MIKAILALSYS
Journal of Multidisciplinary Sciences

e-ISSN : 2987-2286
p-ISSN : 2987-3924

Index : Dimensions, Scilit, Crossref, Garuda, Semantic, Lens,Google Scholar,Base, etc

https://doi.org/10.58578/mikailalsys.v2i1.2411

ASSESSEMENT OF THE INFLUENCE OF BAKING FUEL TYPES ON THE RESIDUES OF SOME HEAVY METALS IN SELECTED BREAD FROM JALINGO, TARABA STATE

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Article Info:

Submitted:	Revised:	Accepted:	Published:
Dec 12, 2023	Dec 22, 2023	Dec 25, 2023	Dec 28, 2023

Abstract

Method of food processing and handling plays pivoted role in its contamination. This research was geared towards assessing the level at which food handling and production processes influence metallic contamination. Samples of flour and baked bread (electric or coal oven) were sourced from market and bread bakeries within Jalingo metropolis. Heavy metals (Lead, Cadmium, Chromium, Nickel, Iron, and Zinc) analysis of the samples was done using Atomic Absorption Spectrophotometer (AAS). Bread baked using coal oven were observed to show elevated level of metallic contamination over those baked using electric oven with Iron (Fe) showing a statistical significant increase at $p<0.05$ while Cadmium (Cd) was not detected in bread baked using both fuel source. Both electric and coal baked bread were analyzed to have

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more metallic deposition when compared to the flour. Although, the heavy metals contamination were within the range of FAO/WHO permissible limit but long term consumption of such food products could lead to bioaccumulation in the biological system and becomes injurious to health.

Keywords: Coal, Oven, Jalingo, AAS, Heavy metals, Bread

INTRODUCTION

Globally, quality amounts of trace metals are annually added to the environment via pollution arising from natural and anthropogenic activities/processes (Bando *et al*., 2019). These have resulted in the contamination of soil, atmosphere, underground and surface water, and food. Thus, trace metals bio-accumulate and bio-magnify as they find their ways into human and animal tissues through the food chain, and food becomes the ultimate source of metal intake into the human body (Khalid and Rehman, 2013).

Bread is a staple that provides high amount of calories and protein intake (Emeje *et al.,* 2010). In addition to carbohydrates, proteins, and some vitamins, bread is also an important source of minerals and trace metals. It is prepared by baking dough which consists of several ingredients. The principal ingredients are flour, yeast, salt and water; optional ingredients include fat, sugar, milk and some additives (oxidants, emulsifying agents and preservatives) (Edem *et al*., 2009; Agu *et al.,* 2010). Also, bread dates back to the Neolithic era and it is one of the most consumed flour products in most societies around the world.

The process of food production also serves as a potential source of food contaminants and poisoning. Therefore, this research aimed at evaluating the level of heavy metals depositions in bread baked using electric and coal oven.

METHODS

Study area

Jalingo LGA is roughly located between latitudes 8° 47' to 9° 01'N and longitudes 11° 09' and 11° 30'E. It is bounded to the north by Lau Local Government Area, to the east by

Yorro Local Government Area, to the south and west by Ardo Kola Local Government Area. It has a total land area of about 195km^2 with an estimated human population of 139,845 people according to the 2006 national population census.

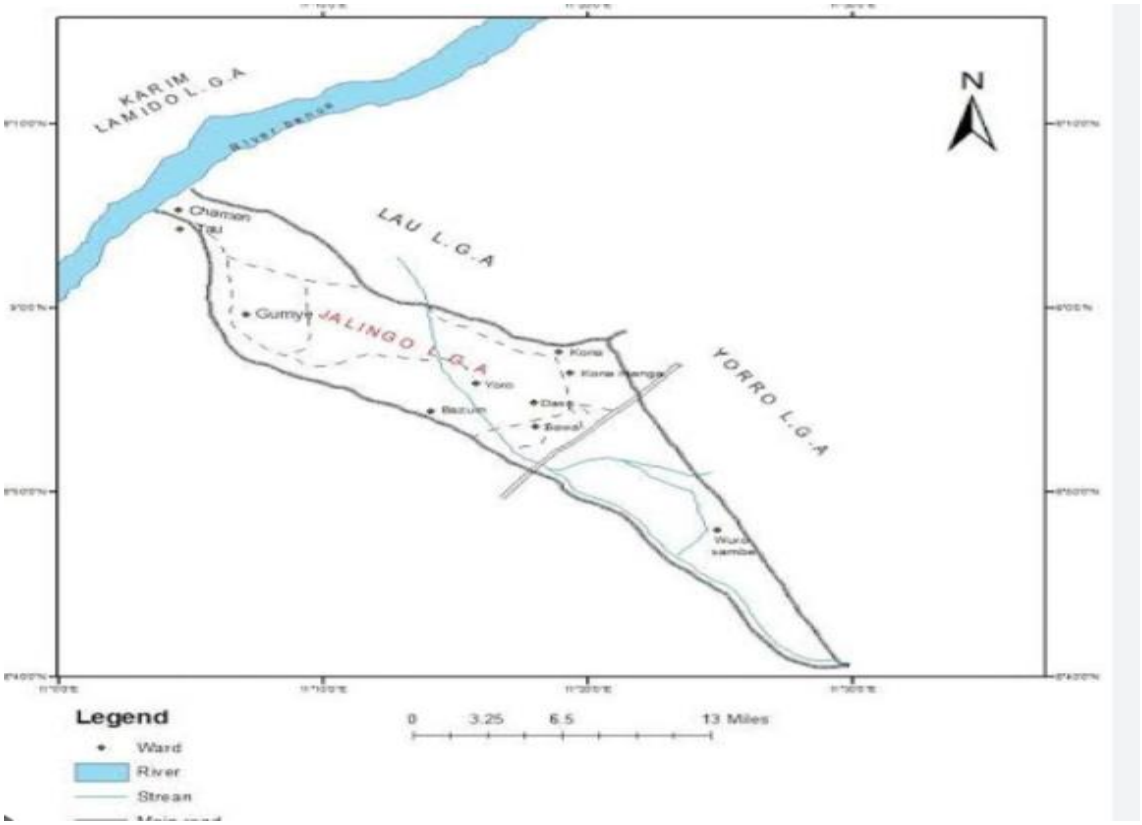


Figure 1: Map of Jalingo (Musa *et al.*, 2022)

Sample collection

Samples of flour and bread baked with coal or electric oven were collected from markets, shops and bread production factories in Mayo dassa, Mile six, Mayo gwoi, Jalingo main market, Sabo gari, NTA area, New Era, Nukkai, Air strip and Lassandi accordingly.

Sample Preparation

The bread samples were sliced and allowed to air dry at room temperature and then oven dried at 60^{o}C (Khaniki *et al.,* 2005; Khalid and Rehman, 2013). The dried samples were each ground to fine powder in an agate mortar and thoroughly mixed to homogeneity, the mortar was rinsed after each sample pounding to avoid cross contamination. The ground samples were sieved using standard test sieve BBS 40 and stored in sterile, air tight sample bottles with screw caps, then labelled accordingly.

Analysis of Heavy Metals

Sample Digestion and heavy metals detection

1.0g of the powdered bread sample was weighed using an electric weighing balance (model AR2130 Ohaus Corporation China) and then put into flat bottom flask. 10ml of $HCl/HClO_4$ was measured using a measuring cylinder in ratio 2:1, and added to the weighed sample in the flat bottom flask, and shaken. The flask was then heated on a hot plate in a fume hood, until a transparent solution was obtained. The transparent solution was then filtered with a filter paper (Whatman No. 1) into a cylindrical flask to remove residual impurities. The filtrate was then diluted with deionised water to a mark of 100 ml. It was then transferred into a sample bottle for analysis of heavy metals. Similar procedure was used to prepare sample blanks, and transferred into a sample bottle for analysis. After the digestion, the solution was allowed to cool followed by filtration using laboratory funnel and filter paper. The filtrate was subsequently diluted with de-ionized water to 100 ml mark and 2 ml of the diluted solution was used for heavy metals content determination with the aid of Atomic Absorption Spectrophotometer (AAS). The heavy metals analysed were Lead, Cadmium, Chromium, Nickel, Iron, and Zinc. The samples were analysed in triplicates for quality assurance as described by Bando *et al.*, (2023) with slight modification.

Statistical Analyses

Descriptive statistics was used to analyse the data generated from the questionnaires. Data generated from analysed samples were subjected to ANOVA using Statistical Package for Social Scientists (SPSS, version 21.0) to test for statistical significance set at $P < 0.05$.

RESULTS

Table 1: Mean Concentration of Heavy Metals of Popular Flour Used in Bread Production

Samples	Concentration of Heavy Metals (mg/kg)*					
	Fe	**Pb**	**Cr**	**Zn**	**Ni**	**Cd**
X	0.0463±0.0011	0.0154±0.0007	0.0110±0.0005	0.0210±0.0005	0.0070±0.0010	ND
Y	0.0350±0.0007	0.0165±0.0000	0.0041±0.0009	0.0192±0.0005	0.0060±0.0005	ND
Z	0.0312±0.0015	0.0170±0.0005	0.0109±0.0005	0.0188±0.0005	0.0055±0.0010	ND

Mean with the same letter within a column are not significantly different at $p<0.05$.

*All values are means of triplicate determinations

ND = Not Detected

Table 1 shows the mean concentration of selected heavy metals in popular flour samples used by most bakers in the study area (Jalingo Metropolis). It shows the concentrations of heavy metals in mg/kg to be Fe (0.0463±0.0011), Pb (0.0154±0.0007), Cr (0.0110±0.0005), Zn (0.0210±0.0005) and Ni (0.0070±0.0010) for sample X, and sample Y has Fe (0.0350±0.0007), Pb (0.0165±0.0000), Cr (0.0041±0.0009), Zn (0.0192±0.0005) and Ni (0.0060±0.0005). In sample Z, the concentration of Fe was (0.0312±0.0014), Pb (0.0170±0.0005), Cr (0.0109±0.0005), Zn (0.0188±0.0005) and Ni (0.0055±0.0010). Cd was not detected in the respective samples.

Table 2: Comparison between mean heavy metal concentrations of samples collected from bakeries using coal oven and electric oven

Type of Oven	Fe	Pb	Cr	Zn	Ni	Cd
Coal oven	0.757 ± 0.013^{a}	0.296 ± 0.019^{a}	0.363 ± 0.071^{a}	0.392 ± 0.012^{a}	ND	ND
Electric oven	0.423 ± 0.046^{b}	0.181 ± 0.020^{a}	0.401 ± 0.064^{a}	0.322 ± 0.021^{a}	ND	ND

Mean with the same letter within a column are not significantly different at $p<0.05$

*All values are means of triplicate determinations

ND = Not Detected

Tables 2 shows the concentration of heavy metals from bakeries that use coal oven as compared to those that use electric ovens for bread samples collected directly from the bakeries were Fe (0.757±0.013 mg/kg and 0.423±0.046 mg/kg), Pb (0.296±0.019 mg/kg and 0.181±0.020 mg/kg), Cr (0.363±0.071 mg/kg and 0.401±0.064 mg/kg), and Zn (0.392±0.012 mg/kg and 0.322±0.021mg/kg) respectively. Ni and Cd were not detected.

DISCUSSION

In this research it was discovered that the selected bread samples revealed an appreciable amount of heavy metals contamination as a result of the methods involved in the production. In a review by Jessica *et al.*, (2020), it was stated that anthropogenic activities are major contributing factors of environmental pollutants. Although some of the studied heavy metals such as Fe, Zn, Ni and Cr are essential in human nutrition, their determination in food products is imperative, since they pose health risks at high concentrations.

The type of energy used during processing and production of food, plays a key role in determining the degree of potential contamination of the finished product. In this study two major sources of energy (heat) that are utilized in baking bread were considered. The results showed that the bread loaves from bakeries that use commercial electric ovens had lesser concentration of the studied heavy metals, as compared to the bread loaves coming from bakeries operating coal oven. This is in harmony with the elevated levels of heavy metals in bread loaves from bakeries that operate heavy oil, as compared to those using electricity (Alomary and Wedian, 2012) and with results obtained by Bando *et al.*, (2023) were food samples that were stored at local kitchen rooftop show elevated level of metallic contamination. The wood used in producing the coal play a key role as a contributing factors to the increased metallic contamination observed in coal oven baked bread. Despite the elevated level of heavy metals observed in the baked bread but it falls within FAO/WHO, 2006 permissible limit; bioaccumulation of it due to long term consumption could result to deleterious effect of human health.

The recorded difference in concentration in the present study was only statistically significant at $p<0.05$ for Fe; this could be attributed to the fact that the electric oven is a cleaner source of energy, and easily eliminated potential contamination of bread loaves by Fe from sand/dust during baking process. Cd was not detected in both studies; it could have been lost during heat treatment of wheat and baking process. The level of metallic contamination in the flour used in baking the bread were found to be lesser when compared to the amount deposited in baked bread.

CONCLUSION

The type of technology used in bread production influences the stock of heavy metal in the finished product. It further showed that flour which is the major ingredient in bread making contains heavy metals, but the concentration in the finished product showed that other ingredients, additives, baking, and packaging processes contribute significantly to the stock of heavy metal in the finished product.

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