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An Assessment of the Wear Element Contamination of Food Processed by Wet Milling Using Atomic Absorption Spectroscopy Technique

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Abstract

This paper 'Assessment of Wear Elements in Food Products by Wet Milling Using Atomic Absorption Spectroscopy Technique' 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 Yelwa area in Bauchi State Nigeria and were analyzed. The presence of heavy metals such as Cadmium (Cd) and Lead (Pb) as well as trace elements; Copper (Cu) and Zinc (Zn) contents in milled beans, tomatoes, sweet pepper and onions were determined using Atomic Absorption Spectrometry. The wear elements detected ranged from 0.008 to 0.017 $mgkg^{-1}$ of Pb and 12.42 to 17.63 $mgkg\text{-}^{1}$ of Fe and Cd went undetected being lower than the detection limits of 0.003 $mgkg^{1}$. However, the trace elements ranged from 6.75 to 11.84 $mgkg\text{-}^{1}$ of Cu and 9.35 to 81.25$mgkg\text{-}^{1}$ of Zn. The highest values of Pb, Cu, Zn and Fe in the milled products were observed in Onion paste (0.017$mgkg\text{-}^{1}$), Tomato slurry (11.84$mgkg\text{-}^{1}$), Beans paste (81.25 $mgkg\text{-}^{1}$) respectively. The level of Fe and Zn in most of the samples was found to be above the permissible level of 15 $mgkg\text{-}^{1}$ and 60 $mgkg\text{-}^{1}$ respectively as set by WHO (2003). Other wear elements were found to be within the safe levels.

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

1. Introduction

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). 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 processing is an essential part of Agricultural Engineering that involves the addition of value to food products and improves palatability for consumption. In all processes of food handling, safety should be of utmost priority to the handlers and the safety of food products especially for human and animal consumption must not be compromised (Zaidi, 2011).

The wet milling process involves the direct contact of food materials with various components of the milling machine which over time experience wear due to friction and dissolution. These wear materials get into the food which in turn has adverse effect on the safety of food for consumption (Havinga, 2006).

The standards regulatory body for food and drugs have set safe consumption levels for these wear elements in food which should not be exceeded (Havinga, 2006).

Wet milling has gradually become a necessity for the making of most delicacies enjoyed every day (e.g. grinding of tomatoes for stews and soups, grinding of beans for akara and moi moi) and for the extraction of oils from seeds. These processes are made possible by advancements in food engineering hence it became interesting to study the safe handling of food substances and this aimed for the study.

2. Materials and Methods

- Weighing balance,: for weighing of dry and wet digested samples (capacity: 6200g, readability: 0.01g)
- Conical flask,: used for digestion of samples in oxidizing acid and heating (100ml)
- Graduated Measuring cylinder: used to measure the volume of sample analyzed (250ml)
- Thermometer : for measuring and recording the temperature of the sample and the sample environment (0-300°c)
- Heating mantle: for heating of samples
- Distilled Water,
- Fumed cupboard : to maintain the moisture content of the samples and weight at a constant level
- Digestion Machine: for digestion of the samples before analysis.

- Concentrated solution of HNO3, H_2SO_4, and $HCIO_4$: Oxidizing acids used for wet digestion to remove the organic matrices in the sample solution. They are usually mixed in ratio of 3:1:1 respectively together with the samples solution.

Samples were collected at random from the different centers and labeled accordingly.

1 g of the sample was digested in 15 ml of HNO_3, H_2SO_4 and $HClO_4$ mixture (5:1:1) at 80 ºC until a transparent solution was obtained as reported by (WHO, 2003).

These transparent solutions were then filtered through Whatman No.42 filter paper and diluted to 50 ml with distilled water to get the required concentrations.

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

3.0 Results and Discussions

The values for Cd, Pb, Cu, Fe and Zn are presented in Table 1. The concentrations of the two heavy metals, Cd and Pb as well as the two or three trace elements, Fe, Cu and Zn in some foodstuffs from Yelwa milling houses were analyzed on wet weight basis.

Table 1: Heavy Metal Concentrations

S/n	Samples	Cu $mgkg^{-1}$	Pb $mgkg^{-1}$	Zn $mgkg^{-1}$	Fe $mgkg^{-1}$	Cd $mgkg^{-1}$
1	Tomatoes	11.84	0.008	41.40	15.29	ND
2	Beans	7.21	0.012	81.25	16.36	ND
3	Pepper	6.75	0.011	15.26	12.42	ND
4	Onion	8.63	0.017	9.35	17.63	ND

ND: Not Detected.

Fig.1. show the graphical relationship between concentrations of metals in tested samples. The results were discussed below and all samples were checked for compliance against limits laid down by FAO/WHO.

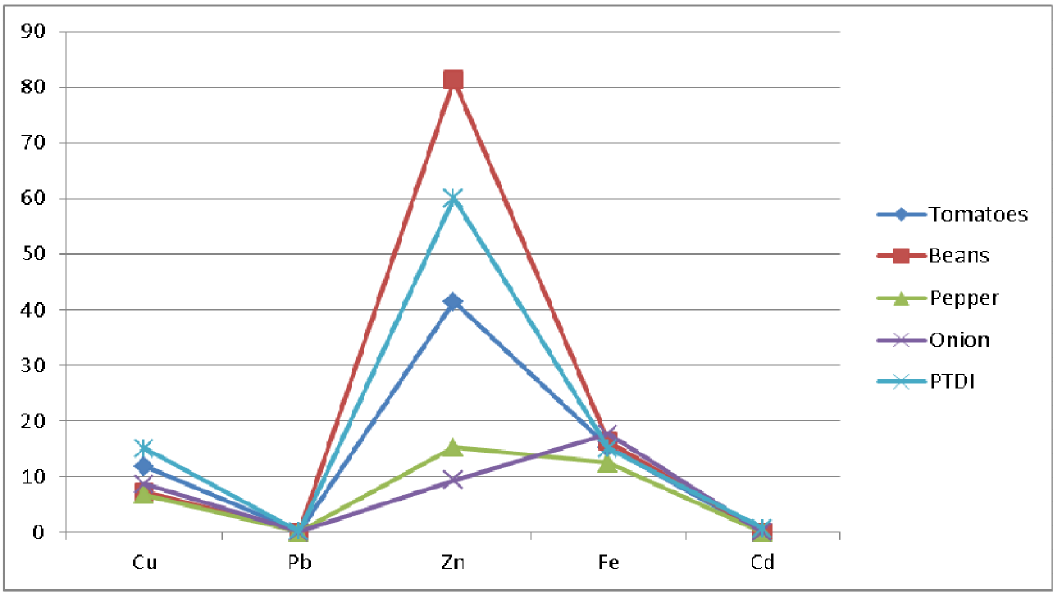

Fig 1: Graphical relationship between concentrations of metals in tested samples and PTDI= Provisional Tolerable Daily Intake limits according to WHO.

3.1 Zinc (Zn)

Zinc concentration is higher as compared to the other metals in the food samples. It was found highest in Beans (81.25mg/kg). The maximum Zinc ion level permitted for food is 60 mg kg^{-1} according to Turkish Food Codex Anonymous(Waheed et al., 2003).

3.2 Iron (Fe)

Iron is an important component of hemoglobin and intake of iron in human body is very good to health. Among various samples, pepper shows lesser concentration 12.42 mg kg^{-1} while in the other samples the concentration of iron is in between 15.29 to 17.63 mg kg^{-1} revolving around prescribed limits of 15mg/kg as set by(Elinder and Järup, 1996) (Waheed et al., 2003) reported that the concentration of iron was 35.6 mg/kg for raw foodstuff.

3.3 Cadmium (Cd)

Cadmium is readily available for uptake by plants as there is a clear association between cadmium concentration in soil and the plants grown on the soil(Elinder and Järup, 1996).The guideline value for cadmium in soil from plant uptake is 1 mg/ kg dry soil weight (French et al., 2006). In the present study the concentration of cadmium in the food samples has been found to be < 0.003 mg kg^{-1} which is the limit of sensitivity of the machine used for the analysis (Waheed et al., 2003). This is an indication of the presence of Cadmium in the food samples at negligible quantities. Cadmium concentrations were within the advisory interval (0.5-5 mg/kg) according to (FOOD, 2008).

3.4 Copper (Cu)

Copper levels in the tested food samples were satisfactorily within save provisional tolerable daily intake limits of 15mgkg^{-1} as set by the (Staff, 1997). The Cu content of the samples ranged between 8.63 – 11.84 mgkg^{-1}.

3.5 Lead (Pb)

The concentration of lead was found maximum in Onion sample at 0.017 mg kg^{-1} and minimum in tomato at 0.008 mg kg^{-1}.WHO has established a provisional tolerable weekly intake for lead of 0.025 mg kg^{-1} of body weight (Staff, 1997). As lead is not being trans- located readily in plants, it could be suggested that lead found in different samples originated from the surface of the milling machines or the 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).

4.0 Conclusion

The study has gone some way towards enhancing our understanding of the wear element and the permissible amount recommended by the FAO /WHO so as to save lives. It is recommended that further research should be conducted in an industrial areas where such crops are planted to trace the genesis were the wear elements have been absorbed before the use of AAS.

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