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ASSESSMENT OF SELECTED HEAVY METAL RESIDUES IN THE KIDNEY, LIVER, MUSCLE AND GIZZARD OF CHICKENS RAISED WITHIN ENUGU METROPOLIS

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ABSTRACT: *Studies were carried out for possible bioaccumulation of the following heavy metals; Pb, As, Cd, Cr, Hg, Ni, V and Cu in the internal parts (kidney, liver, gizzard and muscle) of twenty seven (27) local and exotic chickens raised within Enugu metropolis after wet digestion of samples and subsequent use of atomic absorption spectrometer. All the selected heavy metals were found to be present in the studied parts of the chickens although at concentrations within their respective established permissible limits for meats consumption. The internal organs of experimental chickens accumulated heavy metals in the following increasing order: liver > kidney > gizzard > muscle. Except vanadium, the concentrations of all other metals in the studied parts of the chickens showed significance at $p < 0.05$ from the anova analysis. The mean concentrations of Pb, Cd and Hg were very much higher in the kidney and liver the chickens than other studied metals. The experimental chickens accumulated heavy metals in the following increasing order: local chicken > layer chicken > broiler chickens.*

KEYWORDS: Heavy Metals, Bioaccumulation, Chickens, Kidney, Liver

INTRODUCTION

A complete and balanced diet is necessary for the human health and vitality. Protein is an essential mineral needed to form a perfect diet and is usually produced by two kinds of resource that are plants and animals (Appleby *et a.*,; 2004 and Mogbo *et al*., 2005). Poultry meats is considered as a good source of animal protein with high biological value as it contains all the essential amino acids, many vitamins and minerals which are required for human nutrition besides its relative low price compared with red meat (Institute of medicine, 2003). Environmental pollution is a major global problem poising serious risk to man and animals. Heavy metal pollution is posing a serious problem in Nigeria, threatening the animal and human health and quality of the environment (Deko Fehinti *et al*., 2012). Many heavy metals accumulate in one or more of the body organs with differing half-lives (Teresa *et al*., 1997). Food contamination with heavy metals is a serious threat because of their toxicity, bioaccululation and biomagnifications in the food chain (Demirezen *et al*., 2006). The main sources of metals in chicken meats arises from contamination of poultry feeds, drinking water and processing (Mariam *et al*., 2004). The main heavy metals of concern are lead, cadmium, mercury and arsenic which at even low concentrations pose serious health hazard to primary and secondary consumers due to bio magnifications (Demirezen *et al*., 2006). The effects of metals and metalloids are partly due to the direct inhibition of enzymatic systems and also to the indirect alteration of the essential metal ion equilibrium. Majority of the known metals and metalloids are very toxic to living organisms and even those considered as essential can be toxic if present in excess (Hossn *et al*., 2001).

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The toxic effects of these heavy metals to poultry birds among others include, low feed intake, low hatchability, low digestibility, retarded growth, weight loss liver and kidney damage e.t.c. (Hassan *et al*., 1998).

(Shih *et al*., 2007) stated that the toxic effects of heavy metals to humans include central nervous systems effects, liver and kidney damage, anxiety, constipation, depression, cancer, respiratory distress DNA alteration and death in extreme cases.

The need to verify the level of heavy metal depositions in chicken meats that form part of daily protein requirements of the people necessitated this research.

Experimental

Twenty-seven (27) local and exotic chickens were purchased and processed and the meat parts (gizzard, liver, muscle and kidney) were separated, packaged and sent for analysis. The laboratory analysis was carried out using the procedure as stipulated by (Okoye, 2000). All the precautionary procedures during digestion and atomic absorption spectrometric analysis were adhere to.

Statistical Analysis

The result obtained was subjected to anova analysis at 5% confidence level to determine the bioaccumulation capacity of heavy metals in the respective studied parts of the chickens.

RESULTS AND DISCUSSIONS

Table 1: Mean concentration of Pb, As, Cd, Cr, Hg, Ni, V and Cu in the studied parts of local and exotic chickens from Enugu metropolis (mg/g).

		Pb	As	Cd	Cr	Hg	Ni	V	Cu
Layer	**Muscle**	0.041 ± 0.006^{a}	0.086 ± 0.011^{a}	0.065 ± 0.018^{a}	0.089 ± 0.022^{a}	0.040 ± 0.010^{a}	0.061 ± 0.032^{a}	-	0.074 ± 0.027^{a}
	Gizzard	0.101 ± 0.009^{b}	0.145 ± 0.069^{b}	0.129 ± 0.011^{b}	0.137 ± 0.034^{b}	0.133 ± 0.035^{b}	0.135 ± 0.052^{b}	-	0.146 ± 0.038^{b}
	Liver	0.382 ± 0.035^{c}	0.226 ± 0.062^{c}	0.436 ± 0.048^{c}	0.117 ± 0.021^{c}	0.446 ± 0.057^{c}	0.163 ± 0.061^{b}	-	0.206 ± 0.052^{c}
	Kidney	0.343 ± 0.027^{c}	0.169 ± 0.027^{d}	0.386 ± 0.045^{d}	0.138 ± 0.066^{d}	0.429 ± 0.058^{d}	0.154 ± 0.065^{b}	-	0.149 ± 0.030^{d}
Broiler	**Muscle**	0.063 ± 0.020^{a}	0.076 ± 0.007^{a}	0.044 ± 0.010^{a}	0.035 ± 0.012^{a}	0.055 ± 0.017^{a}	0.042 ± 0.029^{a}	-	0.069 ± 0.010^{a}
	Gizzard	0.148 ± 0.033^{b}	0.099 ± 0.014^{b}	0.082 ± 0.008^{b}	0.091 ± 0.018^{b}	0.112 ± 0.038^{b}	0.092 ± 0.022^{b}	-	0.125 ± 0.011^{b}
	Liver	0.421 ± 0.046^{c}	0.189 ± 0.058^{c}	0.424 ± 0.059^{c}	0.131 ± 0.032^{c}	0.394 ± 0.047^{c}	0.117 ± 0.024^{c}	-	0.193 ± 0.028^{c}
	Kidney	0.394 ± 0.034^{d}	0.144 ± 0.034^{d}	0.324 ± 0.032^{d}	0.111 ± 0.017^{d}	0.365 ± 0.029^{d}	0.109 ± 0.038^{d}	-	0.111 ± 0.020^{d}
Local	**Muscle**	0.083 ± 0.007^{a}	0.092 ± 0.018^{a}	0.053 ± 0.008^{a}	0.019 ± 0.008^{a}	0.066 ± 0.013^{a}	0.065 ± 0.024^{a}	0.060 ± 0.014	0.077 ± 0.024^{a}

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Gizzard	0.187 ± 0.043[b]	0.203 ± 0.073[b]	0.234 ± 0.053[b]	0.207 ± 0.018[b]	0.221 ± 0.033[b]	0.129 ± 0.078[b]	0.068 ± 0.016	0.201 ± 0.049[b]
Liver	0.443 ± 0.069[c]	0.263 ± 0.048[c]	0.457 ± 0.067[c]	0.242 ± 0.022[c]	0.469 ± 0.062[c]	0.191 ± 0.059[c]	0.063 ± 0.012	0.239 ± 0.055[c]
Kidney	0.418 ± 0.060[d]	0.171 ± 0.015[d]	0.448 ± 0.050[d]	0.77 ± 0.026[d]	0.454 ± 0.037[d]	0.159 ± 0.042[d]	0.065 ± 0.011	0.225 ± 0.047[d]

Chicken parts with different super scripts have significantly different concentration of each of the heavy metals in them at $p < 0.05$ along the same column.

The table of the mean concentrations of the studied heavy metals in the experimental chickens raised within Enugu metropolis showed that Pb increased in concentrations in the internal organs of chickens in the following order: liver > kidney > gizzard > muscle with range of mean values 0.382 – 0.421mg/g, 0.343 – 0.418mg/g, 0.101 – 0.187mg/g and 0.041 – 0.083mg/g respectively. Anova analysis showed that Pb concentrations in the experimental chickens were significant at $p < 0.05$. The different biological functions of the studied organs in the body system which accounted for their capacity to bioaccumulate heavy metals could have been responsible for the significance shown by the anova analysis. The mean concentrations of Pb on all the experimental chicken types studied accumulated most in the liver followed by the kidney which is a confirmation of literatures reports that heavy metal accumulates in specific organs in the body (Musa et.al., 2013). The mean concentration of Pb in the internal organs of the experimental chickens were within the maximum permissible limits of 0.50ppm set by (FAO/WHO, 2006).

The mean concentrations of arsenic in the studied parts of the experimental chickens increased in the following order: liver > gizzard > kidney > muscle with range of values of 0.189 – 0.263mg/g, 0.099 – 0.203mg/g, 0.144 – 0.171mg/g and 0.076 – 0.092mg/g respectively. Anova analysis showed that arsenic concentrations in the internal parts of the experimental chickens were significant at $p < 0.05$. The mean concentrations of arsenic in the chickens were within established permissible limits. The order of mean concentrations of Cd in the experimental chickens followed the same pattern as in Pb and hence is as follows: liver > kidney > gizzard > muscle with range of mean values of 0.436 – 0.457mg/g, 0.324 – 0.448mg/g, 0.082 – 0.234mg/g and 0.044 – 0.065mg/g respectively. Like the results of Pb and As in the internal organs of the experimental chickens, Cd mean values were within permissible limits for consumption of the chicken meats.

Anova analysis showed significance of the concentrations of Cd in the studied parts of the experimental chickens at $p < 0.05$. Like Pb, the concentrations of Cd were also very high in the kidney and liver's is of the experimental chickens.

The mean values of Cd obtained in this research was higher than 0.044 ± 0.029ppm, 0.004ppm ± 0.003ppm and 0.004 ±0.008ppm obtained respectively in the liver, gizzard and heart of chicken giblets at retail markets in Egypt as reported by (Soad *et al.*, 2013).

The mean concentrations of Cr in the internal organs of the experimental chickens followed the same order of increase as in Pb and Cd and were within the established permissible limits set by (FAO/WHO, 2006). Anova analysis revealed significance of Cr in the internal organs of the experimental chickens at $p < 0.05$. The mean concentrations of Hg in the internal organs of the experimental chickens increased in the following order: liver > kidney > gizzard > muscle with the range of mean values of 0.394 – 0.469mg/g, 0.356 – 0.454mg/g, 0.112 – 0.221mg/g and 0.04 – 0.066mg/g respectively. The concentrations of Hg in the experimental chickens

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were significant at $p < 0.05$, but however within the established permissible limits of 0.50ppm set for it in consumable meats products.

Also, the mean concentration of Ni, V and Cu in the experimental chickens increased in the following order: liver > kidney > gizzard > muscle respectively and were within their respective established permissible limits for meat consumption.

Ni and Cu in the organs of the experimental chickens showed significance at $P < 0.05$ respectively. The experimental chickens bioaccumulated heavy metals in their respective body systems in the following increasing order: local chicken > layer chicken > broiler chicken.

Of the three experimental chickens studied, local chickens bioaccumulated the highest concentrations of heavy metals in its systems probably because of its age and lack of oral discrimination on what it can find edible in the environment.

Pb, Cd and Hg of the eight heavy metals analysed in the experimental chickens consistently accumulated very highly in the kidney and liver's of the chickens and were very close to reaching their maximum permissible limits in the above-mentioned parts of the chickens.

CONCLUSION

The mean concentrations of Pb, As, Cd, Cr, Hg, Ni, V and Cu in the studied parts (liver, kidney, gizzard and muscle) of both local and exotic chickens raised within Enugu metropolis were all found to be within their respective established permissible limits for meat consumption. Of the four parts of the chicken analyzed, liver and kidney were found to have accumulated the highest concentrations of the studied heavy metals. Uncontrolled anthropogenic activities and unhygienic processing environment of feed fed to chickens could increase the exposure of chickens to heavy metals (Pb, Cd, As and Hg) and raise its concentrations above permissible limits and thereby pose great health risk to the growth of chickens and consumers of chicken meat products.

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