International Journal of Life Science and Agriculture Research
ISSN (Print): 2833-2091, ISSN (Online): 2833-2105
Volume 05 Issue 09 September 2026
DOI: https://doi.org/10.55677/ijlsar/V05I09Y2026-03
Impact Factor: 7.88, Page No: 659-663

Comparative Assessment of Heavy Metal Accumulation in Food Packaged with and Without Newspaper

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ABSTRACT

This study comparatively examined heavy metal accumulation in food packaged with newspaper and without newspaper. Newspaper is the most widely used source of food packaging all over the world. These papers may likely contain heavy metals. Heavy metals are toxic to biological systems because they biodegradable naturally and tend to accumulate in living organisms. Samples of fried akara, masa, fried yam, fried plantain, and suya were randomly collected, with some wrapped in newspaper and others not, to compare their heavy metal composition. The heavy metal levels in food wrapped with newspaper and those not wrapped with newspaper were analyzed using microwave digestion and Atomic Absorption Spectrophotometry. The findings of this study revealed that food wrapped in newspaper had significantly higher Cu, Cd and Pb levels compared to unwrapped foods. Hg concentration is low across all samples, with values ranging from 0.01±0.00 to 0.04±0.01. These findings showed that packaging foods with newspaper can significantly increase the levels of some heavy metals, particularly cadmium (Cd) and copper (Cu). These findings revealed that the use of newspaper for food packaging may expose consumers to heavy metal risk and should be discouraged.

KEYWORDS: Food packaged, Newspaper, Heavy metals, Wrapped, Papers

Published online: September 02, 2026

Cite the Article: Olubiyo, C.K., Olubiyo, G.T., Kehinde, I.T.E., Alege, G.O., Olowo, Simon, A., Shaibu, L. (2026). Comparative Assessment of Heavy Metal Accumulation in Food Packaged with and Without Newspaper. International Journal of Life Science and Agriculture Research, 5(9), 659-663. https://doi.org/10.55677/ijlsar/V05I09Y2026-03

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INTRODUCTION

Food packaging materials are the most widely used source of food wrapping all over the world (Abedi-Firoozjah *et al*., 2022). Such abundant use of Papers and Paper Boards is promoted as they are readily available and in expensive (Sood and Sharma, 2019). A lot of improvement in material as well as package design has led to the production of more improved food packaging systems. However, some queries concerning the toxicological potential of these packaging materials have been raised which according to Ogwu (2026) calls for urgent needs to assess the safety of these packaging materials. The European Council Standard requires that various contaminants like aromatic amines, benzophenone, polyaromatic hydrocarbons, plasticizers and heavy metals are controlled and analyzed in food packages before consumption (Sood and Sharma, 2019).

Heavy metals are a big source of environmental pollution and as a result constitute serious health issue (Chen, 2023). The toxicity of heavy metals has harmful effects on the biological systems as they do not undergo biodegradation, so they get accumulated in living beings causing many diseases and disorders even when present in very low concentration. Heavy metals like chromium, cadmium, copper, zinc and nickel pollute the environment and strongly affect the human health (Al-Tardeh *et al*., 2026). Lead is found in paints, inks etc.; however, most of the countries have prohibited its use in food packaging PPBs as it is deleterious to health (Sood and Sharma, 2019). The main function of food packaging PPBs is to protect and conserve the food's flavour. Sometimes, odorous compounds from the food packaging PPBs may get transferred to the food items and affect the food's flavour. This results in considerable losses and consumer dissatisfaction. The heavy metals like iron, copper, manganese and

nickel are catalytically active even at very low concentration levels and are involved in the generation of odour in food packagings (Dick and Okparanta, 2023).

Paper recycling is a viable option for wastepaper management (Biswas and Akomodi, 2026). According to global statistics, 2.01 billion tons of Municipal Solid Waste (MSW) is generated annually with an average per capita waste generation of 0.74 kilograms (kg). Per capita waste generation is expected to increase by 19% in high income countries while 40% or more in low- and middle income countries (World Bank, 2018). Waste accumulation is estimated to be increased up to 3.40 billion tons by 2050. Therefore, solid waste management has become an alarming problem in both the developed and developing world (Koppiahraj *et al*., 2019). Major components of MSW are food wastes, plastic, metal, paper and paper board, rubber, leather, textile, and hazardous compounds.

Newspaper stands out as a widely accessible traditional material for food wrapping in many regions worldwide. The use of newspaper for food packaging may lead to heavy metal contamination which could pose serious health risks to consumers. Despite the widespread use of newspaper as food wrapping agents, there is limited study on the comparative heavy metal accumulation in food wrapped with and without newspaper. Newspaper ink and other materials may contain toxic heavy metals like lead, cadmium, and copper, which can migrate into food especially when packaged hot. This study compares the accumulation levels of heavy metals in some food wrapped with and without newspaper.

The aim of this study is to comparatively analyze heavy metal accumulation in food packaged with newspaper and without newspaper.

The objectives of the study are:

i. To analyze the heavy metal content in food packaged with newspaper.
ii. To analyze the heavy metal content in food packaged without newspaper.
iii. To compare the heavy metal levels between food packaged with newspaper and without newspaper.

MATERIALS AND METHODS

Collection and Preparation of Samples

A total of six samples each of Akara, Masa, Yam, Plantain and Suya were selected using random sampling techniques. These samples were collected for food packaged with newspaper and those that did not have contact with newspaper. Proper sample preservation and documentation was done to maintain and establish a chain of custody (Alketbi, 2023). Sample preparation entailed careful removal of food (Akara, Masa, Yam, Plantain, Suya) from packaging materials, preserving any potential residue or contact with newspaper.

Heavy Metal Extraction

Four heavy metals; Hg, Pb, Cu and Cd were analyzed from the five food samples wrapped with and without newspaper. This was done using acid and microwave digestion to dissolve the food matrix and release the heavy metals in liquid suitable for analysis as described by Dalla Nora *et al*. (2025).

Digestion of the samples

Closed vessel microwave system (Marsxpress; CEM, USA) was used for the digestion of samples. Operating conditions was followed as per the USEPA 3051 method. Digested solutions were cooled, filtered and diluted to 10 ml with distilled water, prior to ICP-OES analysis.

Multi-element standard (REICPCAL29A) was used to standardize and calibrate the metal concentration. Analytical reagents-grade chemicals and double distilled water was used for the preparation of solutions and dilutions respectively (Dalla Nora *et al*., 2025).

The amount of Hg, Pb, Cu and Cd in the food packaged with newspaper and the non-packaged foods were quantified using Atomic Absorption Spectroscopy (AAS) according to the methods outlined by Ogunfowokan *et al*. (2019).

Data analysis

Data obtained were subjected to Analysis of Variance (ANOVA) and means with statistically significant difference were separated using Duncan Multiple Range Test (DMRT). Similarly, t-test was used to compare the concentrations of heavy metals between food packaged with and without newspaper. Statistical Package for the Social Sciences (SPSS) version 23 was used for the analysis and results were presented as mean plus standard deviations.

RESULTS

Heavy metal concentration in food packaged with newspaper.

Table 1 shows the heavy metal concentration (Pb, Hg, Cd, Cu) in foods packaged with newspaper. Cu having higher concentration when compared with other metals like Cd, Pb and Hg. SP have higher accumulation of heavy metal when compared with MP, AP, YP and PP. Significant differences ($p>0.05$) are indicated by different superscripts within columns.

Table 1: Heavy metal concentration in food packaged with newspaper.

	Pb	Hg	Cd	Cu
MP	0.02±0.00[b]	0.00±0.00[a]	0.04±0.00[a]	0.24±0.00[c]
AP	0.01±0.00[a]	0.02±0.00[c]	0.06±0.00[c]	0.19±0.01[b]
SP	0.04±0.00[c]	0.03±0.01[d]	0.13±0.00[d]	0.31±0.00[d]
YP	0.02±0.00[b]	0.01±0.01[b]	0.05±0.00[b]	0.14±0.01[a]
PP	0.01±0.00[a]	0.03±0.00[d]	0.04±0.00[a]	0.14±0.01[a]

Data are Mean± SD, Samples with different superscripts down the column are significantly different at p>0.05

LEGENDS

MP-Masa packaged with newspaper
AP- Akara packaged with newspaper
SP-Suya packaged with newspaper
YP-Yam packaged with newspaper
PP-Plantain packaged with newspaper

Heavy metal concentration in non-packaged foods with newspaper.

Table 2 shows the heavy metal concentration in non-packaged foods with newspaper, Cu have higher concentration when compared with Cd, Pb and Hg in food packaged without newspaper SP have higher accumulation of heavy metal when compared with MP, AP, YP and PP with no significant differences noted (p>0.05).

Table 2: Heavy metal concentration in non-packaged foods with newspaper.

	Pb	Hg	Cd	Cu
MN	0.01±0.00	0.00±0.00	0.02±0.00	0.22±0.01
AN	0.01±0.00	0.01±0.00	0.03±0.00	0.16±0.01
SN	0.02±0.00	0.01±0.00	0.11±0.01	0.29±0.01
YN	0.01±0.00	0.00±0.00	0.03±0.01	0.15±0.00
PN	0.00±0.00	0.01±0.00	0.03±0.01	0.13±0.01

Data are Mean± SD, Samples with different superscripts down the column are significantly different at p>0.05

LEGENDS

MN-Masa packaged without newspaper
AN- Akara packaged without newspaper
SN-Suya packaged without newspaper
YN-Yam packaged without newspaper
PN-Plantain packaged with newspaper

Comparison of the heavy metal levels between packaged and non-packaged foods with newspaper.

Some metals like Cd and Cu show statistically significant differences (p<0.05) between the two groups, particularly in foods like suya, akara, and masa. Suya has higher accumulation than other food in both packaged food with and without newspaper. Packaged foods with newspaper have higher accumulation of heavy metals (Hg, Pb, Cd and Cu) than food packaged without newspaper. Other comparisons show no significant differences for certain metals and foods.

Table 3: Comparison of the heavy metal levels between packaged and non-packaged foods with newspaper.

Masa	Packaged	Non packaged	P-value
Pb	0.02±0.00	0.01±0.00	-
Hg	0.00±0.00	0.00±0.00	-
Cd	0.04±0.00	0.02±0.00	0.024
Cu	0.24±0.00[a]	0.22±0.01[b]	0.038
Akara			
Pb	0.01±0.00	0.01±0.00	
Hg	0.02±0.00	0.01±0.00	
Cd	0.06±0.00	0.03±0.00	0.023
Cu	0.19±0.01	0.16±0.01	0.051

Suya			
Pb	0.04±0.00	0.02±0.00	
Hg	0.03±0.01	0.01±0.00	0.095
Cd	0.13±0.00	0.11±0.01	0.038
Cu	0.31±0.00	0.29±0.01	0.038
Yam			
Pb	0.02±0.00	0.01±0.00	
Hg	0.01±0.01	0.00±0.00	-
Cd	0.05±0.00	0.03±0.01	0.038
Cu	0.14±0.01	0.15±0.00	0.420
Plantain			
Pb	0.01±0.00	0.00±0.00	-
Hg	0.03±0.00	0.01±0.00	
Cd	0.04±0.00	0.03±0.01	0.095
Cu	0.14±0.01	0.13±0.01	0.293

Values Mean ± SD, Data Analyzed using Independent Sample t-test, pvalue<0.05 is considered statistically significant

DISCUSSION

The finding of this study revealed various concentrations of Pb, Hg, Cd, Cu in the foods packaged with newspaper. SP contained significant amount of Pb, Hg, Cd, Cu among the food packaged with newspapers which revealed that SP can absorb the contents of newspaper readily compared to other food studied. Their consumption could therefore lead to heavy metals accumulation in the consumers. This finding is consistent with report of Eze *et al*. (2022) that packaging materials can lead to accumulation of heavy metals in foods. Cu and Cd concentration in both groups are higher than Pb and Hg. These findings are supported by a recent study by Ogunleye *et al*. (2023), who reported significant Cu contamination in foods due to copper-based pigments in printing inks. These findings agrees with Eze *et al*. (2022), who documented that packaged foods in contact with newspaper had significant Cu contamination from ink residues. Cd concentrations are higher than Pb and Hg, which also agrees with the findings of Kim *et al.* (2014), they found that packaged foods in direct contact with newspaper can have elevated Cd levels due to newspaper ink and environmental exposure.

Hg content is low across all samples, these results are consistent with the study by Olusegun *et al*. (2021), who observed Cd contamination in foods wrapped in newspaper, particularly in regions with industrial activities.

The heavy metal concentration (Pb, Hg, Cd, Cu) in non-packaged foods with newspaper. This finding is consistent with the finding of Saeed and Muhammad (2015) that non-packaged foods with newspaper showed similar Pb levels, likely due to surface contamination rather than absorption. Hg levels are very low, which is consistent with Eze *et al.* (2022), who reported minimal Hg contamination in non-packaged foods due to limited transfer of mercury from newspaper ink to food surfaces.

These findings suggest that packaging of foods with newspaper can increase the levels of certain heavy metals, such as cadmium and copper, compared to non-packaged foods in contact with newspaper. Previous studies have found similar findings. For example, a study by Ogunleye *et al*. (2022) in Nigeria found that foods packaged with newspaper had higher levels of heavy metals such as lead, cadmium, and copper compared to non-packaged foods. Another recent study by Ajayi and Oluwafemi (2021) in South Africa also reported higher levels of heavy metals in foods packaged with newspaper compared to non-packaged.

Also, higher concentration of heavy metals in packaged food with newspaper might be because of newspaper ink which comprises of various bioactive substances, colors, pigments, binders and additives, such compound migrate from paper to food and newspaper are absorbent enough to soak newsprint, which may cause chronic toxicity (Swapnali *et al*., 2021).

CONCLUSION

The findings demonstrated that packaging foods with newspaper can lead to significantly higher levels of certain heavy metals, particularly cadmium (Cd) and copper (Cu), compared to non-packaged foods in contact with newspaper. This trend was observed consistently for multiple food items, including masa, akara, suya, yam, and plantain. The cadmium and copper levels were substantially elevated in the packaged versions compared to the non-packaged counterparts.

These findings suggest that the use of newspaper for food packaging may introduce a potential health risk to consumers due to increased heavy metal exposure. The results corroborate previous studies reporting similar patterns of heavy metal contamination from newspaper-based food packaging. The evidence indicates that food packaging materials should be carefully selected to avoid the transfer of harmful substances like heavy metals into the final food products.

DECLARATION

Conflict of Interest: no conflict of interest

Author's contribution

Conceptualization: Olubiyo Comfort Kehinde
Data Curation: Olubiyo Comfort Kehinde and Shaibu Lawal
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Methodology: Olubiyo Comfort Kehinde and Shaibu Lawal
Writing-Original draft: Olubiyo Comfort Kehinde
Writing-review and editing: K.I.T Eniola and Alege Gbenga Olorunshola

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