-22.00	18.07±6.39 12.21-35.00	**	***	***

* Significant ($p < 0.05$). ** Highly significant ($p < 0.01$). *** Very highly significant ($p < 0.001$).

Table 3: Percentages of samples that contain zinc higher than that recommended by the Egyptian Standards*

Metal	**Permissible limit**	Buffalo			Cattle		
		Liver	**Kidney**	**Muscle**	**Liver**	**Kidney**	**Muscle**
Zinc	15 mg/kg	3%	15%	18%	12%	15%	28%

* E.O.S.Q.C. (2008).

DISCUSSION

1- Comparisons (Mean ± SD, range) between concentrations of zinc (µg/g wet weight) in the examined buffalo and cattle:

The mean ± standard deviation and range of zinc in livers, kidneys and muscles (µg/g wet weight) in buffalo and cattle were recorded in (Table 1). Concentrations of zinc in buffalo livers were 11.89 ± 2.03 as a mean with a range varied from 8.0 to 16.0 µg/g wet weight. While the concentration of zinc in kidneys of buffalo varied from 11.00 to 22.00 with a mean value of 14.06 ± 3.24 µg/g wet weight, respectively. Moreover, the concentrations of zinc in muscles were 18.07 ± 6.39, 12.21 and 35.0 µg/g wet weight, respectively as a mean, minimum and maximum.

Concerning concentrations of zinc in cattle livers, the levels varied from 8.78 to 40.0 with a mean value of 13.19 ± 6.40 µg/g wet weight. While in kidneys the concentrations were 10.23, 30.0 and 14.60 ± 4.30 µg/g wet weight, respectively as a minimum, maximum and mean. Moreover, the mean zinc concentrations in cattle muscles was 17.25 ± 5.77 with a range of 11.43 – 35.00 µg/g wet weight.

Nearly the present study results are agreeing with the findings of Froeslie (1980); Korsud *et al.* (1985); Vaessen and Ellen (1985); Ellen *et al.* (1989); Falandysz and Lorence-Brala (1991); Salisbury *et al.* (1991); Protasowicki (1992); Kottferova and Korenekova (1995) and El-Khawas *et al*. (2007).

Differences of Zinc concentrations (µg/g wet weight) in livers, kidneys and muscles of buffaloes and cattle.

Table (2) pointed out that there is a highly significant difference in zinc concentration between livers versus kidneys, and very highly significant difference between livers versus muscles, as well as a very highly significant difference between kidneys versus muscles.

As for variations in concentrations of zinc (µg/g wet weight) in livers, kidneys and muscles of cattle recorded in (Table 2) there is a significant difference in zinc concentrations in livers versus kidneys, and very highly significant difference in livers versus muscles, and a significant difference in kidneys versus muscles.

2- Percentages of samples that contain zinc higher than that recommended by the Egyptian Standards:

According to E.O.S.Q.C. (2008), zinc levels higher than the Egyptian standards (15 µg/g) recorded in (Table 3) were detected in 3% in buffalo livers, 15 % buffalo kidneys and 18 % buffalo muscles. As for cattle higher levels they could be detected in livers (12%), kidneys (15 %) and muscles (28%).

The results of the present study indicated that the values of zinc in buffalo and cattle muscles were relatively high as compared with those in the livers and kidneys. According to Farmer and Farmer (2000), Lopez-Alonso *et al*. (2000) muscle is one of the most important tissues for zinc accumulation and possessed zinc concentration higher than livers and kidneys. However, zinc concentrations in muscles were lower than those reported for cattle (Jorhem *et al.*, 1989; Falandysz, 1993).

CONCLUSION AND RECOMMENDATIONS

The information given by the achieved results proved that all the examined livers, kidneys and muscles of both buffalo and cattle were found contaminated with zinc. Some tissues showed higher levels of zinc than that recommended by the Egyptian Standards. However, it is still not toxic to human because zinc daily requirement is about 15 mg/day which is never found in the daily serving of meat group of food.

Although Zn is an essential trace element for human, higher concentrations in meat may be a public health hazard. So, for limitation of the risk of zinc in carcass of slaughtered animals the following recommendations should be taken in considerations:

1- Monitoring program must be carried out periodically to determine the changing risks to health from animal food products in Assiut city in order to inform any adopted management strategy.
2- Strict application of regulation on sewage waste pollutants which discharge into farms.
3- Raising the efficient of sewage treatment in industrial societies to involve industrial waste to get rid of all toxic materials.

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دراسة مقارنة مستويات الزنك فى أنسجة الأبقار والجاموس الصالحة للأكل بمحافظة اسيوط وجمهورية مصر العربية

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تم جمع عدد ١٦٨ عينة من الأكباد، الكلى، والعضلات (الحجاب الحاجز) من عدد ٢٣ من ذكور الأبقار وعدد ٣٣ من ذكور الجاموس ، تتراوح أعمارها بين ٢-٣ سنوات، وذبحت بمجزر محافظة اسيوط. وتم قياس مستوى الزنك (جزء فى المليون وزن رطب) بواسطة جهاز قياس الطيف الذرى. وجد بالتحليل أن متوسط ± الانحراف القياسى، والمدى لعنصر الزنك لكبد، كلى، وعضلات الجاموس ما يلى: ١١,٨٩ ± ٢,٠٣ ، ٨,٠٠ إلى ١٦,٠٠ ، ١٤,٠٦ ± ٣,٢٤ ،و ١١,٠٠ إلى ٢٢,٠٠ ، ١٨,٠٧ ±٦,٣٩ ، ١٢,٢١ إلى ٣٥,٠٠ على التوالى. بينما فى الأبقار: ١٣,١٩ ± ٦,٤٠ ، ٨,٧٨ إلى ٤٠,٠٠ ، ١٤,٦٠ ±٤,٣٠ ، ١٠,٢٣ إلى ٣٠,٠٠ ، ١٧,٢٥ ± ٥,٧٧ ، ١١,٤٣ إلى ٣٥,٠٠ على التوالى. دلت النتائج على وجود فروق معنوية كبيرة بين الكبد والكلى لعنصر الزنك ، ومعنوية كبيرة جدا بين كل من الكبد والعضلات وكذلك كلى وعضلات الجاموس. بينما فى الأبقار وجدت فروق معنوية بين الكبد والكلى وكذلك بين الكلى والعضلات، ووجدت فروق معنوية كبيرة جدا بين الكبد والعضلات. وخلصت الدراسة الي أن ٣-٢٨% من العينات التي تم فحصها أكبر من المستوي المسموح به طبقا للمواصفات القياسية المصرية (٢٠٠٨) وان مستويات الزنك أعلي في اللحوم عن الكبد والكلى. ومع ذلك ، تعتبر هذه المستويات غير ضارة لصحة المستهلك لأنها أقل من متطلبات الزنك اليومية (١٥ ملغ) والتي لا توجد أبدًا في الحصة اليومية لمجموعة اللحوم.