Available online at www.equijost.com

Equity Journal of Science and Technology, 2023 10(1): 42 - 45

ISSN 2354-1814; E-ISSN 2683-5961

EQUIJOST *An Official Publication of Kebbi State University of Science and Technology, Aliero, Nigeria*

Health risk assessment of selected heavy metals in bread and popcorn snacks consumed in Birnin Kebbi, Kebbi State

*Ibrahim S. Shabanda, Azeezat O. Aare

Department of Pure and Applied Chemistry, Kebbi State University of Science and Technology, Aliero, Kebbi State, Nigeria

*Corresponding Author's email: ibrahimshabanda@gmail.com

Abstract

The health risks resulting from heavy metals such as Cd, Cr, Pb, Cu, Mn and Ni consumed in bread and popcorn snacks in Birnin-Kebbi, Kebbi State were investigated. The health risk assessment was conducted in accordance with the United States Environmental Protection Agency (USEPA). The estimated daily intake (EDI) for all the studied metals in all the samples were found to be below the provisional tolerable limit based on Codex and the European Union (EU). The hazard quotient (HQ) of all the metals in all the samples were observed to be less than 1, indicating an absence of health risk for the consumers of snacks in the study area. The hazard index (HI) which is the summation of all the hazard quotients for all the metals in bread was 0.8143 and in popcorn was 0.526 which were also less than 1. The results of this study show consumption of bread and popcorn is safe from the risk of the heavy metals. However, long accumulation of these toxic metals may lead to health consequences. Therefore, continuous monitoring of snacks in the study area should be done by the agencies concerned to safeguard the health of the population.

Keywords: Heavy metals, bread, health risk, popcorn, snacks

1. Introduction

Pollution of heavy metals in the environment particularly in food stuff has become a great challenge and topmost concern globally in the recent years. This is due to rapid increase in population that leads to rapid increase in development [1]. The heavy metals are nonbiodegradable in nature as such their accumulation in the environment and food stuff last longer and transferable [2]. Heavy metals such as Cd, Cr, Pb, Cu, Ni and Mn are categorized potentially harmful elements [3]. However, the demand for food safety have become a critical concern to the human population as a result of contaminated food consumption resulting to potential health risk. Therefore, monitoring of heavy metals in food has become significant for the safety of human consumers. Even though, heavy metals are found naturally in the environment, however, human activities such as agricultural, industrial, domestic discharges, traffic activities and also preparatory method increased the amounts of these potential toxic metals even in food stuff [4, 5]. As a result, humans are exposed to these metals through the consumption of contaminated food. Humans can develop serious health effects as a result of significant intake of heavy metals through contaminated foods [6]. On accumulated in the body, these toxic metals can cause high risk of gastrointestinal cancer and reduction of immunological suppression as a result of their competitive behaviour with some of the essential nutrients [7]. Previous researches [8-12] have reported concentrations of heavy metals. Nevertheless, the study of health risk estimation of toxic metals in snacks particularly bread and popcorn particularly in Kebbi State is lacking. To our knowledge this is the first study in the study area. Hence the aim of this study is to assess the health risk associated with Cd, Cr, Pb, Cu, Ni and Mn via bread and popcorn snack consumption. The information would help in creating awareness about any risk to health regarding snack food contamination.

2. Materials and methods

2.1 Sample collection and treatment

Bread and popcorn snacks samples were randomly purchased from the sellers in Birnin Kebbi central market in Kebbi State and were put in new plastic bags. Samples were immediately taken into the laboratory in department of Chemistry at Kebbi State University of Science and Technology, Aliero. The samples were oven dried at 110^{o}C for four hours. After cooling the samples were made into powder using a wooden mortar. The powdered samples were filtered through plastic sieve < 0.75 mm mesh to obtain fine powder. The fine powdered samples were kept in a plastic container until analysis.

2.2 Sample digestion and analysis

2 g of each sample were transferred after weighing into different digestion tubes. A mixture of $HClO_4$, H_2SO_4 and HNO_3 in a ratio of 1:2:2 was added to each digestion tube covered and were placed on a hot plate. The mixtures were heated to a temperature of about 110^{o}C until a clear solution was obtained [13]. The solutions were allowed to cool and diluted with

deionized water. The solutions were filtered using Whatman No 42 filter paper. The filtrate solutions were made to 100mL. The digested samples were analysed for cadmium, copper, chromium, lead, manganese and nickel using Microwave Plasma Atomic Emission Spectroscopy (MP-AES MY19479002).

2.3 Health risk estimation

The human health risk associated to ingestion of the heavy metals in the sample was estimated by calculating the estimated daily intake (EDI), Hazard quotient (HQ) and Hazard index (HI).

2.4 Estimated daily intake

The human health risk via consumption of heavy metals in food was calculated through estimated daily intake (EDI) using the following equation [14].

$$EDI = \frac{C_{bread/popcorn} \times D_{brad/popcarn}}{BW} \qquad (1)$$

Where,

EDI = estimated daily intake, and $C_{bread/popcorn}$ = the mean level of heavy metals in the bread and popcorn snacks (mg/kg), while the $D_{bread/popcorn}$ = the average daily food consumption for adults which is given as 0.170 kg/person/day. BW = the average weight of the body in (kg) estimated by USEPA risk analysis, considered an adult to be 70 kg [15, 16].

2.5 Hazard Quotient

The estimated daily intake (EDI) divided by each metals established reference dose (RfD) was employed in calculating the Hazard quotient as illustrated in the equation below. This is done for the assessment of health risk through consumption of food.

$$HQ = \frac{EDI}{RfD} \qquad (2)$$

Where,

HQ is the Hazard quotient; EDI represents the estimated daily intake and the RfD = the reference dose for each heavy metal. The reference dose values were given by Integrated Research Information System (IRIS) [17]. United State Environmental Protection Agency (USEPA) through the IRIS reported that if HQ of an individual heavy metal is (HQ < 1) then human health risk linked with the particular metal is not expected. However, if is greater than 1 (HQ > 1), then risk linked with the particular toxic metal is expected.

2.6 Hazard Index

The Hazard index of the ingested food was assessed by the summing of quotients of the entire heavy metals as in the equation below:

$$HI = HQ(Cd + Cr + Pb + Cu + Mn + Ni) \qquad (3)$$

3. Results and discussion

3.1 Estimated daily intake (EDI)

The dietary daily estimated ingestion of the toxic metals (Cd, Cr, Pb, Cu, Mn and Ni) are presented in Figure 3.1 below:

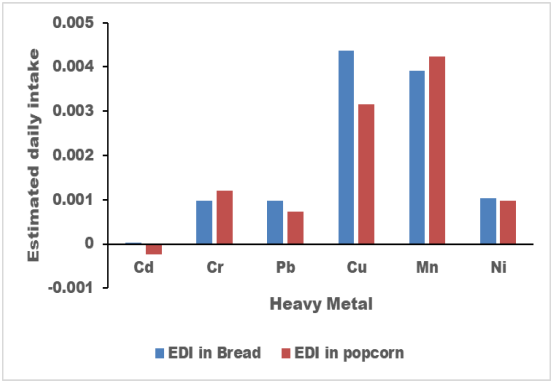

Figure 3.1: Estimated daily intake (EDI) of heavy metals in snacks for adults (mg/day)

From the results it was discovered that the range of Cd EDI was from 0.000243 to 0.0000243 mg/kg in bread and popcorn respectively. These values were lower when compared to the dietary values ranging from 0.040 to 0.080 mg/kg reported for Cd in snacks for both high incomes, middle- and low-income earners in Ibadan city, Nigeria [13]. However, the estimated dietary intake of Cd in this study was shown to be lower when compared to the permissible limits range (0.01 – 0.02 mg/person/day) as established by the European Commission (EU) [18]. Cd has no any biological function in human body. This indicates that consumption of snacks in the study area could not pose any health risk danger to humans.

The daily dietary intake for Cr in the samples in this study ranged from 0.000971 to 0.00121 mg/day in bread and popcorn respectively. These values were found to be lower than 0.088 to 0.141 mg/person/day reported for Cr in snacks [13]. Those values were also lower than the tolerable values 0.025 to 0.2 mg/person/day for Cr by Codex [19].

Pb has no known any biological significance in human body. The values of EDI for Pb obtained in this study ranged between 0.000971 and 0.000729 mg/kg respectively in bread and popcorn snacks. These values were observed to be low when compared with dietary intake of Pb 0.169 to 0.197 mg/person/day in snacks reported [13]. The values obtained in this study were shown to be lower than 0.015 to 0.1 mg/person/day established by Codex [19]. Indicating no risk to human health with regards to Pb on consumption of snacks in this study area.

Estimated daily intake for Cu and Mn in snacks ranged between 0.00437 to 0.00316 and 0.00391 to 0.00423 mg/kg respectively for bread and popcorn. These values were shown to be lower when compared to the range in snacks 0.00014 to 0.00551 mg/kg for Cu and

Mn [20]. On the other hand, the values were below the daily intake of 0.170kg/day. This corroborates that there will be low rate of consumption of nutritionally essential metals such as Cu and Mn in the bread and popcorn snacks in the study area. Therefore, except there is a supplement with time there could be negative effect to human health.

The EDI for Ni in the samples in this study ranged between 0.00104 to 0.000971 mg/kg. The values were seen to be lower than the dietary intake 0.206 to 0.552 mg/person/day reported for snacks [13], and eventually were also lower than 0.15 – 0.7 given by Codex [19]. Therefore, this implies that no risk to human health with regard to Ni on consumption of snacks in the study area.

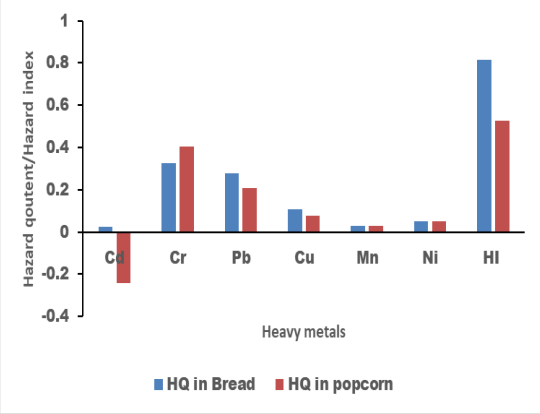

Figure 3.2: Calculated hazard quotient (HQ) and hazard index (HI) of heavy metals in snacks

3.2 Hazard Quotient (HQ)

The values of Hazard quotient were calculated using the equation as shown in equation (2). It is based on the reference dose of the heavy metals given by IRIS [17]. As seen in Figure 3.2, the hazard quotient values for all the heavy metals (Cd, Cr, Cu, Pb, Mn and Ni) were observed to be less than 1. The values in this study are in agreement with the HQ in food reported in Nigeria [20, 21]. According to the United State Environmental Protection Agency (USEPA) through the IRIS [17] if HQ of an individual heavy metal is (HQ < 1) then there is human health risk linked with the particular metal is not expected. However, if is greater than 1 (HQ > 1), then there is high expectation of risk linked with the particular hazard metal. In view of this, there is no obvious health risk to human as a result of the consumption of bread and popcorn snacks in this study area. Therefore, consumption of snacks in the study area is safe.

3.3 Hazard Index (HI)

The summation of the quotients of all the metals studied in the samples gives the hazard index for the entire metals. And it is calculated as presented in equation (3). As shown in Table 3.2 the HI values in this study were observed to be 0.8143 in bread and 0.526 in popcorn. These values are less than 1 (HI < 1). The UNSEPA through IRIS established that if HI ≤ 1 then no possible risk. On this basis, there is no possible health risk in respect to all studied metals on ingestion of snacks in the area of study. Therefore, consumption of snacks is regarded safe to the populace.

4. Conclusion

Following the present study, the health risk as a result of heavy metals consumption were investigated in bread and popcorn snacks. The result revealed that the estimated daily consumption of the metals under study through ingestion of snack is below the tolerable daily consumption. The assessment of health risk revealed that consumption exposure to the metals could not pose any risk to the health of consumers in the study area. However, continuous monitoring of snacks is recommended so as to safe guard the population of consumers from accumulating these toxic metals with long exposure.

References

1. Miri M, Akbari E, Amrane A, Jafari SJ, Eslami H, Hoseinzadeh E, Zarrabi M, Salili J, Sayyad-Arbabi M, Taghayi M. Health risk assessment of heavy metal intake due to fish consumption in the Sistan region, Iran. *Environmental Monitoring and Assessment*. 2017; 189: 583- 593.
2. Saha N, Mollah M, Alam M, Rahman MS. Seasonal investigation of heavy metals in marine fishes captured from the Bay of Bengal and the implications for human health risk assessment. *Food Control*. 2016; 70: 110–118.
3. Antoine JMR, Hoo Fung LA, Grant CN. Assessment of the potential health risks associated with the aluminum, arsenic, cadmium and lead content in selected fruits and vegetables grown in Jamaica. *Toxicology reports*. 2017; 4: 181–187.
4. Oyekunle J AO, Adekunle AS, Ogunfowokan AO, Olutona GO, Omolere OB. Bromate and trace metal levels in bread loaves from outlets within Ile-Ife Metropolis, South-Western Nigeria. *Toxicology Reports*. 2014: 224- 230.
5. Mohammadi RM, Sobhan AS, Karimi H, Sorooshnia R. Natural and anthropogenic source of heavy metals pollution in the soil samples of an industrial complex a case study. *Iranian Journal of Toxicology*. 2015; 9:1336- 1341.
6. Nemati S, Mosaferi M, Ostadrahimi A, Mohammadi A. Arsenic intake through consumed rice in Iran: markets role or government responsibility. *Health Promotion Perspectives*. 2014; 4: 180
7. Salama, AK. Health risk assessment of heavy metals content in cocoa and chocolate products sold in Saudi Arabia. *Toxin Reviews*. 2018;38(4):318-327.
8. Iwegbue CMA. Concentrations of selected metals in candies and chocolates consumed in southern Nigeria. *Food additives & contaminants part B surveillance*. 2011; 4: 22–27.

9. Amos-Tautua BMW, Inengite AK, Abasi CY, Amirize GC. Evaluation of polycyclic aromatic hydrocarbons and some heavy metals in roasted food snacks in Amassoma, Niger Delta, Nigeria. *African Journal of Environmental Science and Technology*. 2013;7: 961-966.
10. Mohammed AA, Iniaghe PO, Okoro HK, Saliu OD, Adeoti TP. Assessment of heavy metal contamination in Vended road-side Snacks using Ilorin as a case study. *Al-Hikmah Journal of Pure and Applied Sciences*. 2016; 3: 51-56.
11. Olajide AJ, Olajide OE, Salami IT, Adeyemi AT, Abiodun SL. Assessment of heavy metals concentrations in selected Road-side fast foods in Ibadan Oyo state, Nigeria. *International Journal of Scientific & Engineering Research*. 2019; 10: 1341-1349.
12. Lima de Paiva E, Morgano MA, Arisseto-Bragotto AP. Occurrence and determination of inorganic contaminants in baby food and infant formula. *Current Opinion in Food Science*. 2019;30: 60-66.
13. Ilupeju O, Adimula VO, Onianwa P.C, Ayom E, Baba AA. Assessment of heavy metals in foods and adult dietary intake estimates. *African Journal of Science, Technology, Innovation and Development*. 2019; 11(2): 261-268
14. USDOE. *The risk assessment information system (RAIS)*. US Department of Energy's Oak Ridge Operations Office (ORO), Oak Ridge. 2011
15. Akpambang VOE, Onifade AP. Trace metals contamination in bread ingredients and bread from Bakeries in Nigeria. *Asian Journal of Applied Chemistry Research*. 2020; 5: 26-37.
16. Gaofeng Z, Huaidong Z, Zijian W. Concentrations of selected heavy metals in food from four e-waste disassembly localities and daily intake by local residents. *Journal of Environmental Science and Health*. 2010; 45:824-835.
17. IRIS. *Integrated risk information system – database.* US Environmental Protection Agency (US-EPA). 2011
18. European Commission. *Dietary exposure to cadmium. food science and technology*. Report on Tasks for Scientific Cooperation. EUR 17527 EN. 1996.
19. Codex Alimentarius Commission. CX/ FAC 96/17. *Codex General Standards for Contaminants and Toxins in Foods*. Joint FAO/WHO Food Standards Programme. 1995.
20. Akpambang VOE, Onifade AP. Trace metals contamination in bread ingredients and bread from Bakeries in Nigeria. *Asian Journal of Applied Chemistry Research*. 2020;5: 26-37.
21. Udowelle NA, Igweze ZN, Asomugha RN, Orisakwe OE. Health risk assessment and dietary exposure of polycyclic aromatic hydrocarbons (PAHs), lead and cadmium from bread consumed in Nigeria. *Roczniki Państwowego Zakładu Higieny*. 2017; 68(3):269-280.