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INVESTIGATION OF TRACE METAL CONTAMINATION IN BREAD BAKED AND SOLD IN WUKARI

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ABSTRACT

Food contamination in the world has become an issue of serious concern since food mater ials are predisposed to certain contaminants during cultivation, production and packaging process es. Cereal is seen as an ideal example of the types of food affected by contaminants like trace metals such as Fe, Mn, Cu, and Zn. This study investigated the presence of trace metals in baked bread sold in wukari, Taraba state. Three samples of bread were purchased from three diff erent bakeries (F.U.W.B, B.B.B and V.S.R.B) in Wukari, Taraba state, Nigeria. The bread samples were oven dried at 60 ^{o}C to constant weights. The dried samples were ground to powder in an agate mortar to obtain adequate granulometry for the analysis. The ground samples were thoroughly mixed to get homogenous and representative samples. 5.0 g of the homogenized sample was weighed into “high form” porcelain crucibles. The crucibles with the samples were then put into murfle furnaces and the temperature was increased gradually until it got to 550 ^{o}C. When the samples in crucibles were observed to be grey and ash in form, the ashed samples were mixed with 2ml of concentrated HNO_3. The dissolved ash samples were transferred into 100 ml volumetric flasks and diluted to volume with distilled water (dH_2O), shaken up and then filtered. The method of Khalid and Rehman (2013) was used to investigate trace metal level in the three bread samples which were analyzed against known standards using Atomic Absorption Spectrophotometry (AAS) with specific lamps for Fe, Cu, Mn, and Zn. The concentration of Cu in the samples of bread baked and sold in Wukari were 4.68mg/g, 5.35mg/g and 62.96mg/g for F.U.W.B, B.B.B and V.S.R.B respectively, with V.S.R.B having the highest concentration of Cu. The concentration of Fe in the samples of bread baked and sold in Wukari were 47.88mg/g, 54.89mg/g and 62.96mg/g for F.U.W.B, B.B.B and V.S.R.B respectively, with V.S.R.B having the highest concentration of Fe. The concentration of Mn in the samples of bread baked and sold in Wukari were 50.79mg/g, 58.36mg/g and 62.83mg/g for F.U.W.B, B.B.B and V.S.R.B respecti vely, with V.S.R.B having the highest concentration of Mn. The concentration of Zn in the samples of bread baked and sold in Wukari were 23.43mg/g, 25.45mg/g and 28.62mg/g for F.U.W.B, B.B.B, and V.S.R.B respectively, with V.S.R.B having the highest concentration of

Zn. Consistent consumption of bread samples with high concentration of these trace metals above the recommended dietary allowance could result to a number of health effects over time.

KEYWORDS: Contamination, Trace metal, Bread, Recommended dietary allowance.

I. INTRODUCTION

Nutritional concerns about cereal-based diets are important issues worldwide especially v itamin and mineral deficiency in susceptible individuals such as children younger than five years and women at reproductive age (Dariush *et al.,* 2014). Mineral compounds are essential to daily food needs (EFSA, 2012). Because of high consumption of wheat in a variety of food products, wheat is considered an important source of mineral compounds (Darius *et al.,* 2014). It contains a number of trace metals such as Fe, Mn, Cu and Zn which can accumulate in the biological system linked to harmful effects (Hu, 2002).

Trace metals are metallic chemical elements such as Chromium, Cobalt, Copper, Iron, Manganese, Zinc etc that normally occur at very low levels in the biological system. Living things need very small amount of some trace metals, although high levels of these metals can be toxic to them (Kelly *et al.,* 2010). For example, Fe is an essential element for normal human blood function. Deficiency or excess of it may lead to adverse pathological conditions. Application of chemical fertilizers and the practice of using sewage sludge during cereal cultivation substantially increase the levels of Zn, Fe, Cu and Mn in soils and cereal crops (Hassan, 2013). Food processing equipment and containers have also been long recognized as a source of trace metals such as Fe, Cu, and chromium (Cr) in processed foods (Onianwa *et al.,* 2001). Trace metals have positive and negative effects on human health. Humans are exposed to trace metals in many different ways such as; ingestion of contaminated water and food, and inhalation of air pollutants or contaminated soil particles. Long-term exposures to trace metals can be very harmful when they are in high concentration.

Bread is a kind of food made from flour, water and other ingredients, usually combined with a leavening agent, kneaded, shaped into loaves, and baked. It is an important staple food of many countries of the world especially the African countries and South East part of Asia (Pomeranz, 1987; Owens, 1997). In Nigeria, bread is consumed extensively in homes, restaurants and hotels. It is one of the most consumed food type with predominant consumption among the poor (Maziya-Dixon *et al*, 2004). Nutritionally, bread is considered a good source of carbohydrate and the whole grains contain other nutrients such as magnesium, iron, zinc, B vitamins, and dietary fibre (USDA, 2010). Bread also provides as much as 50 to 90% of total calorie and protein intakes (Jahed, 2005). Trace metals existence in bread can be attributed to factors such as environmental parameters, mode of production and processing (Jawad and Allafaji, 2012).

Since bread is one of the most commonly consumed food products in Wukari metropolis and there is little knowledge on trace metal contamination in bread baked and sold in Wukari metropolis, there is need to investigate the level of trace metals in bread baked and sold in Wukari.

II. METHODOLOGY

Sample collection

A survey was conducted to know the potential sources of trace metal contamination in breads baked and sold in Wukari. Three samples of baked breads were purchased from three commonly patronized bakeries (Federal university wukari bread (F.U.W.B), Bisco Butter Bread (B.B.B) and Vision Spanish Round Bread (V.S.R.B) in Wukari, Taraba state, Nigeria.

Sample preparation

The method of Khalid and Rehman (2013) was used to prepare the bread samples. The bread samples were oven dried at 60 ^{o}C to constant weights. The dried samples were ground to powder in an agate mortar to obtain adequate granulometry for the analysis. The ground samples were thoroughly mixed to get homogenous and representative samples. The homogenized and dried samples were stored in air tight plastic containers until required for analysis.

Sample digestion

Dry ash procedure (AOAC, 2000) was used for sample digestion. 5.0 g of the bread samples was weighed into "high form" porcelain crucibles. The crucibles with the samples were then put into murfle furnaces and the temperature was increased gradually until it got to 550 ^{o}C when the samples in the crucibles were observed to be grey and ash in form. The ashed samples were mixed with 2ml of concentrated HNO_3. The dissolved ash samples were transferred into 100 ml volumetric flasks and diluted to volume with distilled water (dH_2O), shaken up and then filtered.

Trace metal quantification

The digested samples were analyzed against known standards using Atomic Absorption Spectrophotometry (AAS) with specific lamps for Fe, Cu, Mn, and Zn. Blank determination was carried out to ascertain the background levels of the analytes of interest in the materials and reagents used for the analysis. This was done by running a separate determination under the same experimental condition employed in the actual analysis of the samples excluding the samples.

III. RESULTS AND DISCUSSION

Table 1: Concentration of trace metals (mg/g) in breads baked and sold in Wukari, Taraba state, Nigeria.

Bread Code	Bread type	Fe	Cu	M n	Zn
F.U.W. bread	Not sliced	47.88±0.02	4.68±0.01	50.79±0.02	23.43±0.02
B.B. bread	Not sliced	54.89±0.02	5.35±0.02	58.36±0.02	25.45±0.02
V.S.R.B	Not sliced	62.96±0.02	62.96±0.02	62.83±0.02	28.62±0.02

*The values are mean ±standard deviation of trace metal concentration.

The values shown in table 1 above are the results obtained from the analysis of trace meta ls contamination in bread baked and sold in Wukari, Taraba state, Nigeria. The concentration of Cu in bread samples baked and sold in Wukari were 4.68mg/g, 5.35mg/g and 62.96mg/g for F.U.W.B, B.B.B and V.S.R.B respectively, with V.S.R.B having the highest concentration of Cu. The concentration of Fe in bread samples baked and sold in Wukari were 47.88mg/g, 54.89mg/g and 62.96mg/g for F.U.W.B, B.B.B, and V.S.R.B respectively, with V.S.R.B having the highest concentration of Fe. The concentration of Mn in bread samples baked and sold in Wukari were 50.79mg/g, 58.36mg/g and 62.83mg/g for F.U.W.B, B.B.B, and V.S.R.B respective ly, with V.S.R.B having the highest concentration of Mn. The concentration of Zn in bread samples baked and sold in Wukari were 23.43mg/g, 25.45mg/g and 28.62mg/g for F.U.W. B, B.B.B, and V.S.R.B respectively, with V.S.R.B having the highest concentration of Zn.

Intoxications of trace metals are normally linked with one of the three patterns of occurrence; environmental pollution, accidental inclusion during processing and contamination at processing or storage stage (Moffat and Whittle, 1999). Trace elements though required in smaller quantities are to be taken in diet as they are required by the body for specific functions but taking them in excess causes adverse effects on human health (Kelly *et al.,* 2010).

Like Co, Cu is an essential mineral that is found throughout the body. It helps the body in making red blood cells and keeps nerve cells and the immune system healthy. It also helps in forming collagen, a key part of bones and connective tissues (Elinder *et al.,* 1986). At a suitable level in human system may also act as an Antioxidant, getting rid of free radicals that can damage the cells and deoxyribonucleic acid (DNA) (Friberg *et al.,* 1986).

The concentration of copper in the bread samples was within the range of 4.68 ±0.01mg/g and 62.96 ±0.02 mg/g. The concentration of copper detected in F.U.W.B was within the normal range (2-5mg/g) for adult intake as recommended by W.H.O but less for children as recommended by W.H.O (50-100mg/g). Also, copper in B.B.B was detected to be within the normal range for adult intake (2-5mg/g) but less for children intake (2-5mg/g) according to W.H.O While the concentration of Cu detected in V.S.R.B was more than the W.H.O recommended allowance for adult and children. Besides the concentration of Cu in the cereal, the high Cu concentration detected could possibly be caused by raw materials used for flour production, or contamination of copper in this bread may also be due to the degradation and deterioration of some copper alloy equipments used during the flour making and baking (Oyekyunle *et al.,* 2014). The accumulation of copper above normal range for a prolong period of time could result in the following: increased copper percentages in serum and tissue that in turn causes oxidative stress and affects several immune functions, Vomiting, renal dysfunction, diarrhea, profuse sweating among others (Tumlund *et al.,* 2004).

Recent studies have shown that infants who exclusively feed on cow milk formula may acquire Cu deficiencies as the milk itself is low in Cu (Stern, 2010). A number of nutrition surveys have indicated that the diets of approximately 25% of adolescents, adults and people over 65%, do not meet the recommended daily nutrients intake for Cu (Stern, 2010). Conditions that are associated with copper deficiency include; Osteoporosis, Osteothritis, rheumatoid arthriti s, cardiovascular disease, colon cancer and chronic conditions involving bone connective tissues, heart and blood vessels.

The concentration of manganese in all the bread samples ranged from 50.79±0.02mg/g to 62.83±0.02mg/g. The concentration of Mn detected in F.U.W bread was more than the recomme nded allowance for adults by W.H.O. The concentration of Mn detected in both B.B.B and

V.S.R.B were also more than the recommended allowance for adult. However, Mn values for all the bread samples were within the range of recommended allowance for children by W.H.O. Mn is known to play critical roles in bone mineralization, protein and energy metabolism, metabolic regulation, cellular protection from damaging of free radical species. Mn deficiency could lead to poor growth and impaired reproduction (ATSDR, 2004). The human body contains a total of 15-20mg of Mn, most of which is located in the bone. The concentration of Mn detected in the bread samples exceeded the daily intake of 2-5mg/day recommended by W.H.O for adult but was within the normal range for children. Accumulation of manganese over a long period of time has been reported to cause anorexia, apathy, headache, impotence, leg cramps, speech disturbance, Psychosis etc (Van *et al.,* 1979).

The concentration of zinc in the bread samples was within the range of 23.43±0.02mg/g and 28.62±0.02mg/g. The concentration of zinc detected in all the bread samples was above the recommended allowance for adult and low for children as recommended by W.H.O. Zinc deficiency is characterized by growth retardation, loss of appetite and impaired immune function While excess of it results in the following conditions; sideroblastic anaemia, hypochromic micro cytic anaemia, leukopenia, lymphadenopathy, neutropenia, hypocupraemia and hypoferraemia (J erome, 2007). The concentration of zinc in the bread samples (ranging from 23.43±0.02mg/g to 28.62±0.02mg/g) was above the W.H.O recommended level of consumption for humans and bel ow the W.H.O recommended level of consumption for children .Thus a regular consumer of bread in this environment might suffer zinc associated toxicity and deficiency diseases over time.

In this study, the concentration of Fe in the bread samples was within the range of 47.88 ±0.02mg/g and 62.96±0.02mg/g. The concentration of iron detected in F.U.W.B (47.88mg/g) was seen to be above the W.H.O recommended level (Adult: 8-18mg/g, Children: 1.7mg/g) of consumption for humans (both adult and children). It was also detected that the concentration of Fe in both B.B.B and V.S.R.B was above the W.H.O recommended level (Adult: 8 18mg/g, Chil dren: 1.7mg/g) for human consumption. Consumers of this kind of bread samples might suffer th e toxicity effects of Fe such as hepatic failure, diabetes, testicular atrophy, arthritis, cardiomyopa thy, peripheral neuropathy, and hyper pigmentation (Andrews, 1999).

IV. CONCLUSION

In this study, Iron level in F.U.W.B, B.B.B and V.S.R.B were above the recommended daily allowance stipulated by W.H.O (Adult: 8-18mg/g, Children: 1.7mg/g). Copper level in F.U.W.B and B.B.B were within the normal range for adult (2-5mg/g) but below the range for children while V.S.R.B values were within the recommended dietary allowance stipulated by W. H.O (50-100mg/g) for children. Manganese level in F.U.W.B, B.B.B were within the normal recommended daily allowance for children (25-75mg/g) but were above the normal recommende d daily allowance for adult (0.5-5mg/g). Zinc level in F.U.W.B, B.B.B and V.S.R.B were above t he normal recommended daily allowance stipulated by W.H.O (8-15mg/g) for adult and children (0.5mg/g). Consistent consumption of bread samples with high concentration of these trace metals (Fe and Zn) could result to health effects over time.

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