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Heavy Metal Analysis of Goat Liver Samples from Wamakko, Sokoto and Dange Towns in Sokoto State

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ABSTRACT: The paper examines 30 goat liver samples from Wamakko, Sokoto and Dange towns for concentrations of selected heavy metals. The samples were obtained randomly from strategic points in the towns. After wet digestion, they were analyzed using atomic absorption spectrophotometer, model Shimadzu AA-6800 for Fe, Pb, Zn, Ni, Cd and Cu. The results (mg/kg^{-1}) of the analysis showed that the iron content ranges from 15.3 to 33.2, 6.77 to 41.6, and 6.92 to 26.1 for samples from Wamakko, Sokoto and Dange towns respectively. Lead content ranges from 0.024 to 0.65, 0.045 to 0.65 and 0.043 to 0.081 for samples from Wamakko, Sokoto and Dange towns respectively. Equally, Nickel content in the samples gave values from ND to 0.18, 0.09 to 0.37 and ND to 0.13 for Wamakko, Sokoto and Dange towns respectively while cadmium showed that samples from Wamakko, Dange and Sokoto have 0.006 to 0.040, 0.005 to 0.035 and 0.004 to 0.034 respectively. Also, the analysis for copper gave values of 0.64 to 2.2, 0.64 to 1.86 and 0.024 to 1.0 for Wamakko, Sokoto and Dange samples respectively and analysis of samples for zinc gave a range of 4.38 to 10.17 for Wamakko, 1.93 to 5.43 for Sokoto and 0.97 to 3.38 for Dange. The results of the samples in the three towns have significant difference ($P<0.05$). Thus, the paper concludes that goats reared in rural areas of the State are safer for consumption than those reared in urban and industrialized towns because they contain heavy metals below the permissible limits set by international organizations for foods.

Keyword: Heavy metals, Wamakko, Sokoto, Dange, livers.

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INTRODUCTION

The rise in cases of heavy metal related illnesses such as encephalopathy; disturbances in kidney and liver functions; damage to the reproductive organs; anaemia and many metabolic deficiency symptoms has made heavy metal contamination of a variety of human food sources a source of great concern to environmentalists and health specialists alike (Gazza, 1990). Researchers have stressed the need for evaluation of the levels of these metals in human diet which is one of the easiest routes of exposure to humans (Nwude *et al.*, 2010a). These metals find their way into human diets mostly from contaminated soil or water, as a result of man's various activities in recent years which have increased the quantity and distribution of the metals in the atmosphere, land and water bodies (Hutchson and Meema, 1987). Also, advancement in technology resulting in high levels of industrialization has led to the discharge of effluent containing heavy metals into our environment thereby contaminating soil and water bodies with consequent poisoning of plant and animals.

For instance, the analysis of urban run-off sediments in Lagos State of Nigeria with high level of environmental pollution due to industrialization found Zn, Fe and Cd in very high concentrations (Adekola *et al.*, 2002). Also,

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analysis of water samples of 72 rivers, streams and waterways in southern Nigeria showed toxic concentrations of the elements Pb, Cr, Cd, Fe, Zn, Mn and Cu (Asonye *et al.*, 2007). Thus, consumption of animals raised in such polluted areas poses a great risk to humans (Sedki *et al*., 1995 and Sedki *et al*., 2003). This is because the animals are exposed to the toxic metals in many ways especially by feeding on contaminated plants and soil particles containing heavy metals.

In Sokoto State, most dwellers, particularly low-income earners consume goat meats on a daily basis, this could constitute heavy metal poisoning due to bioaccumulation, as the goats feed indiscriminately on plants and garbage which may be contaminated with heavy metals. In the determination of heavy metal contents in Egyptian meat, Abou-Arab (2001) observed that the Pb, Cd, Zn, Cu, Mn and Fe contents in muscle, liver, kidney, heart and spleen in industrialized areas were higher than in the same organs for rural areas. Equally, in the evaluation of metal accumulation in cattle raised in a serpentine-soil area, Miranda *et al*. (2009) observed that tissue accumulation in animals was related to concentrations of the metals in soils and forage.

Though, some heavy metals are present mainly in muscle tissue (Storelli and Marcotrigiano, 2003), the concentration of essential elements (e.g. Cu, Zn, Mn, Mo, Co, etc) are generally at higher levels in the liver, which tend to act as a store house of trace elements (Noda *et al.,*1995). It is against this background that this study assesses the levels of Pb, Cd, Co, Zn, Cu and Fe in the livers of goats reared and slaughtered in three different towns in Sokoto State with the hope that the results will help to educate the residents as to the health implication of consuming such goat meats.

MATERIALS AND METHODS

Collection of Sample

Thirty liver samples were randomly obtained in July 2010 from 30 goats believed to have been reared in Wamakko, Dange and Sokoto towns in Sokoto State of Nigeria. The samples were procured at strategic points from each town (10 each) early in the morning immediately after slaughter in contaminant-free sample bags and preserved in a refrigerator pending the time of analysis. Samples from Wamakko, Dange and Sokoto towns were labelled W1 to W10, D1 to D10 and S1 to S10 respectively.

Digestion of Sample

About 10.0 g of each liver sample was placed in conical flasks, 5 mL of phosphoric acid were added. It was then heated on a heating mantle for about 1h, until heated to dryness; 100mL of distilled water was added and thoroughly shaken. It was filtered into a 100mL standard flask and the filtrate was made up to mark with distilled water. Aliquots of this were analysed for Pb, Cd, Ni, Zn, Cu and Fe using atomic absorption spectrophotometer, model Shimadzu AA-6800 (Nwude *et al.*, 2010a). All reagents used were of analytical grade and standards were prepared based on the method of Sabir *et al.,* (2003).

Statistical Analysis: Statistical analysis was carried out using student's *t* test to determine if there was any significant difference between the samples (n = 10) from the three different towns at ($P<0.05$) as described in Iwegbue *et al.* (2008).

RESULTS AND DISCUSSION

The results from the analysis carried out are presented in the figures and tables below:

The results on Tables 1, 2 and 3 show that the iron content ranges from 15.3 to 33.2mgkg^{-1}, 6.77 to 41.6 mgkg^{-1}, and 6.92 to 26.1 mgkg^{-1} for samples from Wamakko, Sokoto and Dange towns respectively. The iron content of the meats from the different towns were significantly different

($P<0.05$). There was also significant difference ($P<0.05$) between samples from the same locality. Also Figure 1 shows that samples from Wamakko and Dange towns contained lower amount of iron than the maximum permissible limit (37mg/kg) (Zarei *et al.,* 2011). While 10% of samples from Sokoto town showed higher iron content that the maximum permissible limit. The values obtained however, are lower than those given by Abou-Arab (2001) in the analysis of meat from goat reared in highly polluted areas (51.1±2.2mg/kg). The high amount of iron in some samples from Sokoto town may not be unconnected with the high urban activities like blacksmithing in the areas from which the samples were obtained. While there is no known serious effect of iron, in small amount it is an essential nutrient required for the formation of haemoglobin and man's liver has large storage capacity for iron, as the total iron content of the liver may rise to 10g in certain condition (Underwood and Suttle, 1999).

In the analysis for lead, the tables show a range of 0.024 to 0.65mg/kg, 0.045 to 0.65mg/kg and 0.043 to 0.081mg/kg for samples from Wamakko, Sokoto and Dange towns respectively. Figure 1 equally shows that all the samples were within the upper boundary of the permissible limit (1mg/kg) (Nwude *et al.,* 2010b) but 60 and 80% of Samples from Wamakko and Sokoto respectively are above the lower boundary (0.2mg/kg) though they do not constitute any form of danger to human. Again the low value for samples from Dange may be due to low polluted soil and plants as a result of low industrial wastes and automobile effluents in the town. While the high values for samples from Wamakko and Sokoto towns may be due to high industrial and automobile activities going on in the areas, which release lead and lead compounds into the environment. The values of lead were significantly different ($P<0.05$) among the three different localities.

Equally, analysis for Nickel in the samples gave values from ND to 0.18mg/kg, 0.09 to 0.37mg/kg and ND to 0.13mg/kg for Wamakko, Sokoto and Dange towns respectively. Figure 1 also shows that all the samples from Wamakko, Sokoto and Dange towns were below the permissible limit (40mg/kg) set by the Australia-New Zealand Food Authority (ANZFA) as reported in Iwegbue *et al.* (2008). Nickel has often been associated recently with allergies (contact with jewellery and jeans buttons containing nickel). However, there is no established knowledge of effects of this type when it is absorbed in the gastro-intestinal tract (Bulinski, *et al.*, 1993). The Nickel content in the samples shows a significant difference ($P<0.05$) among the three towns but was not significantly different ($P<0.05$) for samples within the same locality.

Table 1: Levels (mg kg^{-1}) of heavy metals in goat liver samples from Wamakko Town

Samples	Fe	Pb	Ni	Cd	Cu	Zn
W1	31.4±3.2	0.34±0.06	0.18±0.01	0.006±0.0008	1.02±0.06	4.38±0.27
W2	28.2±0.5	0.081±0.004	0.09±0.002	0.037±0.0011	1.8±0.03	8.11±1.2
W3	26.3±1.4	0.024±0.002	0.03±0.001	0.031±0.0028	0.72±0.02	2.32±0.30
W4	28.1±1.7	0.53±0.05	ND	0.033±0.0010	0.90±0.14	10.17±2.6
W5	33.2±1.3	0.38±0.03	0.02±0.001	0.026±0.0023	1.68±0.03	6.65±0.7
W6	30.4±2.0	0.65±0.21	0.13±0.03	0.013±0.0005	1.42±0.04	8.43±0.9
W7	15.3±0.9	0.072±0.003	0.16±0.05	0.017±0.0025	1.23±0.04	8.27±1.5
W8	31.6±1.8	0.54±0.06	0.13±0.02	0.008±0.0001	1.47±0.15	6.18±1.1
W9	32.6±1.3	0.39±0.04	0.09±0.001	0.040±0.0037	0.64±0.01	8.42±1.2
W10	23.4±1.9	0.16±0.02	0.03±0.002	0.036±0.0003	2.2±0.28	8.13±1.1

Table 2: Levels (mg kg^{-1}) of heavy metals in goat liver samples from Sokoto metropolis

Samples	Fe	Pb	Ni	Cd	Cu	Zn
S1	6.77±0.23	0.25±0.01	0.17±0.02	0.005±0.0003	1.0±0.3	3.78±0.61
S2	12.9±0.8	0.32±0.04	0.23±0.03	0.007±0.0001	0.83±0.01	3.16±0.39
S3	29±1.3	0.59±0.13	0.37±0.04	0.033±0.0024	1.5±0.4	5.43±0.76
S4	36.1±1.6	0.24±0.01	0.25±0.03	0.025±0.0035	1.23±0.6	3.03±0.30
S5	21.3±0.8	0.045±0.005	0.21±0.01	0.017±0.0032	1.86±0.3	3.42±0.13
S6	36.3±2.3	0.17±0.01	0.23±0.02	0.026±0.006	2.1±0.3	3.27±0.53
S7	18.2±1.5	0.62±0.03	0.09±0.001	0.035±0.009	0.64±0.004	3.61±0.64
S8	35.6±1.2	0.65±0.07	0.13±0.02	0.008±0.0002	1.35±0.12	2.79±0.25
S9	19.2±2.1	0.51±0.003	0.23±0.03	0.019±0.0004	1.61±0.2	1.93±0.14
S10	41.6±2.3	0.55±0.03	0.27±0.02	0.038±0.0016	1.39±0.6	3.11±0.84

Analysis for cadmium shows that samples from Wamakko, Dange and Sokoto have 0.006 to 0.040mg/kg, 0.005 to 0.035mg/kg and 0.004 to 0.034mg/kg respectively. These values are all within the permissible limit (0.05 to 1mg/kg) (Anonymous, 2003) as shown in Figure 1 (0% was above the permissible limit). The cadmium content was also significantly different (P> 0.05) in the three towns.

The analysis for copper shows values of 0.64 to 2.2mg/kg, 0.64 to 1.86mg/kg and 0.024 to 1.0mg/kg for Wamakko, Sokoto and Dange samples respectively. Equally figure 1 shows that all samples from Wamakko and Sokoto town have values above the permitted level (0.5mg/kg) (Anonymous 2003). The values also agree with the values obtained by Abou-Arab (2001) for goats reared in contaminated soil. The high values of copper in Wamakko and Sokoto may be due to pollution of the soil and plants by products made with cupper and processes that emit copper into the environment. And this can lead to digestive disturbances among sensitive consumers. However, only 50% of samples from Dange have higher values than the permitted limit. The values again are significantly different (P<0.05) in the three towns.

Table 3: Levels (mg kg^{-1}) of heavy metals in goat liver samples from Dange Town

Samples	Fe	Pb	Ni	Cd	Cu	Zn
D1	8.6±0.4	0.062±0.011	ND	0.004±0.0012	0.024±0.005	2.85±0.70
D2	6.92±0.6	0.043±0.001	ND	0.006±0.0026	0.63±0.02	3.38±1.30
D3	11.3±1.2	0.046±0.001	ND	0.034±0.0041	0.41±0.03	1.41±0.34
D4	16.6±2.4	0.081±0.012	ND	0.008±0.002	0.028±0.001	1.27±0.22
D5	13.4±2.1	0.053±0.002	ND	0.006±0.0013	0.59±0.004	1.24±0.16
D6	15.4±0.02	0.066±0.002	ND	0.005±0.0021	0.043±0.006	2.83±0.32
D7	17.9±0.3	0.075±0.003	ND	0.006±0.0016	0.96±0.03	0.97±0.03
D8	21.3±1.7	0.064±0.001	0.01±0.003	0.026±0.002	0.53±0.02	1.94±0.42
D9	9.2±2.8	0.060±0.018	ND	0.018±0.001	1.0±0.05	1.83±0.33
D10	26.1±1.4	0.059±0.003	0.13±0.01	0.006±0.001	0.046±0.006	1.62±0.57

Finally, the tables show that analysis of samples for zinc gives a range of 4.38 to 10.17mg/kg for Wamakko, 1.93 to 5.43 for Sokoto and 0.97 to 3.38mg/kg for Dange, with the samples from Wamakko having the highest range, which may be due to the cement factory located in that area. Though none was higher than the permissible limit of 150mg/kg. The zinc content also showed significant difference (P<0.05) among the three towns.

CONCLUSION

The levels of heavy metals in liver samples of goats as observed in this study shows that livers of goats from industrialized and urban areas like Wammakko and Sokoto towns have high concentration of heavy metals like Cu and Zn. While those from rural areas like Dange town have low concentration of all the metals analysed. As a result they do not pose any detrimental health effects to the consuming populace. So the paper recommends consumption of goats from rural areas than those from urban areas.

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