



Arsenic Content in Rice in Ghana: A Potential Health Hazard

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Abstract— Background and objectives: Arsenic found mostly in rice and rice products is a carcinogen that affects the skin and internal organs. In recent times, concerns have been on the characteristic chronic concentration of this metal in rice even as FAO forecast increasing global production of rice. The aim of this study is to determine arsenic concentration in both local and imported rice patronized by consumers in the Central Region of Ghana. **Method:** A total of thirty-three samples comprising of seven locally produced rice and four imported brands were collected in three months from various outlets in Ghana. The samples were separately milled, digested and then filtered. The clear solution was used to run the arsenic test using A.A.S. **Results:** The local rice had concentration ranging from 0.256-0.420 mg/kg As, while the imported recorded 0.410-0.505 mg/kg As. The values obtained exceeded CODEX value of arsenic concentration in rice. **Conclusion:** Consumers of rice in Ghana are potentially at risk of arsenic related diseases.



Keywords— Rice, arsenic, AAS, carcinogen

I. INTRODUCTION

Rice is one of the world's most important staple foods and supplies more than 50 % of the world's caloric intake (Clemens et al., 2013; Majumder & Banik, 2019)^{1,2}. However, rice consumption poses a major health risk since the soils on which rice is normally grown are polluted with arsenic (As) (Zhao et al., 2014; Gonzalez et al., 2020; Oberoi et al., 2019)^{3,4,5}. FAO's total world rice production for 2021 was 787,293,867 mt (www.fao.org)⁶. Rice plays a crucial role in ensuring global food security and cultivation provides employment for millions of farmers worldwide, supporting rural economies and livelihoods. In view of the gravity of health risks associated with As, different regulatory agencies like World Health Organization (WHO), Ghana Government, Vietnamese and China, have respectively legislated 300, 100-150, 200 and 200 -250µg/kg. (<https://www.sciencedirect.com/journal/heliyon>)⁷.

Recent rice surveys have shown that a significant amount of rice exceeded the WHO standard for arsenic (Zavala &

Duxbury, 2008; Rowell, 2014; Meharg et al., 2009)^{8,9,10}. For instance, polished white rice in the American and French markets on average had 0.25 and 0.28 mg/kg As, respectively, while in Jamaica the white and brown rice samples had As ranging from 0.110 - 0.487 and 0.082–0.250 mg/kg, respectively (Meharg et al. 2009)¹⁰. A study in Vietnam reported a mean concentration of As in Vietnamese rice as 0.115mg/kg (Dinh Binh Chu et al., 2021)¹¹.

In common with many other West African countries, the Government of Ghana conceived rice schemes as a major tool in improving food security and increasing rural incomes. To this end, Asian countries of all political stripes were encouraged to offer their expertise in the production of paddy rice. Ghana achieved the quite difficult feat of having experts from both North and South Korea, Taiwan and China all in the country simultaneously, working on isolated projects in remote areas (rice production in Ghana: country profile---AWS)¹².

Ghana has relatively high rainfall compared with northern Nigeria and Mali and rice can be grown almost everywhere. Rice schemes are found right on the border with Burkina Faso, as in the case of Tono and down to the sea-coast. Rice production methods in Ghana can be divided into three types: Valley-bottom rice, Upland and Controlled flooding. (rice production in Ghana: country profile---AWS)¹².

Ghana is 30% self –sufficient in rice production. The total rice demand is 600,000mt, the range of domestic production is 200,000 - 300,000 tons. The agro-ecological zones and production are respectively for irrigated, lowland/inland valleys and upland are 8, 77 and 15%. The contribution of the Northern, Volta and Upper East is 70% while Ashanti, Upper West, Brong Ahafo, Eastern, Central, Western, Greater Accra has 30% of the total production (Population Census, 2010; USDA/GSS/MOFA 2018-2019)^{13,14}.

Rice research in Ghana has focused on the production of improved varieties with better production yields. While some attention has been given to rice macro-nutrient composition for purposes of both human and animal feeding (Amisshah et al., 2003, Adu-Kwarteng et al., 2003)^{15,16}. There is little published data on the levels of potentially toxic elements (PTEs) in imported or locally produced rice from Ghana, the potential risk of As transfer to rice irrigated with mining-polluted surface waters has been highlighted (Adomako et al., 2010)¹⁷. In 2021, rice, paddy production for Ghana was 1.23 million tonnes. It increased from 70,100t in 1972 to 1.23mt in 2021 growing at an average annual rate of 8.85%. (<https://knoema.com/atlas>)¹⁸.

Given the significance of rice as a staple food and the potential health implications associated with As, this study aims to provide analysis of the arsenic content in local and imported rice in Ghana. The finding shall augment the empirical baseline data on rice in Ghana.

II. MATERIALS AND METHOD

2.1 Procedure

2.1.1 Collection of samples

The samples were collected during July to September 2023. Thirty-three samples of rice grains comprising of two types: seven locally produced rice and four popular imported brands. They were collected thrice in three months from various outlets in the major rice producing regions of Ghana. All the samples coded for laboratory for analysis. The imported rice were from India, China, Thailand and Vietnam.

2.1.2 AAS analysis

The samples were separately milled and labelled, 0.5 grams of each of the milled sample digested and centrifuged. The

clear supernatant used for the arsenic test with AAS (<https://www.sciencedirect.com/journal/journal-of-food-composition-and-analysis>).

III. RESULTS

Table 1: Average Arsenic Content ($\mu\text{g}/\text{kg}$) of Rice.

Rice type	Arsenic ($\mu\text{g}/\text{kg}$)
<i>Local</i>	
R1 Upper East	305 \pm 0.34
R2 North	410 \pm 0.12
R3 Oti	420 \pm 0.25
R4 Ashanti	350 \pm 0.10
R5 Eastern	284 \pm 0.05
R6 Western North	300 \pm 0.10
R7 Volta	256 \pm 0.10
<i>Imported</i>	
R8 India	505 \pm 0.08
R9 China	410 \pm 0.14
R10 Thailand	440 \pm 0.26
R11 Vietnam	500 \pm 0.11
WHO	300
GHANA	100-150
VIETNAM	200
CHINA	200 -250
CODEX	200

Source: Bartels/ Nkuma/ Gadzekpo laboratory results, 2023

R1, R2, R3, R4, R5, R6, R7 -local rice obtained from Ghana
R8- rice imported from India / R9- rice imported from china
R10- rice imported from Thailand / R11- rice imported from Vietnam

IV. DISCUSSION

Rice research in Ghana has mainly been qualitative, there is therefore little published data on the levels of potentially toxic elements (PTEs) in imported or locally produced rice from Ghana (Amisshah et al., 2003, Adu-Kwarteng et al., 2003)^{15,16}.

Arsenic content in local rice

As indicated in Table 1, we found out that the respective average arsenic content in the local rice obtained from the regions of Upper East, North, Oti, Ashanti, Eastern,

Western North and Volta in Ghana respectively were 305 ± 0.34 , 400 ± 0.12 , 420 ± 0.25 , 350 ± 0.10 , 284 ± 0.05 , 300 ± 0.10 and 256 ± 0.10 $\mu\text{g}/\text{kg}$. The sample from Oti region had the highest content of 0.42 mg/kg As, with the least being Volta region having 0.256 mg/kg As. All the reported concentrations are above the WHO, Codex and Ghana standards of 0.2 , 0.3 and 0.1 - 0.15 mg/kg respectively confirming the potential risk of As (Adomako et al., 2010)¹⁷. This finding corroborates earlier study that the arsenic content of raw rice could reach concentrations of about 1 ppm (Sun et al., 2008)¹⁹.

Arsenic content in local and imported rice

The average concentrations of arsenic obtained for the imported rice on sale from India, China, Thailand and Vietnam respectively were 505 ± 0.08 , 410 ± 0.14 , 440 ± 0.26 , 500 ± 0.11 $\mu\text{g}/\text{kg}$. The imported rice relatively typically had higher arsenic content than the local rice. These concentrations are also higher than the standards of WHO, CODEX, Vietnam, China and Thailand shown in Table 1.

In similar research in India, the concentration of As in rice grains was in the range of $0.04 - 0.45$ $\mu\text{g g}^{-1}$ (<https://www.sciencedirect.com/journal/journal-of-food-composition-and-analysis>)²⁰ of which our reported concentration 505 ± 0.08 $\mu\text{g}/\text{kg}$ As (0.505 mg/kg As) obtained in this study is higher for the imported rice from India. Another study in Vietnam reported a mean concentration of As in Vietnamese rice as 0.115 mg/kg (Dinh Binh Chu et al., 2021)¹¹, though below the standard of 200 mg/kg legislated by Vietnam, the present finding of 0.5 mg/kg As reported in this study is much higher.

The findings suggest that rice in Ghana contains higher concentrations of As, which could be a recipe for cardiovascular, haematological, renal, endocrine and hepatic diseases (<https://link.springer.com/journal/10653>)²¹ since the concentrations are above the legislated thresholds as provided in Table 1.

CONCLUSION

All the samples analysed contained higher concentrations of As, above both the local and international legislated standards. This implies that Ghana's rice is prone to As contamination, long term exposure could lead to bioaccumulation within the body. Therefore, the presence of arsenic of such a high concentration in the samples is particularly worrying given that the rice is a staple in very high demand in Ghana.

RECOMMENDATION

The Ministry of Food and Agriculture, the Food and Drugs Authority and other stakeholders must intensify the monitoring of the quality of rice in Ghana.

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