19. Zinc content in liver and kidney of piglets slaughtered in Portugal

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Abstract

The aim of this work was the evaluation of zinc content in piglet's liver and kidney, which was performed after detection of high concentration of this element in several pig's feeding stuff in the analysis carried out under the official control, in Portugal. Determinations were executed by flame atomic absorption spectrophotometry (FAAS) after mineralization. Analytical quality control was carried out using control standards. A total of 46 piglets' offals samples (23 livers and 23 kidneys) from the Aveiro's district slaughterhouses were analyzed. As expected zinc was detected in all samples analyzed and concentrations were higher in liver than in kidney. The highest values found were 720.73 mg/kg in liver and 472.86 mg/kg in kidney (values considerably higher than usually reported in investigations carried out by different authors).

Introduction

Zinc is one of the essential elements in diet required by all animals and plays an important role in several body's processes and biochemical functions, both as structural component of proteins and as enzyme cofactors. Zinc is present in many enzyme systems that are concerned with the metabolism of feed constituents. Different sources of zinc are used as supplementation of the diet in order to cover the physiological animal requirements. However, excess zinc is toxic and its ingestion in high quantities can be harmful for both animal and human health, after consumption. Too much zinc will interact competitively with the metabolism of other minerals in the body, particularly iron, calcium and copper. Zinc chelates are used as growth promoters and diarrhea preventive in weaning pigs (1). Gary L. Cromwell experiments showed that pigs fed the high zinc diet consumed more feed, gained at a faster rate and were more efficient in converting feed to gain than the controls. Zinc requirements in dietary are different according to class of animal. Levels of range are based on age, sex, stage of production and other ration components. A level of 2000 mg/kg Zn produces depression, arthritis, intramuscular haemorrhage, gastritis and enteritis (Straw et al., 2006). Pigs fed 268 mg/kg Zn (Straw et al., 2006), developed arthritis, bone and cartilage deformities and internal haemorrhages. However, one important aspect is the form and bioavailability of zinc source, because it influences the toxic doses of zinc intake. It was demonstrated that different zinc salts will lead a different response to the animal health. Feeding 3000 mg/kg Zn as zinc oxide for 14 days has shown increased weight gains and postweaning scours without adverse signs.

In this study, determinations of zinc were performed in pig's liver and kidney samples. The samples were collected in the central region of the country, where the tradition of eating piglet and its offals is stronger. Metals tend to accumulate in animal's livers and kidneys, which are the most commonly eaten offals. This kind of food normally contains higher concentrations of this metal than other meat products. Taking that into account, this study pretends to determine whether the zinc concentrations in these offals present a risk for human health when consumed. In order to evaluate possible relationship with other elements, determinations of copper, iron and manganese were also performed.

Material and Methods

A total of 46 piglets' offals samples (23 livers and 23 kidneys), from the Aveiro's district slaughterhouses, were analyzed. Determinations were executed by flame atomic absorption

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spectrophotometry (FAAS) after mineralization, according to an internal procedure based on EN ISO 6869 and EN 14082. The samples were dried ashed at 450 oC under a gradual increase in temperature. The ash was dissolved in hydrochloric acid and diluted to the desired volume, then aspirated into the air-acetylene flame of the atomic absorption spectrometer. The metal contents of the samples were derived from the calibration curve, which was made up of 5 standards and prepared by diluting a standard solution with hydrochloric acid. Different standards were used to assure analytical quality control.

Results

Results obtained in liver and kidney samples of zinc, copper, manganese and iron, for each animal, are presented in table 1.

Table 1: Concentration of zinc, copper, manganese and iron in piglet's liver and kidney (mg/kg).

Piglet ID	Zn		Cu		Mn		Fe	
	liver	kidney	liver	kidney	liver	kidney	liver	kidney
1	559.17	120.23	5.15	19.20	2.53	1.46	66.09	33.17
2	73.19	21.48	5.43	3.13	2.29	1.36	34.36	24.55
3	90.84	22.70	3.43	3.59	2.36	1.36	73.43	35.90
4	70.50	17.16	17.10	3.66	2.79	1.20	15.44	20.20
5	580.54	73.59	24.67	20.86	1.90	1.36	47.23	32.29
6	185.02	26.46	8.67	13.79	2.01	1.09	48.26	21.82
7	59.31	19.03	4.32	5.04	2.31	1.15	56.68	20.26
8	30.25	27.49	11.58	4.87	2.07	1.32	20.11	16.77
9	44.87	17.78	5.04	3.48	2.69	1.63	48.91	20.23
10	50.94	19.53	42.54	6.79	3.82	1.81	390.63	25.08
11	121.93	18.73	13.71	3.95	2.29	0.59	67.28	24.23
12	312.58	50.37	11.54	2.75	1.74	0.78	25.27	14.65
13	148.89	18.17	3.45	4.75	1.63	0.46	19.31	11.94
14	91.71	19.67	13.00	5.40	1.54	0.72	14.34	11.13
15	81.71	19.06	9.37	4.27	1.77	0.91	46.35	17.90
16	61.12	17.37	3.01	4.86	1.48	0.42	29.77	15.57
17	720.73	472.86	5.60	9.25	1.73	1.45	61.14	56.84
18	53.70	17.33	11.72	2.69	1.96	0.64	363.35	26.45
19	60.21	18.81	23.47	2.33	2.29	0.80	76.91	57.87
20	63.01	16.20	5.02	2.70	2.55	0.83	31.46	13.40
21	55.56	18.93	5.80	2.53	3.01	0.76	94.12	27.39
22	121.13	21.75	8.98	5.03	2.40	0.94	172.41	48.38
23	71.97	19.08	24.36	4.90	3.68	1.47	87.52	16.97

Figure 1 shows the relationship between zinc values in liver and kidney of each animal. Statistic description is shown in table 2.

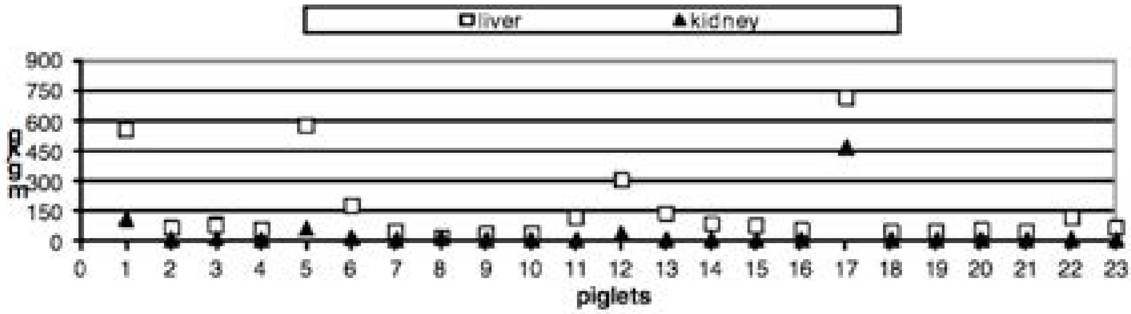

Figure 1. Zinc determinations in piglets' liver and kidney.

Table 2 : Statistic description (Zn). no Samples

	Liver	Kidney
n° Samples	23	23
Mean +/- S (mg/kg)	161.3 +/- 193.1	47.6 +/- 95.7
Median (mg/kg)	73.2	19.1
Range (mg/kg)	30.3 - 720.7	16.2 – 472.9
Correlation coefficient liver/kidney	0.7899	

Determinations of copper, iron and manganese were also performed in order to evaluate its relationship and eventual interaction with zinc high values. Correlations among them were presented in tables 3 and 4.

Table 3
Liver/Kidney correlations

Correlation	Liver /kidney
Zn	0.7899
Cu	0.1364
Mn	0.5675
Fe	0.2133

Table 4
Correlation among elements.

Correlation	Liver	Kidney
Zn/Cu	-0.046	0.330
Zn/Mn	-0.277	0.277
Zn/Fe	-0.158	0.536
Cu/Mn	0.533	0.362
Cu/Fe	0.521	0.190
Mg/Fe	0.428	0.217

As expected, zinc was present in all samples analyzed. However some samples showed concentration values above the usually described for these matrices by other authors. According to K. L. Gabrielson et al. (1996), a control group of piglets revealed zinc levels of 40-90 mg/kg in liver. Considering the maximum value (90 mg/kg) as reference, in our study we found 43% above this level. For kidney, zinc values described in literature usually ranged around 30 mg/kg. Taking that value as reference, there are 17% of cases above this value. It is worth referring that the highest value found for liver (720.73 mg/kg) and the highest value found for kidney (472.86 mg/kg) are from the same animal.

Concerning liver, the mean value obtained (161.3 mg/kg) is much higher than median value (73.2 mg/kg). The last one is closer to the median of results for liver in 6 months pigs observed by M. Lopez-Alonso et al. (2007) which was 78.5 mg/kg. Kidney's mean value (47.6 mg/kg) was also much greater than median value (19.1 mg/kg) and greater than the one of M. Lopez-Alonso et al. obtained (28.9 mg/kg). However, comparisons of data from different studies must be done carefully because we must take into account that zinc and other metals concentration in issues depend on some factors such as age, sex and nutritional habits (data not available in our study). The big difference between these

two statistical measures (mean and median) leads to conclusion that there is a great dispersion of the results (leading to a great standard deviation); although the majority of values are close to the generally described in literature for this matrices there are some of them excessively raised, comparing to the concentrations considered adequate for piglets

Zinc concentrations in the samples analyzed in this study were given in fresh weight. For liver, concentrations ranged from 30.3 mg/kg to 720.7 mg/kg and for kidney it ranged from 16.2 mg/kg to 472.9 mg/kg. All concentrations were significantly higher in liver than in kidney.

In what concerns zinc, the coefficient correlation found between liver and kidney was quite high (almost 0.8). Between liver and kidney, manganese presents a moderate correlation (almost 0.6) and there were weak correlations concerning copper and iron (table 3). There were no significant correlations among all elements studied except between zinc and iron that presents a moderate correlation of 0.54 (table 4).

Conclusion

Zinc concentrations obtained were higher in liver than in kidney and there was a good correlation between them. Although we found several zinc values considerably higher than usually reported in investigations carried out by different authors, there were no significant correlations among all elements studied except a moderate correlation between zinc and iron. The values found for other elements than zinc seem similar to those usually reported.

In conclusion, the results obtained demonstrate the exposure of piglets (and indirectly of humans) to excess concentrations of zinc. They suggest that it is really important to continue the offal´s control of piglets slaughtered as well as the feeding stuffs. In some regions of the country this kind of food is specially appreciated and the concentration values obtained shows that it could be dangerous for human health. In 2014 EFSA launched a call (3) to collect data on the official feed control on zinc monitoring. A critical review of the zinc concentration of feed materials and the calculated background zin concentration of complete feed supports the possibility of a considerable reduction of the currently authorised maximum concentration for total zinc in feed.

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References

[1] Castillo, M.; Martin-Orue S. M.; Taylor-Pickard, J. A.; Perez, J. F.; Gasa, J., 2008, Use of mannanoligosaccharides and zinc chelate as growth promoters and diarrhea preventative in weaning pigs: Effects on microbiota and gut function; J. Anim Sci. 86: 94-101.
[2] Cromwell, G. L., 1997, High levels of zinc for early-weaned pigs – does it work?, Kentucky- College of Agriculture, Faculty Research Publications, Animal & Food Sciences.
[3] EFSA Journal, 2014; 12(5): 3668 [77 pp.]

[4] Gabrielson, K. L.; Remillard, R. L.; Huso, D. L., 1996, Zinc toxicity with pancreatic necrosis in piglets receiving total parenteral nutrition"; Vet. Pathol. 33: 692-696.
[5] Goselink, R. M. A.; Jongbloed, A. W., 2012, Zinc and Copper in dairy cattle feeding, Report 519, Reference ISSN 1570 – 8616, Wageningen UR Livestock Research,
[6] Straw, B. E.; Zimmerman, J. J.; D'Allaire, S.; Taylor, D. J., 2006, Miscellaneous Conditions in Diseases of swine, Blackwell Publishing, 9
[7] Leigh Ackland, M.; Michalczyk, A., 2006, Zinc Deficirncy and its inherited disorders – a review. Genes & Nutrition. Vol. 1, no 1, 41-50.
[8] López-Alonso, M.; Miranda, M.; Castillo, C.; Hernández, J., 2007, Toxic and essential metals in the liver, kidney and muscle of pigs at slaughter in Galicia , north-west Spain. Food Additi. Contam. 24 (9) 943-954.

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