UMYU Scientifica, Vol. 2 NO. 1, March 2023, Pp 10 – 14
https://doi.org/10.56919/usci.2123_002
ISSN: 2955 – 1145 (print); 2955 – 1153 (online)
A periodical of the Faculty of Natural and Applied Sciences, UMYU, Katsina

ORIGINAL RESEARCH ARTICLE

Determination of Heavy Metals Recovered from Artificially Ripe Banana with Calcium Carbide

Aliyu, Bashir[1], Sanusi, Junaidu[1] and Idris, Garba Yar'gamji[2]
[1] Department of Biology, Isa Kaita College of Education Dutsin-Ma, Katsina State, Nigeria
[2] Department of Chemistry, Isa Kaita College of education Dutsin-Ma, Katsina State, Nigeria

ABSTRACT

Calcium carbide is frequently used by vendors to hasten the ripening of banana fruits, and this practice has a long history. Calcium carbide is connected to the negative consequences of heavy metals. Measurements of heavy metal concentrations on artificially ripe bananas using calcium carbide in Katsina state and throughout Nigeria are essential to assist the competent authorities in regulating the use of chemical ripening agents for food safety and consumption. The purpose of the present study is to assess the levels of heavy metals in banana fruits that have been artificially made to ripen. A sample was collected from Mairuwa Fadama of Katsina state's Funtua local government Area. The Banana pulp and peel were analyzed for heavy metals (arsenic, calcium, lead and cadmium) content using standard methods.. Results showed that heavy metal concentrations in banana peel are higher than in banana pulp. The findings give important details about the heavy metals content of the banana peel and pulp eaten in Katsina State. Additionally, the findings showed that banana peels contain considerable levels of heavy metals than the pulp.

ARTICLE HISTORY

Received January 7, 2023
Accepted February 13, 2023
Published February 14, 2023

KEYWORDS

Banana, Calcium carbide, ripening

INTRODUCTION

The banana, scientifically known as *Musa sapientum* and a member of the Musaceae family, is one of the most traded tropical fruits in the world. It ranks as the fourth largest food crop in Africa and is a very common and well-liked economic crop that provides a significant portion of the income for more than 70 million people worldwide (Boliko 2019). In Nigeria Banana are grown majorly for their nutritious and delicious ripe fruits and its consumption cuts across many segments of the society, including all age groups due to the fact that it is highly digestible and it supplies the necessary calories and essential micronutrients required (Ariyo *et al.* 2021). According to Oyeyinka and Afolayan (2020), banana is known to offer numerous health benefits as its edible portion contains carbohydrates and fibre that act as long-lasting form of fuel and helps to stabilize blood sugar levels. Also, it contains vitamins C, A and B complexes, among other nutrients and it is a good source of potassium and magnesium; relevant to maintain nerve and muscle function, in addition to maintaining pH and fluid balance (Rahman *et al.,* 2014; Oyeyinka and Afolayan, 2020).

Fruits can be classified as climacteric and non-climacteric, depending on the ripening pattern. The climacteric stage of fruit ripening is associated with increased production and release of ethylene and an up-regulated cellular respiration. Since banana is a climacteric fruit, it is typically harvested at the pre-climacteric stage (mature but unripe condition) and allowed to ripen (Maduwanthi and Marapana 2019). Ripening process introduces numerous qualities and nutritional characteristics to fruits. The process of fruit ripening is the final stage of fruit development, which is a combination of a series of physiological and biochemical events leading to changes in pigments, sugar content, acid content, flavour, texture and aroma that makes the fruit attractive and tasty (Perotti *et al.,* 2014).

Though this practice reduces post-harvest losses of banana especially during transportation; it is often accompanied with induced ripening with artificial agents (ethylene glycol, kerosene, ether, calcium carbide etc.) to meet consumers' demands and other economic factors (Abhishek *et al.,* 2016). These artificial ripening agents if used inappropriately are toxic and their consumption may cause health problems; such as skin disease, cancers, neurological disorders and organ failure (Ikhajiagbe *et al.* 2021).

Mango, pineapple, plantain, banana, citrus, guava, pawpaw, avocados, and watermelon are among the major fruits grown in Nigeria (Ibeawuchi *et al.*, 2015). Transporting and distributing of fruits from farms to markets can take several days. During this time the naturally ripened fruits may become over ripened and spoiled.

Correspondence: Sanusi Junaidu. Department of Biology, Isa Kaita College of Education Dutsin-Ma
. ✉ Ismailjunaid63@gmail.com; Phone Number 08163286669
How to cite: A. Bashir, S, Junaidu and I. Garba Yar'gamji. (2023). Determination of Heavy Metals Recovered from Artificially Ripe Banana with Calcium Carbide. UMYU Scientifica, 2(1), 10 – 14. https://doi.org/10.56919/usci.2123_002

A part from this fruits must be moved and distributed over several days from farms to markets. Fruits that have ripened naturally during this time may get too ripe and spoil. Along with spoilage, naturally ripened fruits may sustain damage during road transport, increasing the financial losses of fruit sellers. Fruit vendors prefer to harvest fruits before they are fully ripe in order to reduce loss and artificially ripen the fruits later on before selling them to customers. Spoilage naturally ripened fruits can also be damaged during transportation, these increases economic loss for the fruit sellers. To minimize the loss, fruit sellers prefer harvesting fruits before full ripening and later ripen the fruits artificially before selling to the consumers (Mursalat *et al*., 2013). This process of maturation can be artificially accelerated by using different chemicals of which calcium carbide is the most commonly used. Investigations by Fattah and Ali (2010) revealed that many wholesalers used to sell fruits ripened by chemicals to avoid financial loss. Reports have shown that a number of chemical and biological agents are used for artificial ripening of fruits. Some of the chemical agents include ethylene gas, ethephon, ethylene glycol, etherel and carbides of Calcium and Potassium (Singal *et al*, 2012).

Calcium carbide used to induced and accelerate ripening of fruits is considered extremely hazardous, because it contains traces of the heavy metal arsenic and cadmium Hussain *et al.* (2008). Despite all this health implications use of chemical ripening agents is not regulated in Nigeria, this is due to lack of awareness by stake holders such as policy makers, farmers, traders and consumers, food and drugs regulatory agencies. Thus, there is need to investigate the extent to which these ripening agents affect the quality of the fruits and nutritional value sold in our markets.

There are several methods of applying CaC_2 on fruits for ripening purposes. In Nigeria some famers are still using CaC_2 for ripening purposes, some dealers placed fruits in an enclosed compartment together with the huge amount of CaC_2 block and before the compartment is closed, water is sprinkled into the compartment, some put a small packet of carbide in a fruits container and carbide powder is spread onto the fruits surface (Mandel *et al*., 2013). It was also discovered that CaC_2 block was placed concurrently with the unripe banana in a box and all the bananas were ripened within 24 hours Mahmood *et al.* (2013).

The aim of this research is to determine the heavy metals recovered from artificially ripe banana using calcium carbide in Katsina state.

MATERIALS AND METHODS

Sample collection and preparation

Thirty kilogram (30kg) of banana fruit was procured from Mairuwa Dam site of Funtua local government, Katsina state. A matured but unripe fruit was selected for this study. Grade one Calcium carbide was purchased from Katsina central market. All the selected sample of banana was fresh, undamaged, firm and healthy and labeled as described by Lawrence *et al.* (2014)

Sample Treatment

The mature green banana samples were cleaned with tap water and taken into the laboratory for further treatment. The samples were separated into five treatment groups of five kilogram (5kg) and each group was placed under the same atmospheric condition as per Table 1 (Turner *et al*., 2020) .The fruit ripening time was measured as the time it took the whole fruits to change colour from green to yellow (Sogo-Temi *et al*., 2014).

Table 1: Detail treatment of fruits with calcium carbide

Treatment No.	Details of Treatment
T1(Control)	Fruits was allowed to ripe naturally without calcium carbide
T2	5kg of Fruits and 1g of calcium carbide in muslin cloth for 48hours
T3	5kg of Fruits and 2g calcium carbide in muslin cloth for 48hours
T4	5kg of Fruits and 3g of calcium carbide in muslin cloth for 48hours

Determination of Heavy Metals

Twenty gram (20g) of banana pulp and peel were weighed into two acid washed platinum crucibles. Twenty (20mL) of concentrated HNO_3 was added to each of the containers and leave for 20 minutes (it is imperative that this step be carried out before the addition of perchloric acid otherwise, explosion may occur). Two (2**)** each of $HClO_2$ and HCl in the ratio of 10:1 was added and left for about 10 minutes. The samples were heated in the crucible in a hot plate from 135–1800c and evaporate the content almost to dryness. 10 mL of deionized water was added and boil gently to dissolve the residue. Cool and filter through No. 42 wattman filter paper into 100 mL volumetric flask and make to mark with deionized water. The banana pulp and peel the standard solutions were aspirated into the air-acetylene flame of Varian 220 (*fast sequential*) Atomic Absorption Spectrometer. A blank sample was also prepared and analyzed along the sample. Arsenic residues in different samples were determined from the wet digested sample by using ICP-AES (Inductively Coupled Argon Plasma-Atomic Emission Spectrometry)while, calcium was determined by using Flame Photometric method (AOAC, 1998).

RESULTS AND DISCUSSION

The experiments were carried out to measure the amount of heavy metals recovered from banana fruit pulp and peel that were both naturally ripe and ripened with CaC_2 at different concentrations.

Figure 1 and 2 are the results of heavy metals recovered in parts per million (ppm), where the highest concentrations of arsenic were found in the pulp and peel at 3g (1.36ppm and 2.29ppm), 2g (1.19ppm and 2.02ppm), and 1g (0.89ppm and 0.89ppm) of CaC_2. Arsenic was absent from the pulp and peel of untreated bananas (0.00ppm).

The amount of calcium was also observe to increases with the increase of CaC_2 of pulp and peel 3g (37.87ppm and 291.20ppm), 2g (26.25ppm and 286.08ppm), 1g (22.74 and 213.38ppm) and least concentration was observed from untreated (0.29ppm and 55.85ppm).

The amount of lead contents increases with the increase of CaC_2 concentration of pulp and peel in 3g (0.68ppm and 0.78ppm), 2g (0.11ppm and 0.40ppm), 1g (0.08ppm and 0.33) and (0.01ppm and 0.10ppm) in the untreated banana.

Cadmium at pulp and peel in 3g (0.52ppm and 0.79ppm), 2g (0.27ppm and 0.59ppm), 1g (0.19ppm and 0.38ppm) and absent in the untreated.

The results revealed that high heavy metal concentration in the peel is due to the direct contact ofbanana has with the chemical of CaC_2 and it increases with increase of the concentrations at both pulp and peel.

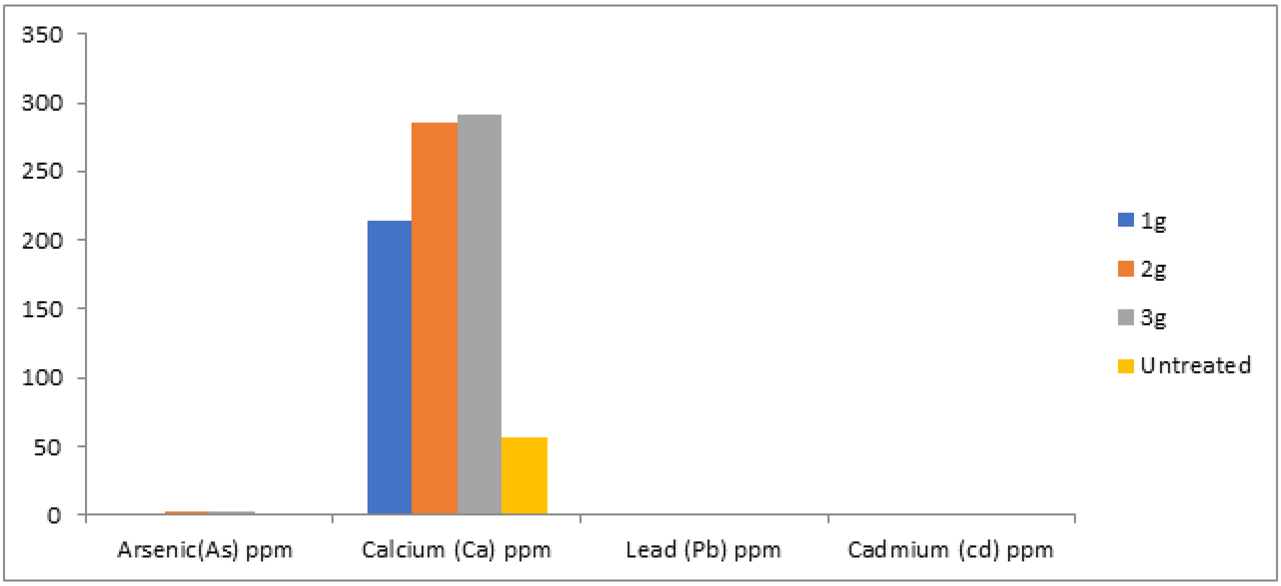

Figure 1: Heavy metals recovered from Banana pulp ripped with calcium carbide

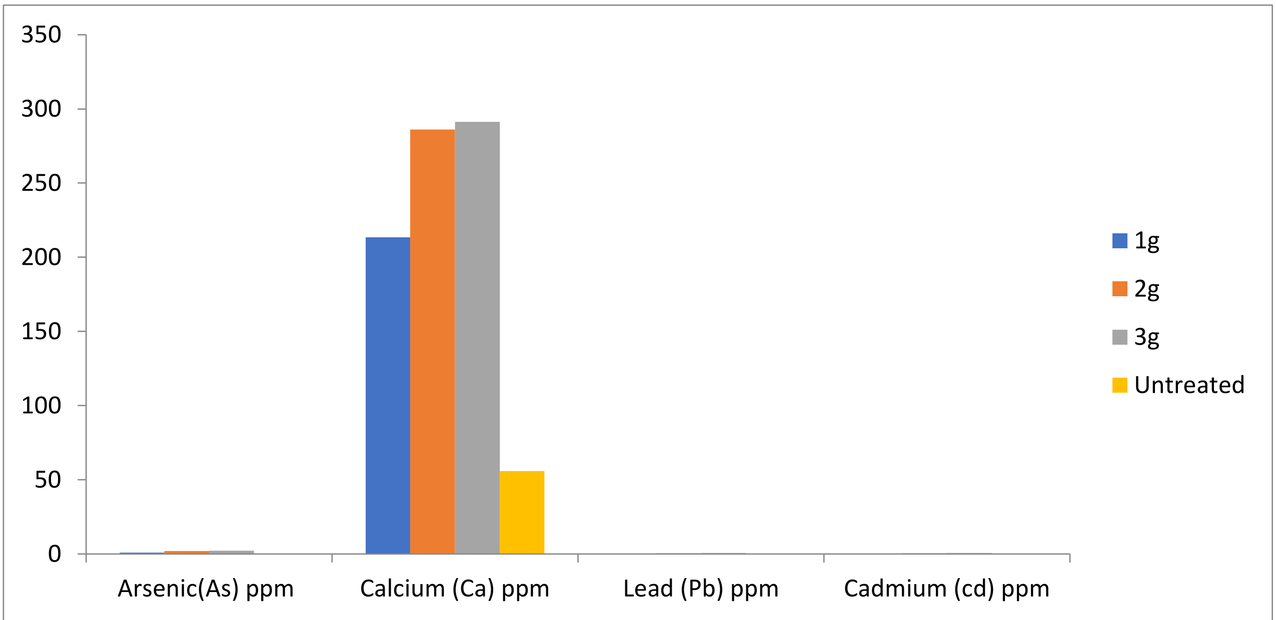

Figure 2: Heavy metals recovered from Banana peel ripped with calcium carbide

The findings is in conformity with the work done by Maduforo *et al*., (2020) on Heavy metal in Banana variety sold by fruits vendors in Enugu state Nigeria. The result of heavy metal increases with the increase of chemical ripening agent. Similar work was also done by Adekalu *et al*., (2020) on Survey on the use of Calcium Carbide as ripening agent in Ilorin metropolis, his findings revealed that artificially ripe banana with CaC_2 had high level of heavy metal contents compared to naturally ripen samples (controls). This study found that carbide treatment increased metal contamination on the surface of fruits. The concentrations of As, Ca, Pb, and Cd in treated banana were found to be higher. The Joint FAO/WHO Expert Committee on Food Additives (JECFA) has designated As and Pb as toxic heavy metals, with PTWIs of 15 g/kg bw (equivalent to 2.1 g/kg bw/day) and 25 g/kg bw. As and Pb have also been classified as carcinogens by the International Agency for Research on Cancer (IARC) (Alimentarius 2019). As a result, strict control over carbide ripening is required. Our research found that after carbide treatment, the concentrations of, As, Ca, Pb, and Cd in banana peel increased significantly. As a result, the presence of these metals in higher concentrations on the surface of fruits can be used as an indicator of carbide ripening.

CONCLUSION

The study identified the heavy metal content in the pulp and peel of bananas, which are widely distributed in Katsina state, northern Nigeria. The findings revealed that the banana peel had a high calcium and arsenic level. It is interesting to note that the levels of cadmium and lead are low and rise with an increase in calcium carbide, in contrast to the widely held belief that calcium carbide is frequently used to ripen fruits. However, due to the fact that banana peel has the highest concentration of heavy metals, it should be consumed with caution to avoid a long-term buildup of heavy metals in the body's cells. The investigation needs to be repeated often and in different regions of Nigeria to serve as a sort of quality control.

RECOMMENDATIONS

The finding of this study recommends the following:

i. There is need for Government agencies to regulate the use of calcium carbide as ripening agents and suggest safety method of ripening fruits.
ii. Banana should be allowed to ripe naturally before consumption, this will help to reduce health hazard risk as most of the chemical ripening agents are toxic to human health.
iii. Proximate analysis should be carried to determine the nutritional values of the naturally ripped and artificially ripped banana fruits.
iv. Research on metabolic effect of chemically ripped banana fruits should be carryout to determine the histopathological effects of heavy metals

ACKNOWLEDEMENT

Researchers wish to acknowledge the managements of the Tertiary Education Trust Fund (TETFUND) and that of Isa Kaita College of Education Dutsin-Ma), for sponsoring this research under the 2020 Institutional Base Research (IBR) of TETFUND which became possible through the recommendation and approval of the management of Isa Kaita College of Education Dutsin-Ma.

REFRENCES

Abhishek, R. U., Venkatesh, H. N., Manjunath, K., and Mohana, D. C. (2016). Artificial ripening of fruits-misleading ripe and health risk. Everyman's Science, 6, 364-369.

Alimentarius C. 2019. Codex general standard for contaminants and toxins in food and feed. Rome (Itlay): Food and Agricultural Organization (FAO)/World Health Organization (WHO).

Ariyo, O., Balogun, B., and Solademi, E. A. (2021). Effect of accelerated ripening agent on nutrient and antinutrient composition of banana. Journal of Agriculture and Food Sciences, 19(1), 63-77. **[Crossref]**

Boliko, M. C. (2019). FAO and the situation of food security and nutrition in the world. Journalof nutritional science and vitaminology, 65(Supplement). **[Crossref]**

Fattah, S. A., and Ali, M. Y. (2010). Carbide ripened fruits-a recent health hazard. Faridpur Medical College Journal, 5(2), 37-37. **[Crossref]**

Hussain, A. I., Anwar, F., Sherazi, S. T. H., and Przybylski, R. (2008). Chemical composition, antioxidant and antimicrobial activities of basil (Ocimum basilicum) essential oils depends on seasonal variations. Food chemistry, 108(3), 986-995. **[Crossref]**

Ibeawuchi, I. I., Okoli, N. A., Alagba, R. A., Ofor, M. O., Emma-Okafor, L. C., Peter-Onoh, C. A., and Obiefuna, J. C. (2015). Fruit and vegetable crop production in Nigeria: The gains, challenges and the way forward. Journal of Biology, Agriculture and Healthcare, 5(2), 194-208.

Ikhajiagbe, B., Ogochukwu, O. F., and Ogwu, M. C. (2021). Shelf Life, Fruit Quality and Safety of Banana (Musa Species) Ripened through Traditional Ripening Techniques in Nigeria.

International Journal of Fruit Science, 21(1), 66-81. [Crossref]

Kumar, K. S., Debjit Bhowmik, S. D and M.Umadeva. (2012). Traditional and medicinal uses of banana. Journal of pharmacognosy and phytochemistry 1(3): 51-53.

Lawrence, M. S., Stojanov, P., Mermel, C. H., Robinson, J. T., Garraway, L. A., Golub, T. R., and Getz, G. (2014). Discovery and saturation analysis of cancer genes across 21 tumour types. Nature, 505(7484), 495-501. [Crossref]

Mahmood T., Saeed I., Anwer H., Mahmood I. and Zubair A. (2013). Comparative study to evaluate the effect of calcium carbide (CaC2) as an artificial ripening agent on shelf life, physio-chemical properties, iron containment and quality of Prunus persica l. Batsch. European Academic Research, 1(5):685-700

Mandal, A. B., Raju, M. V. L. N., Elangovan, A. V., Bhanja, S. K., and Sahoo, S. K. (2013). ICAR-Nutrient requirements of poultry

Mursalat, M., Rony, A. H., Rahman, A. H. M. S., Islam, M. N., and Khan, M. S. (2013). A critical analysis of artificial fruit ripening: scientific, legislative and socio-economic aspects. Che thoughts, 3(1), 1-7.

Oyeyinka, B. O. and Afolayan, A. J. (2020). Comparative and correlational evaluation of the phytochemical constituents and antioxidant activity of Musa sinensis L. and Musa paradisiaca L. fruit compartments (Musaceae). [Crossref]

Rahman A. H. M., Islam M. N., Imtiaz M. Y., Abdullah F. P., Mehnaz M., Sabrina S. A. and Mohidus S. K. (2014). Nutrition value analysis of artificially ripened banana (bari-1 hybrid banana, Musa spp.). In: Proceedings of the International Conference on Chemical Engineering (ICCE-2014), Dec. 29-30, 2014, Dhaka, Bangladesh. pp. 172-176

Singal, A. G., Yopp, A., S Skinner, C., Packer, M., Lee, W. M., and Tiro, J. A. (2012). Utilization of hepatocellular carcinoma surveillance among American patients: a systematic review. Journal of general internal medicine, 27(7), 861-867. [Crossref]

Sogo-Temi, C. M., Idowu, O. A., and Idowu, E. (2014). Effect of biological and chemical ripening agents on the nutritional and metal composition of banana (Musa spp). Journal of Applied Sciences and Environmental Management, 18(2), 243-246. [Crossref]

Turner, A. D., Tarnovius, S., Hatfield, R. G., Teixeira Alves, M., Broadwater, M., Van Dolah, F. and Suarez-Isla, B. A. (2020). Application of six detection methods for analysis of paralytic shellfish toxins in shellfish from four regions within Latin America. Marine drugs, 18(12), 616. [Crossref]