ASSESSMENT OF HEAVY METAL CONTENTS OF READY TO EAT FLOUR MEALS ON SALE IN ONDO METROPOLIS, NIGERIA.

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ABSTRACT

Heavy metal is the fourth often notified hazard category in the Rapid Alert System for Food and Feed (RASFF) from 1980–2016. Accumulation of these metals in humans had resulted in diseases; there had been few cases of general population poisoning as a result of long term exposure to Cadmium in contaminated foods and water. This study therefore investigated the heavy metal concentrations of fifteen ready to eat flour meal samples on sales in Ondo State, Nigeria. Each flour meal sample was purchased from different retailers in an open market in Ondo State capital.

The flour meals were evaluated using Flame Atomic Absorption Spectrophotometer. The results of the analysis showed that all the flour meals had one or more concentrations of the heavy metals to be high above Food And Agriculture Organization (FAO) and World Health Organization (WHO) permissible limits, particularly in sample EOF that contains: Cd (0.400mg/kg), Cr (2.308mg/kg), Pb (0.601mg/kg) and Fe (499.030mg/kg). Only samples YPF and BAF had high levels of Zn (150.25mg/kg and 174.300mg/kg) respectively. None of the samples have Cu level above the standard. The result of this study revealed that Cd, Cr, Pb are in high concentration in almost all the samples analyzed; and thus pose a high public health risk in ready to eat flour meals obtained from the market in Ondo, Nigeria. There is need for regular monitoring of heavy metals in the processing of flour meals sold in Oja Oba market, Ondo State.

Key Words: Heavy metal, Flour, Concentrations, Analysis, Flame.

INTRODUCTION

Flour is a fine powder made from various plants, mainly grains and starchy food stuff. Flour made from these plants is used mainly in baking, while some are 'ready to eat' flour meal; which is the most readily available food for many cultures (Cookbook, 2017) including Ondo State people. Foods are generally constant sources of toxic metals and they can accumulate in organs of human body and animals causing damages (Tomori and Onibon, 2015; Muchuweti *et al.,* 2006). Toxic or heavy metals accumulate in plants grown on soil contaminated by them (Marcin, 2018). Heavy metal contamination of agricultural soil can be as a result of wastewater irrigation, nature and characteristics of the soil, phosphate ferterlizers, municipal solid waste inceneration (Morrow, 2010; Pyatt, 2007 and Muchuweti *et al.,* 2006). Heavy metals, when present in the body disrupt normal cellular processes (FAO, 2016). There have been few cases of general population poisoning as a result of long term exposure to cadium in contaminated foods and water (Mann, 2012).Accumulation of Cd in rice crops along jinzūriver bank in Japan resulted in itai-itai diseases and renal abnormalities in members of the local agriculture that consumed the contaminated rice (Nogawa, 2004). Over doses of ingested iron can result in excessive levels of free iron in the blood; which can damage DNA, proteins, lipids and other cellular components and lead is highly poisonous when swallowed affecting almost every organ and system in the human body (USFDA, 2015).

Due to the dangerous effect of heavy metals, emphasis is usually placed on them during food monitoring to ensure they do not exceed maximum permissible levels set by World Health Organisation (WHO) and Food and Agricultural Organization (FAO) (Tomori and Onibon, 2015; Muchuweti *et al.,* 2006).

Researchs have been carried out on the levels of heavy metals grains, in snack food made from wheat flour, hull of oats grains and vegetable (Tomori and Onibon, 2015; Onabanjo *et al.*, 2009;Malomo *et al.*, 2003; Tompkin, 2004; Mann, 2012; McLaughlin *et al.*,1996; Callin *et al.*, 2009 and Mckie *et al.*, 2001). There have been little or no information on the level of heavy metals in ready to eat flour meals on sale in Akure the capital of Ondo State of Nigeria.

The aim of this study was therefore to evaluate the concentration of heavy metals in ready to eat flour meals on sale in Akure, Ondo State with the view of knowing the potential health effect associated with the consumption of these products.

MATERIALS AND METHODS

Sample collection: 15 different samples of ready to eat flours namely White pap flour(WPF), Yellow pap flour(YPF), Brown pap flour(BPF), Wheat flour (durum) - SF,Wheat flour(WF), Banana flavoured custard flour(BAF), Vanilla flavoured custard flour (VF), Yam flour 1 (Elubodudu flour) - EDF,Yam flour 2 (Elubofunfun flour) - EFF, Plantain flour (EluboOgede flour) - EOF, Yam flour (poundoyam flour) - PF, Cassava flour (kpukpuru flour) - KF, Bean flour (BF), Rice flour (RF), Quaker Oats (QOF) flour were purchased from Oja Oba market in Akure,Ondo State. All the samples were neatly packed and sealed.

Sample preparation and analysis: 0.8g of each of the samples was weighed into a Pyrex beaker; 8ml of HNO_3 was added to the sample and left overnight. The solution was heated for one hour on a hot plate at 120^0C, several additions of 4ml of 33% H_2O_2 was made until the digest was colourless. The residue was dried at 80^0C (low heat), cooled and diluted up to 25ml with distilled water, and made up to mark in a 60 ml sample bottle fur laboratory analysis (Jones *et al.*, 1991).

RESULTS AND DISCUSSION

Table 1*:* Concentration (mean±SD; mg/Kg) of some Heavy Metals in Ready-to-Eat Flour Samples.

S/N	Sample*	Cd	Cr	Cu	Fe	Pb	Zn
1	WPF	0.005±0.000	2.720±0.039	2.830±0.070	431.701±14.710	0.035±0.002	33.30±0.600
2	YPF	0.021±0.001	3.101±0.020	4.750±0.050	386.351±6.432	0.020±0.001	150.25 ± 4.350
3	BPF	0.120±0.002	0.250±0.001	17.600±1.101	447.104±16.494	0.050±0.002	11.20± 1.710
4	SF	0.200±0.000	0.140±0.020	26.606±2.010	48.850±2.520	0.260±0.018	13.250±0.820
5	WF	0.030±0.001	0.165±0.021	18.500±1.040	39.200±2.000	0.180±0.027	4.660±0.340
6	BAF	0.145±0.007	1.400±0.015	46.560±2.020	268.100±7.040	0.455±0.021	174.300±4.910
7	VF	0.132±0.005	2.150±0.010	29.450±2.002	217.505±1.350	0.330±0.011	96.400±6.930
8	EDF	0.002±0.002	0.225±0.015	0.895±0.016	440.15±13.61	1.275±0.110	6.303±0.076
9	EFF	0.050±0.007	1.005±0.011	0.230±0.008	390.390±8.510	4.955±0.350	5.254± 0.130
10	EOF	0.400±0.00	2.308±0.014	1.345±0.009	499.030±10.420	2.305±0.201	16.85± 1.140

11	PF	0.0250±0.003	3.200±0.140	2.460±0.063	534.401±2.023	0.103±0.028	11.035±1.640
12	KF	0.017±0.002	1.960±0.060	2.011±0.020	433.10 ± 5.85	0.601±0.021	5.350±0.070
13	BF	0.400±0.14	1.025±0.019	23.330±1.002	233.650±6.690	0.034±0.005	44.800±1.980
14	RF	0.150±0.004	2.520±0.108	1.970±0.051	395.400±6.650	0.270±0.028	11.600±0.154
15	QOF	0.30 ± 0.000	1.313±0.099	0.301±0.013	54.80±2.607	0.500±0.050	32.305±2.055
	FAO/WHO	0.2	2.3	73.3	425.5	0.3	99.4

The result of the analysis (Table 1) shows the concentration of heavy metals to be Cd (0.200mg/kg, 0.400mg/kg, 0.400mg/kg and 0.300mg/kg) in samples SF, EOF, BF and OF respectively. Cadmium in SF is 0.200mg/Kg. This is in line with values recorded for the product by Onifade*et al*., (2014) and Rholings, (2012). It is higher than the average values gotten for wheat flour in Great Britain reported by Ysart*et al*., (1999); wheat flour in Sweden (Jorhem*et al*., 2001); Wheat flour in Japan (Kim and Kim, 2010); flour in Greece (Karavoltsos*et al*., 2002); and some values for Nigerian wheat by Diboforji, (2012). It compares with wheat flour in Ghana and Turkey (Doe *et al*., 2013). The cadmium content of SF is equal to FAO/WHO standard limit of 0.2mg/Kg, therefore it can be considered as safe and free of health and ecological risk to consumers and handlers. Samples EOF, BF and OF are high in cadmium above the limit stipulated by WHO/FAO therefore pose health and ecological risk due to cadmium. Cadmium is 0.120mg/Kg in BPF and WPF is 0.005±0.000mg/Kg. This is in line with values reported by Musa and Azkna, (2013) for pap flour in southwest Nigeria (reported as 0.0047±0.001mg/Kg), but slightly below values reported by Ekezedoli *et al*., (2009) for similar products (0.008mg/Kg). Cadmium in the custard flours BAF, VF, EDF, EFF, and PF are 0.145mg/kg, 0.132mg/Kg 0.002mg/Kg, 0.050mg/kg and 0.0250mg/Kg respectively. Which are less than the FAO/WHO standard and poses no significant health and ecological risk due to cadmium. This is in line with values recorded for the product by Onifade *et al*., (2014) and Rholings, (2012). Cassava flour KF has cadmium content 0.017±0.002mg/Kg which is lower than the values reported by Iwealaet *al*., (2014).

The table shows high values of Cr (2.720mg/kg, 3.100mg/kg, 2.308mg/kg, 3.200mg/kg and 2.520mg/kg) in samples WPF, YPF, EOF, PF and RF respectively. They therefore pose health and ecological risk due to chromium. Chromium, within the pap flours is highest in YPF and lowest in BPF, with closer values between YPF and WPF; Chromium in WPF is 2.720mg/Kg. This is less than values reported for chromium in similar samples Musa and Azkna, (2013) of 3.4mg/Kg, and those of Iwealaet *al.*, (2014) of 7.1mg/Kg. Since these products are staple food consumed by a lot of Nigerians (Diboforjiet *al*., 2010), their consumption data becomes important.

The values for Iron (Fe) are (447.104mg/kg, 431.701mg/kg, 440.15mg/kg, 499.030mg/kg, 534.401mg/kg and 433.10mg/kg) in samples WPF, BPF, EDF, EOF, PF and KF. The FAO/WHO limit for iron is 425.5mg/Kg (Tegegnee*t al.*, 2015), therefore these samples pose health risk to the consumers. According to Onianwa*et al*., (2002), iron in food products are often high and exceed

the limit in many cases, attributable to the high values set for the limits, commonness of iron sources in process and production lines as well as the ease of contamination of samples by iron prior to and during analysis.

The values for lead (Pb) are (0.455mg/kg, 0.330mg/kg, 1.275mg/kg, 2.305mg/kg 4.955mg/kg, 0.601mg/kg and 0.500mg/kg) in samples BAF, VF, EDF, EOF, EFF, KF and QOF respectively. These samplesare high in lead and thus pose risk of lead toxicity. Lead is present in all three with close ties, highest in BPF and lowest in YPF; lead in WPF is 0.035mg/Kg, YPF is 0.020mg/Kg, while BPF is 0.050mg/Kg. These are higher than values reported by Ale *et al.*, (2012), and Bulea, (1999). They agree with values reported by Watanabe *et al*., (1998) for corn flour in China, and Jorhem*et al.*, (2001).Lead in SF is 0.260mg/Kg and WF is 0.180mg/Kg. These are higher than values reported by Ale *et al.*, (2012), Kim and Kim, (2010) and Bulea, (1999). They agree with values reported by Watanabe *et al*., (1998) for wheat in China and Jorhem*et al.*, (2001). The FAO/WHO limit for lead is 0.3mg/Kg which is higher than values for the samples. The wheat flour samples therefore pose no significant health and ecological risk to handlers and consumers. Lead in EDF, EFF, and PF are 1.275mg/Kg, 4.955mg/Kg and 0.103mg/Kg. According toTegegne*et al*., (2015), food products from rural and non-industrial setting, often dried and sold in road sides, are exposed to significant levels of lead from petrol emissions on the road side. This could possibly account for the relatively high values of lead in unpackaged products such as EDF and EFF. PF is a packaged product hence the low level of lead compared to the others.

Only samples YPF and BAF had high levels of Zn (150.25mg/kg and 174.300mg/kg) respectively.) The concentration of zinc is higher in YPF and lower in the other two pap samples. WPF is 33.300mg/Kg, YPF is 150.25mg/kg, and BPF has 11.20mg/Kg. The values for WPF agrees with that of Onianwa *et al.,* (2000) which is 33.5mg/Kg, Custards samples BAF and VF have zinc levels of 174.300mg/Kg and 96.400mg/kg and that of BAF is higher than the permissible limit and therefore pose health and ecological risk due to zinc. None of the samples have Cu level above the standard. However, sample EOF is found to contain high levels of Cd, Fe, Pd and Cr. This may be due to the processing procedure of the food as suggested by (Hajeb, et al.,). The process therefore requires monitoring.

CONCLUSION

The result of this study has revealed that Cd, Cr, Pb posed a high health risk in ready to eat flour meals obtained from the market in Ondo, Nigeria. The concentrations were far above the permissible limits set by FAO/WHO for human consumption.. Therefore, regular monitoring of heavy metals in grains and tubers is very crucial to avoid excessive build-up of these metals in the human food chain.

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