*Special Conference Edition, November, 2017*
http://dx.doi.org/10.4314/bajopas.v10i1.68S

*Bayero Journal of Pure and Applied Sciences: 10(1): 341 - 344*
**ISSN 2006 – 6996**

# EVALUATION OF HEAVY METALS IN BEANS AND SOME BEANS PRODUCT FROM SOME SELECTED MARKETS IN KATSINA STATE NIGERIA

**[*1]Yaradua, A.I., [2]Alhassan, A.J., [1]Shagumba, A.A., [1]Nasir, A., [2]Idi, A., [2]Muhammad, I.U. and [3]Kanadi, A.M.**

[1]Department of Biochemistry, Faculty of Natural and Applied Sciences, Umaru Musa Yar'adua University, P.M.B. 2218, Katsina, Nigeria.
[2]Department of Biochemistry, Faculty of Basic Medical Sciences, Bayero University Kano, P.M.B. 3011, Kano, Nigeria.
[3]National Agency for Food and Drug Administration and Control (NAFDAC), P.M.B. 2015, Katsina, Nigeria.
*Correspondence Author: aliyuyaradua5@gmail.com Phone: +2348020344915

**ABSTRACT**
***This study was conducted to determine the heavy metals concentration in bean samples and some of their end products (Bean porridge, bean dumpling) obtained from some major selected markets (Batsari, Charanchi, Kafur and Mai'adua) in Katsina state Nigeria. The objectives were mainly to detect the presence of heavy metals in beans and their processed products sold in some selected markets in the study area, compare the effect of processing on concentration of heavy metals in samples in relation to the permissible limits specified by WHO/FAO, NAFDAC, FEPA and E.U Standards. Samples of beans were collected in the year 2016 from the selected markets. Analysis for the concentration of these heavy metals; Cu, Cr, Cd, Fe, Ni, Mn, Pb and Zn was conducted by the use of AAS (by Atomic Absorption Spectrophotometry) method. The difference between concentrations of heavy metals in unprocessed and processed bean samples was done by the use of T-test statistical analysis. Results from this study indicate that concentration value of Cu, Cr, Cd, Fe, Ni, Mn and Zn, in the samples were generally lower than the FEPA, WHO/FAO maximum permissive limits while Pb was not detected in all the samples. The low levels of heavy metals are indicative of low levels of contamination of farmlands were the beans samples were cultivated by these trace metals in spite of increasing use of fertilizers and pesticides in modern agriculture, as well as emissions from other anthropogenic sources***
***Key words: Beans, Heavy metals, Katsina, market, vegetable, beans.***

## INTRODUCTION

Beans are regarded as functional foods (Caˆmara et al. 2013) for human health benefits due to several therapeutic properties: in particular, their consumption is associated with a reduced risk of cardiovascular and digestive tract disease, diabetes mellitus and obesity (Timoracka´ et al. 2011). More so beans represent the 50% of the grain legumes consumed as a human food source (Caˆmara et al. 2013), but the prolonged consumption of unsafe concentrations of heavy metals through foodstuffs may lead to the chronic accumulation of heavy metals in the kidney and liver of humans causing disruption of numerous biochemical processes, leading to cardiovascular, nervous, kidney and bone diseases (Jarup, 2003).

The aim of the present study was to assess the composition of some selected heavy metals in beans samples sold in selected markets in Katsina state, and to compare the effect of processing on concentration of heavy metals in samples in relation to the permissible limits specified by WHO/FAO, FEPA and E.U Standards.

## MATERIALS AND METHODS

### STUDY AREA

The study was carried out during 2016 in Katsina State, Nigeria located between latitude $12^0$15'N and longitude of $7^0$30'E in the North West Zone of Nigeria, with an area of 24,192km$^2$ (9,341 sq metres). Market sold bean samples were obtained from some major selected markets (Batsari, Charanchi, Kafur and Mai'adua) in the State and conserved as dried seeds until analysis. Beans samples were homogenized with a stainless steel blender; from each sample were taken approximately 1 g and digested, the samples were then washed with distilled water dried and grounded into fine powder. Beans porridge and beans dumplings were prepared using local processing methods, dried in an oven at 100$^o$C and grounded into fine powder.

**Acid Digestion and Heavy Metals Determination**

Tri-acid mixture (15 ml, 70% high purity $HNO_3$, 65% $HClO_4$and 70% $H_2SO_4$; 5:1:1) was added to the beaker containing 1 g of sample. The mixture was then digested at 80°C, cooled and filtered using Whatman No. 42 filter paper and the filtrate was diluted to 50 ml with deionised water. Evaluation of the heavy metals in the digested samples was carried out using atomic absorption spectrophotometry.

**Daily Intake of Metals (DIM)**

The daily intake of metals was calculated using the following equation:

$$\mathrm{DIM} = \frac{C_{\mathrm{metal}} * C_{\mathrm{factor}} * D_{\mathrm{intak}}}{B_{\mathrm{weight}}}$$

Where, $C_{metal}$, $C_{factor}$, $D_{intake}$ and $B_{weight}$ represent the heavy metal concentrations in the unprocessed beans samples, the conversion factor, the daily intake of the food crops and the average body weight, respectively. The conversion factor (CF) of 0.085 was used for the conversion of the beans samples to dry weights. The average daily intake of the beans was 0.527 kg person$^{-1}$ d$^{-1}$, and the average body weight for the adult population was 60 kg; these values were used for the calculation of HRI as well.

**Health Risk Index (HRI)**

The HRI refers to the ratio of the daily intake of metals in the food crops to the oral reference dose (RfD) and was calculated using the following equation:

$$\mathrm{HRI} = \frac{\mathrm{DIM}}{\mathrm{RfD}}$$

An HRI > 1 for any metal in food crops indicates that the consumer population faces a health risk.

**Statistical Analysis**

The recorded data were subjected to two-way analysis of variance (ANOVA) to assess the influence of market location on the concentrations of heavy metals in the bean samples tested. Student's t-test was used to assess effect of processing methods on heavy metals concentration of samples.

**RESULTS**

A total of 4 bean samples from some selected markets in Katsina State were analyzed in this study. As shown in Table 1, among the heavy metals evaluated, the highest concentration was observed for Cr (range: 0.189- 0.586 ppm), followed by Fe (range: 0.031–0.084 ppm), Cd (range: 0.002–0.009 ppm). Zn was only detected in beans samples from Batsari and Mai'adua markets. Mn and Ni were only detected in beans sample from Kafur market (0.049 ppm, 0.002 ppm), while Pb was not detected in all the samples analysed. Analyses of the data by variance to correlate market location to heavy metal concentrations in beans samples showed that the difference in concentrations are statistically insignificant (P>0.05).

**Table 1** Heavy Metal Concentration (ppm) In Unprocessed Beans from Some Selected Markets in Katsina State.

| Markets | Pb | Cr | Zn | Ni | Fe | Mn | Cd |
|---|---|---|---|---|---|---|---|
| **Batsari** | ND | 0.586 ± 0.052 | 0.001 ± 0.001 | ND | ND | ND | 0.004 ± 0.001 |
| **Charanchi** | ND | 0.248 ± 0.036 | ND | ND | ND | ND | 0.002 ± 0.001 |
| **Kafur** | ND | 0.189 ± 0.046 | ND | 0.002 ± 0.003 | 0.031 ± 0.002 | 0.049 ± 0.004 | 0.009 ± 0.001 |
| **Mai'adua** | ND | ND | 0.001 + 0.001 | ND | 0.084 + 0.002 | ND | 0.003 ± 0.002 |

ND: NOT DETECTED

The results for heavy metals concentrations in processed bean samples is shown on tables 2 and 3, from the results there is a slight increase in the concentrations of Fe and Zn after processing. From the results, there was a reduction in the heavy metals Cd, Mn, Ni and Cr concentrations in the processed samples, this suggested that the processing reduce the concentrations, but statistically there was no significant (p>0.05) differences in the heavy metal concentrations between both the processed and unprocessed beans samples from the selected markets in Katsina state. The health risk index (HRI) calculated for heavy metals detected in samples were all below 1

**Table 2** Heavy Metal Concentration (ppm) In Beans Porridge from Some Selected Markets in Katsina State.

| Markets | Pb | Cr | Zn | Ni | Fe | Mn | Cd |
|---|---|---|---|---|---|---|---|
| **Batsari** | ND | ND | 0.020 ± 0.001 | ND | 0.186 ± 0.011 | ND | 0.003 ± 0.001 |
| **Charanchi** | ND | 0.161±0.032 | 0.006 ± 0.002 | ND | 0.277 ± 0.003 | ND | 0.006 ± 0.001 |
| **Kafur** | ND | 0.083 ± 0.028 | ND | 0.016 ± 0.006 | ND | ND | 0.008 ± 0.001 |
| **Mai'adua** | ND | ND | 0.004 ± 0.008 | ND | 0.176 ± 0.005 | 0.001 ± 0.003 | 0.002 ± 0.001 |

KEY: ND- Not Detected

**Table 3** Heavy Metal Concentration (ppm) In Beans dumplings processed from beans of Some Selected Markets in Katsina State.

| Markets | Pb | Cr | Zn | Ni | Fe | Mn | Cd |
|---|---|---|---|---|---|---|---|
| **Batsari** | ND | 0.405 ± 0.126 | 0.001 ± 0.002 | ND | 0.027 ± 0.002 | ND | 0.004 ± 0.001 |
| **Charanchi** | ND | 0.075 ± 0.048 | 0.004 ± 0.003 | ND | 0.046 ± 0.002 | ND | 0.006 ± 0.001 |
| **Kafur** | ND | 0.263 ± 0.023 | 0.001 ± 0.000 | 0.007 ± 0.001 | ND | 0.031 ± 0.022 | 0.008 ± 0.001 |
| **Mai'adua** | ND | 0.103 ± 0.232 | 0.034 ± 0.012 | ND | 0.308 ± 0.002 | 0.008 ± 0.002 | 0.002 ± 0.001 |

ND: NOT DETECTED

**DISCUSSION**

Heavy metals are non-biodegradable and their bio-accumulation increases in nutrition deprived state therefore, developing countries with higher prevalence of under nutrition are at a greater risk of heavy metal toxicity. The results obtained in the present study show that the heavy metal content of almost all the samples was lower than the WHO/FAO maximum permissible limits in foods. In the present study, the mean Lead content in all the samples was below detection limit, Which is similar to that reported for market sold beans in eastern Nigeria and a study conducted in Vadodara India (Okoye et al., 2009; Chandorkar and Deota, 2013). But differ from that reported for beans samples from Italy, Mexico, India, Japan, Ghana and Ivory Coast with a Pb concentration range of 4.084-14.475ppm (Di Bella et al., 2016) and that reported for leafy vegetables from Kaduna state Nigeria (Mohammed and Folorunsho, 2015) The Cadmium concentration range for both the unprocessed and processed bean samples was 0.002-0.009 ppm which is lower than that reported for market sold legumes in eastern Nigeria, Europe, Asia and parts of West Africa (Okoye et al., 2009; Di Bella et al., 2016) The variations observed can be attributed to use of fertilizers (contributes to cadmium content) and soil condition that affects the absorption by plants. In the present study, the mean Fe concentration in both samples was lower than that reported in a study in eastern Nigeria (Okoye et al., 2009) and much lower than that recorded by Zahir et al., (2009) who analysed different sample of beans and reported a high Fe concentration of 7.9-24.8 ppm in Pakistan and Di Bella et al., (2016) who reported a concentration range of 60.591-219.815ppm in their study. The result for Mn, Ni concentrations in the present study differs from results of other studies that reported higher concentration ranges (Okoye, 2008; Di Bella et al., 2016). The HRI calculated for metals in the study was below 1 indicating the safety of consumption of the samples.

**CONCLUSION**

This study determine the heavy metals concentration in bean samples and some of their end products (Bean porridge, bean dumpling) obtained from some major selected markets (Batsari, Charanchi, Kafur and Mai'adua) in Katsina state Nigeria. Results from this study has shown that concentration values of Cu, Cr, Cd, Fe, Ni, Mn and Zn in the samples were generally lower than the FEPA, WHO/FAO maximum permissive limits while Pb was not detected in all the samples. Analyses of the data by variance to correlate market location to heavy metal concentrations in beans samples showed that the difference in concentrations are statistically insignificant ($P>0.05$).

There were no significant ($p>0.05$) differences in the heavy metal concentrations between both the processed and unprocessed beans samples The calculated Hazard Quotient (HQ) for the heavy metals studied was below 1 which indicates safety of consumption with no risk to human health.

**REFERENCES**


Caˆmara CRS, Urrea CA, Schlegel V (2013) Pinto beans (*Phaseolus vulgaris L.*) as a functional food: implications on human health. *Agriculture* 3:90–111.

Chandorkar S, Deota P (2013). Heavy Metal Content of Foods and Health Risk Assessment in the Study Population of Vadodara. *Curr World Environ* 8(2):291-297

Okoye COB, Odo IS and Odika IM (2009) Heavy metals of grains commonly sold in markets in south east Nigeria. *Plant Product Research Journal* Vol 13 pp 4-7

Di Bella Giuseppa, Clara Naccari, Giuseppe Daniel Bua, Luca Rastrelli, Vincenzo Lo Turco, Angela Giorgia Potortı` and Giacomo Dugo (2016) Mineral composition of some varieties of beans from Mediterranean and Tropical areas. *International Journal of Food Sciences and Nutrition* vol. 67, no. 3, 239–248

Järup L. (2003). Hazards of heavy metal contamination. *Br Med Bull* 68(1): 167–182.

Mohammed, SA and Folorunsho, JO (2015) Heavy metals concentration in soil and Amaranthus *retroflexus* grown on irrigated farmlands in Makera Area, Kaduna, *Nigeria. Journal of Geography and Regional Planning* Vol. 8(8), pp. 210 - 217

Timoracka´ M, Vollmannova´ A and Ismael DS (2011) Mineral trace elements and flavonoids content in white and colored kidney beans. *Potravina´rstvo* 5:56–60.

Zahir E, Naqvi II and Mohi Uddin SH (2009) Market basket survey of selected metals in fruits from Karachi city (Pakistan), *Journal of Basic and Applied Sciences* 5(2):47-52