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Investigation of Metallic Element Deposition and Contamination of Some Food Product Processed By Wet Milling (An Investigation of Local Milling in Bali Main Market)

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ABSTRACT

This paper 'Investigation of metallic element deposition and contamination of some food product processed by wet milling' was carried out to determine the levels of Wear Elements introduced into food consumed by humans after being wet milled. Samples were collected from a selected milling house in Daniya area of Bali, Taraba State Nigeria and were analyzed. The presence of heavy metal such as Lead (Pb) and some amount of trace elements such as; Iron (Fe), Copper (Cu) and Zinc (Zn) contents in milled beans, millet, maize, tomatoes, pepper and onions were determined using Atomic Absorption Spectrophotometry technique. The wear elements detected ranged from 11.03 to 17.94 mg/kg of Fe, 4.11 to 12.28 mg/kg of Cu, 8.54 to 81.50 mg/kg of Zn, 0.008 to 0.018 of Pb and Ni went undetected being lower than the detection limits of 1.00mgkg. The result also showed that the highest values of Fe, Cu, Zn and Pb presence in the milled products were observed in Maize paste (17.94mgkg), Tomato slurry (12.28mgkg), Millet paste (81.50 mg/kg) respectively. It was found out that the level of Fe and Zn in most of the product samples was found to be above the permissible level of 15 mg/kg and 60 mg/kg respectively as set by WHO (2003) result from the rubbing of surfaces between plates, contact between product and machine surface and sometimes contact between product and lubricating oil. Other wear elements were found to be within the safe levels.

Keywords: Wear Element, Atomic Absorption Spectrometry, and Wet Milling.

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Introduction

A mill is a device that breaks solid materials into smaller pieces by grinding, crushing, cutting or shearing, (Andrews & Kwofie, 2010; Ampadu-Mintah, 2008; Bothwell, Seftel, Jacobs, *et al*, 1964; Deugnier, *et al*., 1992). The milling process reduces the mean particle size by cutting and crushing mechanism which could bring about abrasion (dry milling), and dissolution (predominantly in wet milling). Wet milling involves dispersing of materials in a liquid and the use of solid grinding element to reduce size. Wear caused by the milling causes a portion of the elements used in the manufacture of the grinders to exist in Free State which in turn come in contact and contaminate the food materials being processed (Haslina et al., 2008). The particles that get detached from machine members due to rubbing/ abrasion between surfaces in contact and dissolution in wet food materials are known as wear elements (Mathieu et al., 2008).

Food contamination by metals is an inevitable product of modern technology.(Nriangu and Azcue, 1990 and WHO) reported that the diet of man is a major exposure route for most of the unknown toxic contaminants in the environment. Among these contaminants, heavy metals have contributed markedly to the contamination of foodstuffs. It has been reported that Hg, Pb, Cd, Ni, Cr, Co, V, Mn, Fe, Zn, Sn and several other metals appear in processed food every day (Ateiza A.A, Lucas J, Ossai *et al* and Lawal A.O), but concentrations vary greatly (Jarup *et al*). Food processing equipment has long been recognized as a source of metal contamination of foodstuffs (Jamp. L, 2003 and Peterson and Johnson, 1978). The concern of the food processor is to see that the product is free of toxic or harmful metals or even of essential metals in quantities great enough to cause poisoning (Reilly, 1980). However with high quality steel, (Cheftel, 1988 and Reilly, 1980) pointed out that metals are unlikely to migrate from processing equipment into food. According to European Communities (EC) Low levels of heavy metals can often be reasonably achieved by using good manufacturing and processing practices.

Material and Method

The apparatus/materials used for this experiment are as follows:

- Weighing balance: for weighing of dry and wet digested samples
- Conical flask: used for digestion of samples in oxidizing acid and heating
- Graduated Measuring cylinder: used to measure the volume of sample analyzed
- Thermometer: for measuring and recording the temperature of the sample and the sample environment
- Heating mantle: for heating of samples
- Distilled Water,
- Fumed cupboard: to maintain the moisture content of the samples and weight at a constant level
- Concentrated solution of HNO_3 and $HCIO_4$: Oxidizing acids used for wet digestion to remove the organic matrices in the sample solution.
- Digestion Machine: for digestion of the samples before analysis.

Sample Digestion

The samples were digested according to the method described by the Association of Official Analytical Chemist (AOAC). 2g of the milled samples each were weighed into 250ml beaker, 10ml of the oxo-acidic mixture (HNO_3 acid and $HClO_4$ acid) in the ratio 4:1 10ml of this acid mixture was added to each of the samples and stirred.

They were evaporated on a hot plate in the fume cupboard until the black fume disappeared leaving only the white fume. The samples were allowed to cool and deionized water was added to dilute the resulting solution. These were filled into 50ml volumetric flask each for the maize and wheat sample respectively, then made up to mark in 50ml volumetric flasks using deionized water. The samples were transferred into clean sample bottles for atomic absorption spectrophotometer (AAS) analysis.

Result and Discussion

The concentrations of each Fe, Cu, Zn, Pb and Ni in the filtrate were determined by using atomic absorption spectra photo-meter

Table 1. The Table shows the various concentrations of heavy metals

S/N	Samples	Fe (mg/kg)	Cu (mg/kg)	Zn (mg/kg)	Pb (mg/kg)	Ni (mg/kg)
1	Beans	16.08	7.13	78.39	0.014	ND
2	Millet	17.53	8.31	81.50	0.009	ND
3	Maize	17.94	7.89	81.08	0.011	ND
4	Tomatoes	14.21	12.28	38.40	0.008	ND
5	Pepper	11.03	4.11	13.17	0.018	ND
6	Onion	15.43	7.23	8.54	0.013	ND

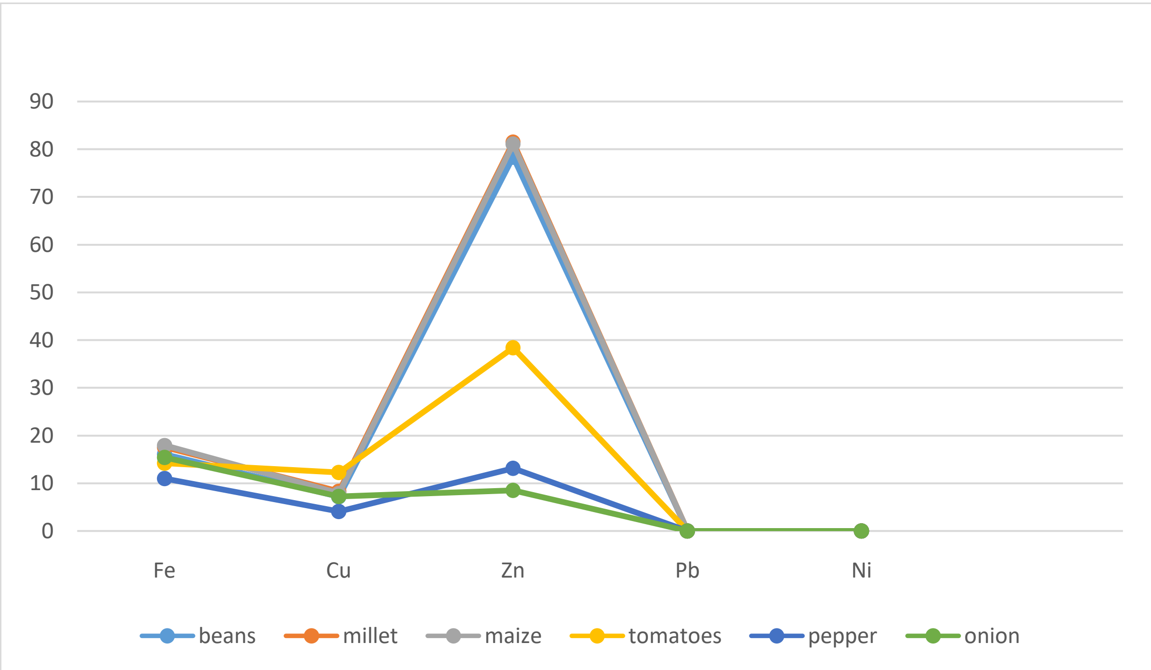

Fig 1: Graphical relationship between concentrations of metals in tested samples and Provisional Tolerable Intake limits according to WHO/FAO.

Iron (Fe) Iron is an important and essential component of hemoglobin and the intake of iron in human body is very beneficial to health. Among various samples, pepper indicate lower concentration of 11.03mg/kg while other samples theconcentration of iron is range between

15.43 to 17.94 mg/kg, the prescribed limit is 15mg/kg as set by (Elinder and Järup, 1996) meanwhile (Waheed et al, 2003) reported that the concentration of iron was 35.6 mg/kg for raw foodstuff. In other studies by Kwofie et al the result shows presence of iron which range from 3.86 to 22.21 mg/kg the level of contamination increases with the increase in quantity of the product.

Copper (Cu): the result shows that, levels of copper in the tested food samples were satisfactorily within save provisional daily intake limits of 15 mg/kg as set by the (Staff, 1997). The Cu content of the samples ranged between 7.13 – 12.28 mg/kg. A study carried out by (jahun et al, 2013) shows that amount of copper presence in milled food product to be 6.75 to 11.84 mg/kg.

Zinc (Zn): the concentration of Zinc was found to be higher compared to other metals presence in the food samples. Millet has the highest concentration of (81.50 mg/kg). The maximum Zinc ion level recommended for food is 60 mg/kg as mentioned by (Waheed et al., 2003). (Jahun et al, 2013) also found out the amount of zinc in food product particularly in beans to be 81.25mg/kg.

Lead (Pb): concentration was found out to be maximum in pepper sample at 0.018 mg/kg and minimum concentration was found in tomatoes at 0.008 mg/kg. The world health organization (WHO) has established a provisional tolerable weekly intake for lead to be 0.025 mg/kg of body weight (Staff, 1997). Lead is not readily being trans- locatedin plants, it could be that lead found in different samples may have originated from the surface of the milling machines or probably lubricating oils used. In other studies, results showed that the concentration of metals in food stuff ranged between 0.04-8.88 Cu, 3.07-126.0 Fe, 0.19-22.8 Zn, 0.15-1.16Cd and Pb has been in the range of 0.11-2.04 mg/kg (Waheed et al., 2003).

Nickel (Ni): Nickel is an essential nutrient in some chemical processes in the body. Its precise functions in the body are not well understood. Nickel is a common trace element in vitamin supplements. Nickel is a hard, silver-white metal found in soil, water, and foods such as nuts, dried beans, and chocolate. The body needs very small amounts of nickel. Nickel is likely safe in amounts up to 1 mg daily. According to WHO Taking more than 1 mg daily is possibly unsafe. Taking amounts slightly above the 1 mg level increases the chances of unwanted side effects. Higher doses are poisonous.

4.0 Conclusion

The study has broadenedand enhanced our understanding of the wear element, how they come in contact with food and the permissible amount recommended by the FAO /WHO so as to save lives. It is recommended that further research should be conducted in industrial areas where such crops are planted to trace the genesis where some of these wear elements have been absorbed before being subjected to AAS.

Grinding is the process used for most of the foodstuffs consumed in this part of the world. Results obtained from this study shows that a significant amount of Fe is introduced into the samples as contaminants by the processing tools. The presence of Fe in the samples is dependent on the elemental composition of the grinding discs of the commercial milling machine and domestic blender as these grinding discs are mostly made of 99% of Fe (Osei, 2001). The introduction of these metallic elements into the samples as a result of the abrasive friction of the grinding plates during grinding, contact between surface of the milling machine and sometime from lubricating oils.

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