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FOREWORD

It is with great delight I welcome you to volume 4 issue 2 of Federal Polytechnic – Journal of Pure and Applied Sciences (FEPI-JOPAS). It is a peer-reviewed open-access multi-disciplinary Journal of global recognition which is referenced and indexed in African Journal Online (AJOL). It is a highly commendable Journal that publishes excellent research contributions and exhibiting also special attention to experience papers coming from the many application areas of pure and applied Sciences. FEPI-JOPAS publishes full-length research work, short communications, critical reviews and other review articles.

The aim of FEPI-JOPAS is to provide intellectual bedrock for both indigenous and international scholars with quality research outputs to express and communicate their research findings to a broader populace. It serves as a valuable platform for the dissemination of information to 21st Century researchers, professionals, policymakers, manufacturers, production staff, R & D personnel as well as governmental and non-governmental agencies. It also aimed to provide a platform for academics and industry practitioners to share cases on the application of management concepts to complex real-world situations in pure and applied sciences and related fields.

This volume 4 issue 2 of FEPI-JOPAS is loaded with quantum and well-featured diversity of trending topics in applied and basic research. These hot and trending topics are: Sustainable Art and Design: Activating Sighting as the Phenomenon of Representational Drawing; Assessment of Heavy Metals in Processed Meat (Tinko) Sold within Igbesa Community; The Hypoglycemic Effect of Musa Sapientum in Alloxan Induced Diabetic Albino Wistar Rat; Rainwater Quality Evaluation for Agricultural Use: Case Study of a Portland cement Producing Area; Analytical Approach to Investigating the Influence of Blood Group and Blood Genotype on the Performance of Students of Federal Polytechnic, Ilaro; Dough Mixing Time: Impact on Dough Properties, Bread-Baking Quality and Consumer Acceptability; Chemical Composition of Harvested Rainwater Around a Cement Factory in Ibeshe, Yewa North, Ogun State.

Furthermore, other topics to be encountered in this issue that have added colour and beauty to this edition are: Physicochemical properties and sensory evaluation of milk candy ‘toffee’ (a

NIGERIA candy) enrich with coconut, tigernut and groundnut; Informal Settlements in Developing Countries: Issues, Challenges and Prospects; Comparison of Sensory Properties of Meals Produced from Cowpea and Pigeon Pea; Automated Lecture Timetable Generation Using Genetic Algorithm; Septic Tanks Contamination in Groundwater Quality around Elementary Schools in Ibadan, Oyo State Nigeria; and Waste Disposal Systems in Some Selected Abattoirs Located in Ilaro Metropolis. FEPI-JOPAS has been centered on discerning the changing needs of the academic world and is committed to advancing research around the world by publishing the latest research in various academic fields and ensuring that the resources are accessible in print, digital, and online formats.

In addition, I would like to thank many people who worked so hard to ensure that publishing this issue 2 of volume 4 is a reality. I would like to thank the Editorial Board for their guidance and the publishing team for the continued support and effort in streamlining the publication process. I am grateful to the reviewers who provided timely and constructive reviews for the papers assigned to them. The authors are solely responsible for the information, date and authenticity of data provided in their articles submitted for publication in the Federal Polytechnic Ilaro – Journal of Pure and Applied Sciences (FEPI-JOPAS).

I am looking forward to receiving your manuscripts for the subsequent publications. You can visit our website (https://fepi-jopas.federalpolyilaro.edu.ng) for more information, or contact us via e-mail us at fepi.jopas@federalpolyilaro.edu.ng

Thank you and best regards.

Prof. Olayinka Oyewale AJANI

(Editor-in-Chief)

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Assessment of Heavy Metals in Processed Meat (Tinko) Sold within Igbesa Community

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Abstract
Meat is a major source of protein, fat and other essential nutrients required for growth and development. To meet up with the increasing demand, meat products can be processed and preserved for consumption. This study assessed the levels of heavy metals (Cd^{2+}, Cr^{6+}, Cu^{2+}, Fe^{3+}, Pb^{2+}, and Zn^{2+}) in processed and preserved meat ("Tinko") sold and consumed in the Igbesa community. Atomic absorption spectrophotometry (AAS) was used to determine the presence of these metals. The concentrations of Cd^{2+}, Cr^{6+}, Cu^{2+}, Fe^{3+}, Pb^{2+}, and Zn^{2+} were 0.005, 0.223, 1.445, 2.165, 1.018, and 1.669 mg/kg, respectively. Cadmium, chromium and zinc were within the safe limits of 0.02, 1.50, and 2.00 mg/kg, respectively. While copper, iron and lead exceeded the safe limits of 1.00, 2.00, and 0.05 mg/kg, respectively, as established by WHO/FAO. Regular daily intake limits of heavy metals in diets should be monitored and practices that increase the concentration of metals in the environment should be discouraged.

Key words: Heavy metals, Tinko, meat, WHO/FAO, permissible limit, processed.

INTRODUCTION

Meat generally is excellent in supplying high-quality protein, vitamins, and mineral salts (Kramiliah *et al.*, 2021). Traditionally processed meat products are consumed in different countries, amongst which is the meat delicacy called 'Banda, or Kundi' (Vilar *et al.*, 2016. The word "tinko" or kundi is of Yoruba origin while the Igbo refers to it as "banda". It is frequently made using a carcass, which is then sliced, cooked for 15 to 30 minutes, dried, sun-dried, or smoked for 18 to 30 hours, cooled, and then packaged in sacks and jute bags. A stable substance, banda has a shelf life of six to twelve months, or possibly up to two years, at room temperature (Licata *et al*, 2017).

For the sake of both food safety and human health, the risk of heavy metal contamination in meat is of major concern, contamination in meat was apparently caused by contaminated animal feed and raising cattle close to polluted environments (Aitken, 2014).

Concerns and understanding about the toxicity of heavy metals and their effects on the environment and human health have grown significantly in recent years. Lead (Pb), cadmium (Cd), and arsenic (As) are three particularly poisonous heavy metals that are dangerous to people even in low amounts. WHO/FAO acceptable limits for cadmium and lead are set at 1.0, and 0.05 mg/kg, respectively. The desire for food safety from customers around the world has sparked research into the risks linked with consuming foods contaminated with heavy metals.

The goal of the present study was to determine heavy metal levels including cadmium, chromium, copper, iron, lead, and zinc in processed and preserved horse meat ("Tinko") sold and consumed in the Igbesa community.

MATERIALS AND METHODS

Materials

The processed meat (Tinko) was purchased in Oba Adesola markets in Ado-Odo/Ota local government in Ogun State, Nigeria. The samples were collected in a sterile zip-log bag. Sample preparation and analysis were performed in the chemistry laboratory at the Ogun State Institute of Technology, Igbesa.

PREPARATION OF AQUA REGIA

Aqua regia is a mixture of concentration of HCL and HNO_3 in ratio 3:1 by adding measured 90ml of HCl, and add 30 ml of HNO_3 together (90:30).

Digestion of Sample

The samples were shredded into tiny pieces, measured, and put into a ceramic mortar, and transferred into the muffle furnace. Ashing was done at a temperature of 450°C for 4hrs (AOAC, 2003). Using **(SX-4-10 ELECTRIC MUFFLE FURNANCE).** The samples that had been ashed were taken out of the muffle furnace and preserved in a desiccator prior to the wet digestion process. 2 g of

the ashed sample was weighed into a round bottom flask and 20 mL of aqua regia was added. The round bottom flask was placed on a heating mantle and covered with watch glass covers and heated until all organic matter was digested and a dirty yellow solution was obtained. The round bottom flask was removed from the heating mantle and allowed to cool before adding 30ml of distilled water and the sample was filtered and made it up to the mark in a 50 ml volumetric flask (Sobukola *et al.,* 2007), and transfer it to a sample bottle

Analysis of total metals by Atomic Absorption Spectrophotometer (AAS)

Preparation of Stock solution

50mL of Stock solutions of the following concentrations 1ppm, 2ppm, and 5ppm were prepared from 1000ppm standards of Cu, Zn, Fe, Cd, Cr, Pb using the dilution method by making up 0.05ml; 0.1ml and 0.25 ml of the respective standards to 50ml in standard volumetric flask respectively. The sample was analysed using Atomic Absorption Spectrophotometer (AAS) model 225/23x series for Cu, Cd, Fe, Cr, Pb, and Zn.

RESULTS

The result of the heavy metals analysed in processed meat sample is shown in Table 1.

Table 1: The concentration of heavy metals in analysed processed meat samples (mg/kg)

Sample	Cu	Cd	Fe	Cr	Pb	Zn
Processed meat sample	1.445	0.005	2.165	0.223	1.018	1.6690
WHO/FAO standards	1.0	0.02	2.000	1.500	0.05	2.000

RESULTS AND DISCUSSION

The concentration of Cd, Cu, Pb, Fe, Cr, and Zn were found to be 0.005, 1.445, 1.018, 2.165, 0.223 and 1.669 respectively in the "Tinko" sample respectively.

Copper

Cu was found to be 1.45 mg/kg in the "Tinko" sample. The concentration was found to be higher than the permitted limit of 1.0 mg/kg

Deficiency of copper can lead to anemia, low number of white blood cells, osteoporosis in infant and children defect in connective tissue leading to skeletal problems (Mahurpawa 2015)

Cadmium

A non-essential element found in foods and natural waterways, cadmium mainly builds up in the liver and kidneys. A concentration of 0.005 mg/kg was found from the results, which is less than the WHO-reported permissble limit of 0.02 mg/kg (2016).

Iron

The concentration of iron (Fe) in the "Tinko" sample was found to be 2.17 mg/kg which was slightly above the permissible limit of 2.0 mg/kg. According to the results, Fe content was found to be over the permitted limit of 2.000ppm (WHO,2011).

Lead

Pb concentration in the tinko sample, was 1.02 mg/kg which was above the permissible limit of 0.05ppm. According to (Olaniran., 2013). The high Pb content could be as a result of accumulation in the animal during the preparation and feeding processes.

Lead can be absorbed and stored in human bones blood and tissues. Lead in human

be absorbed and stored in human bones blood and tissues. Lead in human body has been reported to increase blood pressure in adult

(Ametepey *et al* 2018)

Chromium

Cr had a concentration of (0.22 mg/kg), as shown by the results, this amount was below the allowable limit of 1.50 mg/kg according to (WHO/FAO, 2016).
Ndu and ThankGod (2018) reported significant concentrations of Fe, Ni, Cd, Pb and chromium in some roasted meat samples sold in Port Harcourt by hawkers. Similar reports were also reported for roasted meats samples in Enugu (Okeke *et al.,* 2018).

ZINC

From the result zinc (Zn) had a value of 1.67 mg/kg which was below the permissible limit of 2.0 mg/kg.

In emerging nations, zinc deficiency is becoming a bigger concern. Zinc (Zn) accumulation in high amounts can cause eminent health problems, such as stomach cramp, skin irritation, vomiting, nausea and anemia (Wuana and Okieimen, 2011).

CONCLUSION

This study aimed at quantifying the levels of heavy metals in 'Tinko'. With the exception of Cd, Cr and Zn, whose concentrations are below the WHO guideline, Cu, Fe and Pb concentrations were higher than the stated limits. The high Pb level could be as result of the animal grazing on grasses grown on contaminated soil, or exposure to automobile fumes during the meat processing. Regular daily intake limits of heavy metals in our diets should be monitored highest standards of quality control should be upheld. However, practices that increase the amount of metals in the environment ought to be stopped and discouraged

REFRENCES

Ainsworth. M, Understanding and improving global food response to ozone pollution Plant J., 90 (2017), pp. 886-89

Aitken, P. Koopman, S.E.M. Lewis health concern of nature, 432 (2014), pp. 48-52

Allen, P. MacNaughton, U. Satish, S. Santanam, J. Vallarino, J.D. Spengler Associations of cognitive function scores with heavy metals and effects Environ. Health Perspect., 124 (2016), p. 805.

Ameteptey ST et al Health risk assessment and heavy metal contamination levels in vegetables from Temale metropolis Ghana. International Journal of food contamination (2015).5

AOAC (2003). Official Method of Analysis. Association of Official Analytical Chemists, Arlington, USA

Bender, A, (1992) Meat and meat products in human nutrition in developing countries, FAO Food Nutrition Paper, 53. 1-91.

Bernard A. Cadmium & its adverse effects on human health. Indian J Med Res. 2018;128(4):557–64.

Geosci., I .FoodpollutionNat. Geosci., 1 (2018), p. 409

Harmanescu, M., Alda, L. M., Bordean, D. M., Gogoasa, I., and Gergen, I, (2011). "Heavy metals health risk assessment for population via consumption of vegetables grown in old mining area; a case study: Banat County, Romania," Chemistry Central Journal. 5.64.

Hernadez, S. Anna, B. Sofia, R. Christina, B. MagnusThe dilemma in prioritizing chemicals for environmental analysis: known versus unknown hazardsEnviron. Sci.: Processes Impacts., 18 (2016), pp. 1042-1049

Jamieson, M. Arias-Estévez, E. López-Periago, E. Martínez-Carballo, J. Simal-Gándara, J.-C. Mejuto, L. García-Río. Heavy metals in industryAgric. Ecosyst. Environ., 123 (2018), pp. 247-260

Licata, H. Awata, S. Linder, L.E. Mitchell, G.L. DelclosAssociation of dietary intake and biomarker levels of copper, cadmium, lead, and mercury among Asian populations in the United States: NHANES 2011–2012 Environ. Health Perspect., 125 (2017), pp. 314-323

Liu, X., Song, Q., Tang, Y., Li, W., Xu, J., Wu, J., Wang, F. and Brookes, P. C, (2013)."Human health risk assessment of heavy metals in soil–vegetable system: A multi-medium analysis'', Science of the Total Environment, 463–464. 530-540.

Lu ann, S. Avnery, D.L. Mauzerall, J. Liu, L.W. HorowitzGlobal food poisoning yield reductions due to surface ozone exposure: 2. Year 2030 potential food production losses and economic damage under two scenarios of O3 pollutionAtmos. Environ., 45 (2011), pp. 2297-2309.

Mahurpawa M: Effect of heavy metals on human health International Journal of Research Granthaalayah, social issues and Environmental Problems (2015)

Mathew BB, Tiwari A, Jatawa SK. Free radicals and antioxidants: A review. Journal of Pharmacy Research. 2011;4(12):4340–4343.

Okeke, O., Aburum, C. M., Ozuah, A. C. & Ezeh, E. (2018}Omojola,A.B {2008}.

Olaniran AO, Balgobind A, Pillay B. Bioavailability of heavy metals in street food: impact on microbial biodegradation of organic compounds and possible improvement strategies. Int J Mol Sci. 2013;14(5):10197–10228.

Regoli L. The Relative Contributions of Different Environmental Sources to Human Exposure and the EU Cadmium Risk Assessment Meeting of UNECE Task Force on Heavy Metals. Presentation for the UNECE Long-Range-Trans-boundary Air Pollutants – Task Force on Heavy Metals; 16–18 March, 2005; Berlin. 2015

Rossy.J S.A. Banwart, N.P. Nikolaidis, Y.-G. Zhu, C.L. Peacock, D.L. SparksSoil functions: connecting Earth's critical zoneAnnu. Rev. Earth Planet. Sci., 47 (2019), pp. 333-359

Schäfer, M. Liessendangering the human healthProc. Natl. Acad. Sci., 110 (2013), pp. 11039-11043Tai, S.W. Bihaqi, N.H. ZawiaEnhancedtaupathy and AD-like pathology in aged primate brains decades after infantile exposure to lead (Pb)NeuroToxicology., 39 (2013), pp. 95-101

Sengupta, A. Baccarelli, V. BollatiEpigenetics and environmental chemicalsCurr. Opin. Pediatr., 21 (2019), pp. 243-251

Simkin, M. Bashash, D. Thomas, H. Hu, E.A. Martinez-Mier, B.N. Sanchez, N. Basu, K.E. Peterson, A.S. Ettinger, R. Wright, Z. Zhang Prenatal lead and copper exposure and cognitive outcomes in children at 4 and 6–12 years of age in Nigeria Environ. Health Perspect., 125 (2017), Article 097017

Sobukola OP, Adeniran OM, Odedairo AA, Kaji Hausa OE (2007). Heavy metal levels of some fruits and leafy

Tchounwou, P. B., Yedjou, C. G., Patlolla, A. K., Sutton, D. J, (2014). "Heavy Metals Toxicity and the Environment," Molecular Clinical and Environmental Toxicology, 101. 133-164

Teo J, Goh K, Ahuja A, Ng H, Poon W. Intracranial vascular calcifications, glioblastoma multiforme, and lead poisoning. AJNR. 2017; 18:576–579.

ThankGod, P. (2018).Analysis of some heavy metals in hawked charcoal roasted beef (suya) within Port Harcourt metrop-olis European Journal of Pure and Applied Chemistry.

Thürmer K, Williams E, Reutt-Robey J. Autocatalytic oxidation of lead crystallite surfaces. Science. 2012;297(5589):2033–2035.

vegetables from selected Markets in Lagos, Nigeria. Afr. J. Food. 4 (2): 389-393.

Vivian,MOxidative stress and male infertility Nat. Rev. Urol., 14 (2017), pp. 470-485.

WHO (2001). Lodex Alimentation commission food additives and contaminants. Joint FAO/WHO food standards Program, Alinoem Oi/2A, pp: 1-289.

WHO. Aluminium; Geneva: World Health Organization, International Programme on Chemical Safety (Environmental Health Criteria 194); 2011.

WHO/FAO (2010). Summary and Conclusion, joint FAO/WHO expert committee of food additives. (JECFA/73/Sc) 73rd meeting, Geneva

World Health Organization (WHO), (2006). "Street Food Vending in the Region: Food Safety Challenges," AFRO Food Safety Newsletter, 2. 5-8. www.afro.who.int/des

Yield and organoletic characteristics of suya{an intermidate moisture meat prepared from two different muscles of a mabired bull. African journal of biotechnology.