Risk Assessment of Trace Metals in Roasted Chicken Parts (Gizzard) in Akwa Ibom State, Nigeria

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ABSTRACT

Risk assessment of trace metals in roasted chicken part (gizzard) were carried out in Uyo, Ikot Ekpene and Eket of Akwa Ibom State. The samples were treated using standard analytical methods as described by A.O.A.C, 2000. The results obtained for trace metals in Uyo town were as follows: Cd (0.581 ± 0.010mg/kg), Co (0.031± 0.011 mg/kg), Pb (0.027± 0.06 mg/kg), Cr (1.566 ± 0.212 mg/kg), Cu (7.690 ± 0.233 mg/kg) and Zn (8.790 ±0.345 mg/kg). Ikot Ekpene were analyzed to be a follows: Cd(0.104 ± 0.022 mg/kg), Co(4.002 ±0.0332 mg/kg), Pb(0.104 ±0.0347 mg/kg), Cr(1.417 ± 0.136 mg/kg), Cu(6.972 ± 0.192 mg/kg) and Zn(3.410 ± 0.026 mg/kg).Eket revealed heavy metal concentrations as follows Cd(0.135 ± 0.008 mg/kg), Co(2.842 ± 0.013 mg/kg), Pb(0.0135 ± 0.002 mg/kg), Cr(0.0165 ± 0.002 mg/kg), Cu(5.965 ± 0.094 mg/kg), and Zn(10.842 ± 0.187 mg/kg). In Correlation analysis, Cd and Cu showed a highest positive heavy metal association with correlation coefficient of 0.994969, followed by Cd and Cr with correlation coefficient of 0.971449 then Cr and Cu with a correlation coefficient of 0.942794 while Pb and Zn have a negative correlation coefficient of -0.99069 significant at P<0.001 which shows that as Zn increases, the concentration of Pb decreases. There was also a positive correlation between Co and Pb with a correlation coefficient 0.626918, Pb and Cr correlated with a coefficient of 0.53991 and a negative correlation between Cr and Zn (-0.64949), Co and Cu (-0.61529), Cd and Co (-0.53323) and Co/Zn (-0.515) all significant at P<0.05. Estimated target Hazard Quotients (THQ) shows (Cd, Cr, Cu), (Cd, Co, Cr, Cu, Zn) and (Cd, Co, Cu, Zn) in Uyo, Ikot Ekpene and Eket respectively were greater than one which indicate a potential significant health risk associated with the consumption of roasted gizzard from Akwa Ibom, Nigeria.

Key words; Risk assessment, Trace metals and Roasted chicken

INTRODUCTION

Poultry meat is considered as a good source of animal protein with high biological values as it contains all the essential amino acids, many vitamins and minerals which are required for human nutrition beside its relative low price compared to red meat (Akan, 2010).

Contamination by heavy metals is one of the major problem worldwide, regional and even at local level as it influences the functional and structural integrity of an ecosystem. The concentration and distribution of heavy metals in birds are highly influence by the biological and physiological processes such as growth, breeding molting, age and eating habits (Kim, 2007). Bioaccumulation of heavy metals in tissues of birds has received vast attention because of the lethal effect of their accumulation, apart from the fact that birds are often located in high levels in the food chain which makes them suitable for use in bioaccumulation studies (Burger, 1994).

The risk of heavy metal contamination in meat is of great concern for both food safety and human health because of the toxic nature of these metals at relatively minute concentration (Akan, 2010). According to Demirezen (2006), some heavy metal ions that are known to be potentially toxic are lead, cadmium, mercury and arsenic and can be harmful to birds even at low concentration when ingested over a long period of time. The effect of metals and metalloids are partly due to the direct inhibition of enzymatic system and also to the indirect alternation of the essential metal ion equilibrium. Most of the known metals and metalloids are very toxic to living organisms and even those considered to be essential can be toxic if presence in excess and can even reacts with important cellular component through, covalent and ionic bindings resulting in damage to cell membrane and alternation of the normal cellular functions (Bruins, 2006). The concentrations of heavy metals however, seems to vary among the species and thus, applying the reference range for them to the other species may be erroneous. Chicken meat widely consumed in Akwa Ibom State are rich in many of the essential nutrients such as amino acid, fatty acid and vitamins.

Materials and methods

The fresh Gizzard samples were obtained from Uyo, Ikot Ekpene and Eket Town, of Akwa Ibom State respectively. The samples were treated with distilled water and dry in an oven for three days. The sample were weighed and digested in a conical flask with 10 m/l of perchloric acid and 20m/l of nitric acid at 130^0C in a fume cupboard until the solution appeared colourless with a slight increase in temperature. Digestion was complete when fume of hydrochloric acid appear and slicer became white. It was taken to dryness and the flask was allowed to cool sufficiently to avoid splattering before 50m/l of distilled water was added and filtered with Whatman filter paper. The digest was used for the determination of heavy metal concentration using atomic adsorption spectrophotometer (AAS) (A.O.A.C, 1994).

Determination of Target Hazard Quotient (THQ)

The Health risk posed to the people of Akwa Ibom state from the consumption of chicken was characterized by Target Hazard Quotient (THQ) which is the ratio between the exposure and the reference doses (RfD). Rfd represents reference oral dose which is an estimation of the daily exposure to which the human population may be continually expose over a lifetime without an appreciable risk of harmful effects (Akoto, 2014). According to Chien 2002, if the ratio between exposure and the reference oral dose exceed one, there will be a concern for health risk but if this is less than one, there will be no risk posed.

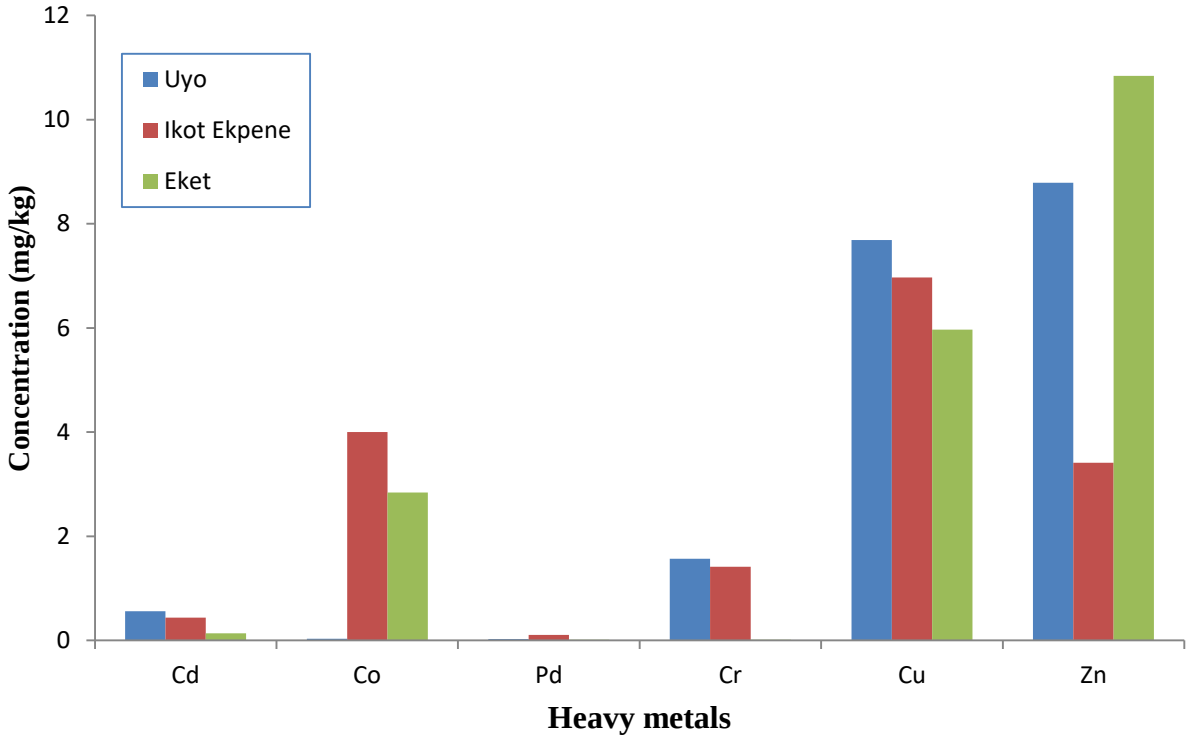
THQi = CDli/RfD

Where
CDli = Chronic daily intake via ingestion
RfD = Oral reference dose of the contaminant (mg/kg/day).

Hazard Index (HI)

This is the sum of the individual target hazard quotients and it helps to reveal the potential risks to human health through more than one heavy metal and was been developed by (USEPA, 2011).
HI = EHQ=HQpb + HQcd+ ……HQn
When the hazard index is greater than one, there is concern for potential health effect (Huang, 2008).

Results and Discussion



Heavy metals (Cd, Co, Pb, Cr, Cu and Zn) were analyzed in Gizzard samples from different parts of Akwa Ibom State, as shown in the Table above, the results obtained for heavy metals in Uyo town were as follows: Cd (0.581 ± 0.010), Co (0.031± 0.011), Pb (0.027± 0.06), Cr(1.566 ± 0.212), Cu(7.690 ± 0.233) and Zn(8.790 ±0.345). However, the heavy metals concentration of Gizzard from Ikot Ekpene were analyzed to be as follows: Cd(0.104 ± 0.022), Co(4.002 ±0.0332), Pb(0.104 ±0.0347), Cr(1.417 ± 0.136), Cu(6.972 ± 0.192) and Zn(3.410 ± 0.026) and that of Eket revealed heavy metals concentration as Cd(0.135 ± 0.008), Co(2.842

± 0.013), Ps(0.0135 ± 0.002), Cr(0.0165 ± 0.002), Cu(5.965 ± 0.094), and Zn(10.842 ± 0.187) respectively.

The concentration of heavy metals from the respective source were different, with Uyo town having the highest value of cadmium concentration. Cd results were in accordance with Scheuhammer (1987), who reported that, exposure to Cd concentration of less than one might pose a risk of chronic exposure.

Hathaway (1991) revealed that consumption of cobalt causes interstitial pneumonitis, myocardial, thyroid disorders and sensitization of the respiratory tract and skin.

This study also reveal low value of Pb in all part of Akwa Ibom state. Berger and Gochifeld, (2000) suggested that, Pb level as low as 0.4mg/kg can cause adverse physical effects.

The study analyzed concentration values for Copper and Zinc in the Gizzard of a chicken were lower than the report of kim (2007) and Sileo (2003), who also describe the clinical signs and diagnosis of Zn poisoning in birds in the laboratory and natural environment. Exposure to high dose of copper can cause anemia, liver and kidney damage, also stomach and intestinal irritation.

Heavy metals inter-relationship in the Gizzard of Chicken.

	Cd	Co	Pb	Cr	Cu	Zn
Cd	1					
Co	-0.53323*	1				
Pb	0.324796	0.626918*	1			
Cr	0.971449**	-0.31729	0.53991*	1		
Cu	0.994969**	-0.61529*	0.228415	0.942794**	1	
Zn	-0.45055	-0.515*	-0.99069**	-0.64949*	-0.35885	1

** Correlation is significant at the 0.01 level (2 tailed)

* Correlation is significant at the 0.05 level (2 tailed)

The correlation analysis calculated among the concentration of heavy metals in the Gizzard of chicken was to assess heavy metals relationship and their origin. Strong positive significant correlation was observed between some individual heavy metals. Cd and Cu showed a highest positive heavy metal association with correlation coefficient of 0.994969, followed by Cd and Cr with correlation coefficient of 0.971449. Cr and Cu showed a correlation coefficient of 0.942794

while Pb and Zn have a negative correlation coefficient of -0.99069 all significant at P<0.001 which shows that as Zn increases, the concentration of Pb decreases. There was also a positive correlation between Co and Pb with a correlation coefficient of 0.626918, Pb and Cr correlated with a coefficient of 0.53991 and a negative correlation between Cr and Zn at -0.64949, Co and Cu with a correlation coefficient of -0.61529, Cd and Co with -0.53323 and finally Co and Zn with -0.515 all significant at P<0.05.

Health risks from the consumption of poultry in Akwa Ibom State, Nigeria

(Table 1 : THQ & HI)

Parameter	**THQ**						HI
Sample location	Cd	Co	Pb	Cr	Cu	Zn	
Uyo	16.60	0.07	0.20	14.90	5.49	0.84	38.1
Ikot Ekpene	12.40	3.81	0.75	13.50	4.98	3.33	35.77
Eket	3.90	2.71	0.10	0.17	4.26	1.03	12.17

Table 1 above shows the estimated target Hazard Quotients (THQ) for individual metals and Hazard Index (HI) from the consumption of poultry in Akwa Ibom State. All the ratio between the exposure and reference oral dose exceeding one in the above table indicate a potential significant health risk associated with the consumption of poultry from Akwa Ibom.

Pb and Zn shows a THQ of less than 1 which indicates that, there will be no significant health risks from the intake of individual metals through consumption of poultry. Although Zn has the highest concentration among the studied metals but its health risk was low when calculated. This may be attributed to the value of reference dose in diet which decreased the THQ.

Hazard index (HI) calculated on heavy metals consumption reveals high risk involved in the poultry consumption from Akwa Ibom State with Uyo having the highest value of 38.10 and Eket with the lowest value of 12.17. According to Huang(2008), when the hazard index exceed 1.0 there is concern for potential health effect as exposure to THQ of more than one may produce an adverse effect on the consumer.

CONCLUSION

Analysis of heavy metals concentration in Gizzard revealed the presence of some heavy metal which may affect the food chain. Although it is known that people ingest heavy metals from poultry product, the health risk study carried out indicate high risk for human health linked to the consumption of poultry Gizzard as Cd with high health risk value is known to be highly toxic compound to which chronic exposure results in severe disease or even death, hence there is an urgent need to initiate an expensive epidemiological study of people who constantly consumed chicken Gizzard from Akwa Ibom State.

REFERENCES

Akan, J.C., Abdurrahman, F. I; Sodipo, O.A and chiroma, Y. A. (2010). Distribution of heavy metals in the liver, kidney and meat of Beef, Mutton, Caprine and Chicken from Kasuwanshanu market in Maidugari metropolis, Borno State, Nigeria. *Research Journal of Applied Sciences Engineering and Technology*, 2(8): 74-748.

Akoto, O. Bismark Eshun F, Darko G. and Addw E. (2014). Concentrations and Health Risk Assessments of Heavy metals in fish from the Fosu Layoon. *Int. J. Environ. Res.* 8(2): 403 – 410.

AOAC (1994). Association of Official Analytical Chemist. In Official methods of Association of Official Analytical Chemist. Washington, DC: AOAC, pp418

Bruins, F; Mogbo, S; Alissa, A; Appleby, D. Awofolu, E.; Tersa, T. and Hobson, N. (2006). Heavy metals environmental Aspects. *Iranian Journal of Environmental Health Sciences and Engineering* 14, 13 – 18.

Burger, J. Gochfeld M. (2000). Effect of lead on birds (Laridae): A review of laboratory and field studies. *Journal toxicol. Env. Heal:* B. 3, 59.

Burger, J. C., Veitch, R and Gochfeld. (1994). Locational differences in metal concentrations in feathers of Australasian Gannet (morus serrator) in New Zealand. *Environment. Monit. Assistant*, 32, 47 – 57.

Chien, L. C, Hury T. C, Choany K. Y, Yeh C.Y, Meng P.J, Shieh M.J. and Han B.C. (2002). Daily intake of TBT, Cu, Zn, Cd and as for fishermen in Taiwan. *The Sci. Tot. Environ.* 285(1-3): 177 – 185.

Demirezen, H. and Benjamin, T. (2006). Social domestic fowl. Transaction of the Kansas. *Academy of science*, 71, 375 – 380.

Hathaway, G. J., Proctor. H. H; Hughes T. P. and Fischman M. L. (1991). Proctor and Hughes chemical hazuds of the workplace. 3rd Ed. New York NY. Van Nostrand Rainhold.

Huang, M. L., Zhou S.L, Sun, B and Zhao Q.G. (2008). Heavy metals in wheat Grains: assessment of china. *The Sci. Tot environ*. 405 (1-3):54-61.

Kim, J. K., Park, T. H. and Koo, S. (2007). Trace elements and pollutants concentrations in shore birds from Yeongjong Island, Korea in the East Asian-Australian migration flywags. *Ectoxicology*, 16: 403 – 410.

Kin, J. and Koot H. (2007). Heavy metal concentrations in diet and livers of black crowned night heron nycticorax nycticorae and grey heron Ardea cineraa chucks from pycongtark, Korea. *Ecotoxicology*, 16, 411.

Lenntech, Watertreatment solution (2011). Manganse, BV/Rotterdamseweg.N0.2 M2629.http//www.lenntech.com//fiedt,ref.cabalt%2520. (1998 – 2013).

Scheuhanmer A. M. (1987). The chronic toxicity aluminum cadmium, mercury and lead in bird: A review. *Environ. Polhit* 46, 263.

Sileo, L.; Beyer, W. N. and Mateo, R.(2003).Pancreatitis in wild Zinc poisoned waterfowl. *Avian pathol*. 32,655

USEPA (2011). USEPA regional screening level (RSL) summary table. Nov. 2011.