J. Mater. Environ. Sci. 5 (6) (2014) 1737-1741
ISSN : 2028-2508
CODEN: JMESCN

Copper and zinc contents in different organs of animals slaughtered in Casablanca city-Morocco

A. Chafik[1], R. Eddoha[2], A. Bagri[1], B. Nasser[1], A. Essamadi[1*]

[1]*Laboratoire de Biochimie et Neuroscience-Equipe de Biochimie et Toxicologie Appliquée, FST, Université Hassan Premier, BP 577 Settat, Morocco.*

[2]*Laboratoire de Biochimie, Nutrition et Valorisation des Ressources Naturelles, FS, Université Chouaib Doukkali, Route Ben Maachou 24000 El Jadida, Morocco.*

Received 18 May 2014; Revised 16 June 2014; Accepted 16 June 2014
[*]*Corresponding Author. E-mail: essamadi2002@yahoo.fr; Tel: (+212 6 66 17 08 81)*

Abstract

This work is mainly devoted to the study of trace elements concentrations, copper and zinc, in different organs of 50 cattle, 50 sheep, 30 camels and 40 equines slaughtered in municipal slaughterhouse of Casablanca, which is the main source of consumption meat in the study area. The organs that have been studied were the liver, lung, skeletal muscle, heart and kidney for each animal. All organs were digested, mineralized and analyzed for copper and zinc using an Inductively Coupled Plasma – Atomic Emission Spectroscopy (ICP-AES). The copper concentrations found in different organs ranges from 1.42 to 22 ppm in cattle, 0.80 to 18.57 ppm in sheep, 1.10 to 14.22 ppm in camel and 0.78 to 4.65 ppm in equine. For zinc, the concentrations found ranges from 4.35 to 9.56 ppm in cattle, 3.30 to 8.73 ppm in sheep, 4.05 to 10.88 ppm in camel and 0.27 to 10.44 ppm in equine. Cattle in their organs accumulate the highest concentrations of copper compared to other species. The highest concentration of copper was observed in liver. The organs of cattle and camel are the richest in zinc in comparison with the sheep and equine. However, zinc accumulated mainly in the liver and skeletal muscle.

Keywords: Copper, Zinc, Organs, Animal, Consumption, ICP-AES

Introduction

In Morocco, the last few years, there has been a constant increase in supplies of the population of animal protein. Animals destined for slaughter constitute in additional a very important source of trace elements essential to human nutrition [1-4]. Copper (Cu) and zinc (Zn) remains among the essential trace elements and indispensable for the proper functioning of the body [5-10]. Although they are found only in very low quantities, copper and zinc are implicated in the activity of many enzymes involved in very many metabolic processes, and consequently, they ensure the proper functioning of many physiological activities [11-14]. Copper and zinc deficiency leads to a wide variety of pathological consequences and metabolic defects [15]. The distribution of copper and zinc among the tissues of animals varies with the age, sex, diet composition and physiological status [16]. In Morocco, the studies on the metabolism of copper and zinc are scarce, disparate and there is little knowledge on the tissue levels of these trace elements in different animals destined for slaughter and thus for consumption.

The main aim of the present study was to investigate the distribution of copper and zinc in liver, lung, skeletal muscle, heart and kidney of cattle, sheep, camel and equine slaughtered in municipal slaughterhouse of Casablanca and destined for consumption of population of this city. This study, we allow draw up the status on the wealth of copper and zinc in these animals.

2. Materials and methods

2.1. Samples collection

During the period of March-April 2013, samples of liver, lung, skeletal muscle, heart and kidney were collected in the municipal slaughterhouse of the Great Casablanca Region from 50 cattle, 50 sheep, 30 camels and 40 equines. For each animal, samples were collected accompanied by a veterinary hygiene inspector who helped in the collection of organs. All samples were packed in labeled plastic bags and immediately transported in a cooler to the laboratory and stored at -27°C until analysis.

2.2. Samples analysis

For each collected sample a quantity of 0.2 to 0.7 g was digested with sulphuric acid in eppendorf tubes, and mineralized, using the method described by Hill et al. [17]. Thus, the content for each eppendorf was transferred into a test tube into which 3 ml of nitric acid (HNO_3 65%) were added. The test tubes were heated on a hot plate, first at low temperature and then at high temperature (until 450°C). The beginning of the mineralization is characterized by the presence of a brown fume. After the total disappearance of this fume, the test tubes were cooled and 2 ml of hydrogen peroxide (H_2O_2 35%) were added, then the test tubes were returned to a hot plate until a limpid solution was obtained. Finally, the test tubes were cooled again and transferred into plastic tubes. The volume for each tube was adjusted to 10 ml with double distilled water and stored to room temperature for mineral analysis.

Trace elements analyses were conducted at the Technological and Scientific Research Support Units (UATRS) of the National Center for Scientific and Technical Research (CNRST) at Rabat, Morocco. The elements were determined by Inductively Coupled Plasma - Atomic Emission Spectroscopy (ICP-AES). The standards used are of commercial type containing the mineral analyzed in a pure state. Each analysis was repeated in triplet.

2.3. Statistical analysis

Statistical differences between the different organs (liver, lung, skeletal muscle, heart and kidney) were determined by one-way analysis of variance (ANOVA). The limit of significant level was accepted at $p<0.05$.

3. Results and discussion

3.1. Comparison of copper concentrations in organs of different animals studied

The results found for copper concentrations in liver, lung, skeletal muscle, heart and kidney of cattle, sheep, camel and equine are presented as mean ± standard deviation (SD) in table 1.

Table 1: Copper concentrations in organs of different animals studied (Mean ± SD)

	Copper concentrations (ppm)				
	Liver	**Lung**	**Skeletal muscle**	**Heart**	**Kidney**
Cattle	22±7.07	4.35±1.24***	1.42±0.21^{a*b***}	3.04±0.65***	4.52±0.57***
Sheep	18.57±6.50	1.06±0.39	0.80±0.14	2.48±0.45*	3.10±0.85
Camel	14.22±6.12*	1.65±0.49***	1.10±0.24**	2.06±0.22	1.43±0.14***
Equine	4.65±1.17***	0.95±0.11	0.78±0.09	2.66±0.22***	Sampling not performed

$^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$, a: difference (Cattle Vs Camel), b: difference (Cattle Vs Sheep and Equine)

The highest concentration of copper in liver was present in cattle compared to camel ($p<0.05$) and equine ($p<0.001$). The lowest concentration was recorded in liver of equine ($p<0.001$). Copper concentration in liver of sheep is comparable with those found in cattle and camel. Our values on copper concentrations in camel and cattle liver, are comparable with those already obtained in Morocco [18], whose copper concentration in liver is lower in camel than in cattle. However, the results reported in Saudi Arabia [19], China [20] and Sudan [21] showed that copper concentration in liver was significantly higher for camel than cattle and sheep. If the normal values of copper in cattle liver range from 35 to 91 ppm [18], it is evident that the result of this study shows a slightly lower value of copper, but comparable to that reported in a previous study [22-23]. Moreover, the present concentration of copper in sheep liver is comparable with that found in Iraq [22] and Turkey [24]. On the other hand, our value in camel was in the range (10-26 ppm) reported in Morocco [18] and comparable to that found in Saudi Arabia [25]. In equine, hepatic copper concentration in this study is low compared to those observed in other studies [26-27].

Copper concentration in lung was statistically higher in cattle when compared to other animals ($p<0.001$). Another significant difference in lung was observed in camel compared to sheep and equine ($p<0.001$). The copper concentrations in lung of sheep and equine were comparable. The value of this study on the copper concentration in cattle lung is comparable with that found in Pakistan [28]. At reverse, our values are low compared with those reported in the literature in sheep [27, 29] and camel [20, 30].

The highest concentration of copper in skeletal muscle was recorded in cattle when compared to camel ($p<0.05$), sheep and equine ($p<0.001$). A significant difference in skeletal muscle was also observed in camel compared to sheep and equine ($p<0.01$). Copper concentrations in skeletal muscle of sheep and equine were comparable. In the present study, the copper concentration in skeletal muscle is comparable with those

reported in other studies in cattle [23, 31-33]. Moreover, the value found in sheep is comparable to that found in Egypt [34]. In camel, the values found in Saudi Arabia [25] and Iran [35] are comparable with those of the present study.
In heart, the copper concentration was statistically higher in cattle when compared to camel ($p<0.001$). The lowest concentration was recorded in heart of camel when compared to sheep ($p<0.05$) and equine ($p<0.001$). Copper concentrations in heart of cattle, sheep and equine were comparable. The present concentrations of copper in heart were comparable with those reported in other countries in cattle [24, 34] and sheep [34, 36-37]. In comparison to previous value [35], our value is slightly lower in camel. Similarly, the value found in equine is lower compared to that found in China [27].
The highest concentration of copper in kidney was observed in cattle when compared to other animals ($p<0.001$). A significant difference in kidney was also observed in camel compared to sheep ($p<0.001$). The result of this study on the copper concentration in cattle kidney is comparable with the results reported in different literature sources [31-32, 38]. Moreover, in sheep, our value is comparable with that found in Turkey [24] and Egypt [34], and slightly lower of the values found in other countries [39-40]. In camel, the value of the current study is lower compared to values reported in other studies [26, 35].
It appears from this study that the copper concentrations in different organs of different animals studied, are generally in agreement with the literature data [18, 22-25, 28, 31-38]. Our study also shows that copper concentrations are slightly low and limited to threshold deficiencies especially in cattle [18]. The lower concentrations observed in our study may be attributed to copper deficiency in diet source offered to animals. In camel, it was always observed in several studies that this animal regulates its copper contents at levels much lower than other ruminants [18, 41-42]. In equine, although there are limited data studying the tissue distribution of copper in this species, the values of this study are much lower compared to those reported in other studies [26-27]. The comparison of copper values in the different organs showed that the concentration of this element is mainly concentrated in liver. The low concentrations observed in other organs than liver attested the predominant role of this organ in the copper storage. In animals, the results suggest that meat and offal of cattle are the richer in copper. However, in spite the age of sheep that does not exceed 12 months, the copper concentrations in sheep and camel are comparable. This is due to the fact that camel behaves like a species of small ruminants [42]. While probably the meat and offal of equine contain lower concentrations compared to other species. This difference could be explained by the fact that equine destined for slaughter are the draft animals, and therefore probably suffer from several deficiency, especially those in trace elements.

3.2. Comparison of zinc concentrations in organs of different animals studied

The results found for zinc concentrations in liver, lung, skeletal muscle, heart and kidney of cattle, sheep, camel and equine are presented as mean ± standard deviation in table 2.
The highest concentration of zinc in liver was present in camel compared to cattle ($p<0.05$), sheep ($p<0.01$) and equine ($p<0.001$). The lowest concentration was recorded in liver of equine ($p<0.001$). Zinc concentrations in liver of cattle and sheep were comparable. A study in Morocco [18] reported that zinc concentrations in liver were lower in camel than in cattle. Moreover, the results reported in Sudan [21] indicate that the hepatic concentrations of zinc in camel were less concentrated than other ruminants. The results reported in Saudi Arabia [19] show that differences in liver zinc concentrations between camel, cattle and sheep were not statistically significant. The present results on zinc concentrations in liver for different animals studied are low compared to those reported in different literature sources in cattle [18-19, 21-22, 24, 31- 34, 37-38, 40, 43], in sheep [22, 24, 34, 37, 40], in camel [18, 21, 25] and in equine [27, 44-45].

Table 2: Zinc concentrations in organs of different animals studied (Mean ± SD)

	Zinc concentrations (ppm)				
	Liver	**Lung**	**Skeletal muscle**	**Heart**	**Kidney**
Cattle	9.56±0.47*	8.72±1.56***	9.04±0.17	4.35±0.34	5.39±0.99*
Sheep	8.73±0.31**	3.30±1.01	6.97±0.17***	3.54±0.70	6.29±0.45
Camel	10.88±1.73	4.05±0.15*	9.84±0.34	4.85±0.41*	4.71±0.50***
Equine	0.27±0.27***	2.5±1.14	10.44±0.29***	5.05±0.16***	Sampling not performed

$^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

In lung, the highest concentration of zinc was observed in cattle when compared to other animals ($p<0.001$). Another significant difference in lung was observed between camel and sheep ($p<0.05$). However, zinc concentrations in lung of sheep and equine were comparable. Zinc concentrations in lung obtained in this study are low compared to those reported in previous studies in cattle [38], sheep [27, 29], camel [30] and equine [44].

Zinc concentration in skeletal muscle was statistically higher in equine when compared to other animals ($p<0.001$). The lowest concentration was recorded in skeletal muscle of sheep ($p<0.001$). In comparison with previous observations in, cattle [31-34, 37, 40, 43], sheep [34, 40], camel [25] and equine [44], the results of this work on zinc concentrations in skeletal muscle for different animals studied appeared lower.

The highest concentration of zinc in heart was observed in equine when compared to cattle and sheep ($p<0.001$). A significant difference in heart was also observed between cattle and camel ($p<0.05$). However, zinc concentrations in heart of camel and equine were comparable. The results of this study on zinc concentrations in heart are low compared to those found in other studies in cattle [34, 37] and camel [30]. In contrast, the concentration found in cattle is comparable with that found in Turkey [24]. Also, the concentration found in sheep is comparable with that found in Iran [36], while she is lower as compared to that reported in other countries [24, 34, 37]. In equine, the value found in China [27] is comparable to that of the present study.

The highest concentration of zinc in kidney was recorded in sheep when compared to cattle ($p<0.05$) and camel ($p<0.001$). Zinc concentrations in kidney of cattle and camel were comparable. Our results on zinc concentrations in kidney for the different animals studied are low compared to those reported in many countries in cattle [31-34, 37-38, 40], sheep [34, 37, 39-40] and camel [25, 30]. In contrast, our concentrations found in kidney of cattle and sheep were comparable with that found in Turkey [24].

In general, the results of this study on zinc concentrations in different organs of different animals studied are low compared to the results reported in many studies [18, 19, 21-25, 27, 30-34, 38, 40, 43-45]. These lower concentrations observed in our study may be attributed to zinc deficiency in diet source offered to animals. On the other hand, it seems that camel regulates its zinc contents to lower levels than those of other ruminants [18, 41-42]. In equine, low zinc concentrations obtained in liver and lung compared to other species, could only be explained by the fact that equine destined for slaughter are the draft animals, and therefore probably suffer more deficiency, especially those in trace elements. Without taking account of low zinc concentrations in different organs of different animals studied, it appears that the highest concentrations of zinc were observed in liver and skeletal muscle. In animals, cattle and camel accumulate high concentrations of zinc in liver, lung and kidney compared to equine. In contrast, the equine present the high concentrations in skeletal muscle and heart as compared to other species. Sheep that have been the subject of this study possess an age not exceeding 12 months. While these sheep are not adults, they have the concentrations of zinc that are comparable to those of cattle and camel.

Conclusion

This study showed that copper is mainly concentrated in liver and zinc is accumulated in liver and skeletal muscle. The observed difference between organs in term of accumulation of these elements could be attributed to specific physiological functions of the organs. Thus, trace elements concentrations in organs varied according to the age, sex, copper status of the diet and status of animal. On the other hand, the results of the present work have shown differences between species in terms of accumulation of minerals in their organs. The organs of cattle are the richest of copper. Concerning zinc, cattle and camel contain the highest levels for this element. Other additional studies are needed to draw up the tissue levels of trace elements in animals for slaughter to prevent deficiencies by studying the enzymatic activity of certain enzymes whose the cofactors are the copper and zinc, such as superoxide dismutase [46-47].

Acknowledgements-The authors thank the President of urban municipalities of Casablanca, the Director and the responsible for veterinary service of Casablanca slaughterhouse.

References

1. Yen J.T. Trace Elements in Man and Animals – 9, Proceedings of the Ninth International Symposium on Trace Elements in Man and Animals, NRC Research Press, (1997).
2. Mills C.F. *Phil. Trans. R. Soc. Lond.* 288 (1979) 51.

3. Golden M.H. *Hum. Nutr. Clin. Nutr.* 36 (1982) 185.
4. Soetan K.O., Olaiya C.O., Oyewole O.E. *Afr. J. Food Sci*. 4 (2010) 200.
5. Angelova M., Asenova S., Nedkova V., Koleva-Kolarova R. *Trakia J. Sci.* 9 (2011) 88.
6. Tapiero H., Tew K.D. *Biomed. Pharmacother.* 57 (2003) 399.
7. Scherz H., Kirchhoff E. *J. Food Comp. Anal*. 19 (2006) 420.
8. Reis L.S.L.S., Pardo P.E., Camargos A.S., Oba E. *J. Med. Med. Sci*. 1 (2010) 560.
9. Yatoo M.I., Saxena A., Deepa P.M., Habeab B.P., Devi S., Jatav R.S., Dimri U. *Vet. World*. 6 (2013) 963.
10. Šoch M., Vydrová P., Brouček J., Suchý K., Smutný L., Smutná Š., Čermák B., Zábranský L., Šimková A., Švejdová K., Václav Š. *Scientific Papers: Animal Science and Biotechnologies*. 46 (2013) 316.
11. Minate L., Carfagnini J.C. *Prev. Vet. Med.* 53 (2002) 1.
12. Healy J., Tipton K. *J. Neurol. Transm.* 114 (2007) 777.
13. Liochev S.I., Fridovich I. *Free Radic. Biol. Med.* 48 (2010) 1565.
14. Binet C. Oligo-éléments et oligothérapie : Matière médicale, propriétés et indications thérapeutiques. Argile et compléments alimentaires diététiques, Dangles Editions, (2007).
15. Deen A., Bhati A., Sahani M. *J. Camel Pract. Res.* 11 (2004) 135.
16. Doyle J.J. *J. Anim. Sci.* 50 (1980) 1173.
17. Hill A.D., Patterson K.Y., Veillon C., Morris E.R. *Anal. Chem.* 58 (1986) 2340.
18. Essamadi A.K. Thèse de Doctorat d'Etat Es-Sciences-Biochimie, Université Chouaib Eddoukali, Faculté des Sciences - El Jadida. Série D. E. N° : 2000, (2000).
19. Al-Busadah K.A. *Pakistan J. Biol. Sci.* 6 (2003) 1856.
20. Zongping L. *Vet. Res. Commun.* 27 (2003) 397.
21. Bakhiet A.O., Mohammed A.A., Siham E.S.M., El-Badwi M.A.S. *Int. J. Trop. Med.* 2 (2007) 1.
22. Al-omran L.S.Z. *Basra studies journal*. 8 (2009) 1.
23. Dermauw V., Lopez-Alonso M., Duchateau L., Du Laing G., Tolosa T., Dierenfeld E., Clauss M., Janssens G.P.J. *PLoS One*. 9 (2014) 1.
24. Mendil D., Tuzen M. *Environ. Monit. Assess*. 182 (2011) 423.
25. Mutassim M.A., Aljumaah S.R., Ayadi M. *Asian J. Anim. Vet. Adv.* 8 (2013) 91.
26. Egan D.A., Murrin M.P. *Res. Vet. Sci.* 15 (1973) 147.
27. Zongping L. *Sci. Total Environ.* 309 (2003) 117.
28. Ayub M., Zuber M., Yousaf M., Zahoor A.F., Khan Z.I., Ahmad K., Mansha M. *Pakistan. Afr. J. Pharm. Pharacol.* 7 (2013) 1396.
29. Akoto O., Bortey-Sam N., Nakayama S.M.M., Ikenaka Y., Baidoo E., Yohannes Y.B., Mizukawa H., Ishizuka M. *Int. J. Environ. Sci. Toxic*. 2 (2014) 81.
30. Zongping L. *Vet. J.* 169 (2005) 444.
31. Lopez Alonso M., Benedito J.L., Miranda M., Castillo C., Hernandez J., Shore R.F. *Food Addit. Contam.* 17 (2000) 447.
32. Miranda M., Lopez Alonso M., Castillo C., Hernandez J., Benedito J.L. *Environ. Int.* 31 (2005) 543.
33. Sedki A., Lekouch N., Gamon S., Pineau A. *Sci. Total Environ.* 317 (2003) 201.
34. Abou-Arab A.A.K. *Food Chem. Toxicol.* 39 (2001) 593.
35. Badiei K., Mostaghni K., Pourjafar M., Parchami A. *Comp. Clin. Pathol.* 15 (2006) 58.
36. Kojouri G. A., Aghajani E., Jahanabadi S., Kojour A. *Iranian J. Parasitol.*, 6 (2011) 17.
37. Abd EI-Salam N.M., Ahmad S., Basir A., Rais A.K., Bibi A., Ullah R., Shad A.A., Muhammad Z., Hussain I. *Life Sci. J*. 10 (2013) 937.
38. Jukna C., Jukna V., Siugzdaite J. *BJVM*. 9 (2006) 35.
39. Botha C.J., Shakespeare A.S., Gehring R., Van der Merwe D. *J. S. Afr. vet. Assoc.* 72 (2001) 183.
40. Irfana M., Iqbal S., Nagra S.A. *Int. J. Agr. Biol.* 6 (2004) 816.
41. Faye B., Grillet C., Tessema A. *Rev. Elev. Med. Vet. Pays. Trop.* 39 (1986) 227.
42. Faye B., Kamil M., Labonne M. *Rev. Elev. Med. Vet. Pays. Trop.* 43 (1990) 365.
43. Koréneková B., Skalická M., Naï P. *Vet. Arhiv.* 72 (2002) 259.
44. Farmer A.A., Farmer A.M. *Sci. Total Environ.* 257 (2000) 53.
45. Salisbury C.D., Chan W., Saschenbrecker P.W. *J. Assoc. Off. Anal. Chem.* 74 (1991) 587.
46. Bengoumi M., Essamadi K., Charcornac J.P., Tressol J.C., Faye B. *Vet. Res.* 29 (1998) 557.
47. Yang J., Dong S., Jiang Q., Si Q., Liu X., Yang J. *Gene*, 518 (2013) 388.