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Milling Method: Level of Heavy Metal Content in Foodstuffs and Soup Ingredients

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Abstract

The study examined the concentration of heavy metal in food stuffs and soup ingredients using traditional (grinding stone) and modern (burr mill) milling methods in selected food crops. The food samples; Maize (Zea mays), Beans (Phaseolus Vulgaris), Soya beans (Glycine Max), Tomatoes (Solanum Lycopersicum), and scent leaves (Ocimum Gratissimum) were purchased from two popular markets in Akungba Akoko, Southwestern Nigeria and were washed with distilled water, and grinded into powder and paste form with grinding stone and burr mill machine. The samples were analyzed for copper, iron, lead, cadmium, lead and chromium using atomic absorption spectrophotometry. The result of the study showed that food items grinded into paste form with burr mill machine introduced the highest concentration of heavy metals into the food samples while those grinded into powder form with the burr mill machine had the lowest metal concentrations. Grinding stone varies between and also present some level of heavy metals into the food items. The trend of heavy metals in the food samples was found as Fe > Zn > Cu > Pb > Cd. Chromium was not detected in any of the food samples. The study revealed that both traditional and modern milling methods used introduced traces of heavy metals into the food samples.

1.0 Introduction

Maize (Zea mays), beans (Phaseolus vulgaris), soya beans (Glycine max), tomatoes (Solanum lycopersicum) and scent leaves (Ocimum gratissimum) are common foodstuff and soup ingredients consumed in Nigeria. Beans, maize (corn) and soya beans are cereal grains that may be eaten or cooked in different forms, tomatoes are edible berry that may be used for cooking soup or make different kind of dishes while scent leaves are used for cooking soup or making herbs. These ingredients and foodstuff could be grinded in wet or dry form before cooking. One of the essential ways by which someone could be exposed to trace elements is through what the body consumed [1].

In Nigeria, milling of food items or soup ingredients could be done by the traditional way of using pestle and mortal and grinding stone or the way of using of milling machines and blender. The use of grinding stone is rigorous and time consuming while milling machine is faster and more convenient. The grinding stone is made from hard stones or rocks. Using grinding stone involves holding the upper mill stone with both hands and grinding forward and backward on the grinding

stone. During the grinding process, some of the stone components may grind to powder, mix with the food substance and consumed with it in the process. The operation of milling machine involves the plates rubbing against each other as the food stuffs or soup ingredients is being grinded either in dry or wet form. The rubbing action of the plates causes wear and tear which leads to friction thereby bringing impurities into the grinded food ingredients [2] Grinding discs have poor wear resistance because of the materials used for their production [3,4,5]. Common impurities in grinded food/soup ingredients arises mostly from the metal coating of the machine parts, bearings, grinding discs, and brushing [2].

Heavy metals are elements that occur naturally, they possess high atomic weight. The density of heavy metal is more than that of the water, at least five times [6,7]. They are widely distributed in the environment due to their various industrial, technological, domestic, medical and agricultural applications [8]. It is expedient to add that heavy metals are natural components of the ecosystem in seas, water, lakes, rivers, lakes, streams and atmosphere. The activities of man have altered the distribution and quantities of the metals in our natural system. The high concentration of heavy metals could be toxic and harmful to the health. Lead, Arsenic, Chromium, Cadmium and Mercury have been placed among the high status metals that are of importance to the health of the public [2]. While some heavy metals could be harmful to human being, heavy metals such as copper, cobalt, iron, nickel, magnesium and zinc have essential functional roles in the body. Lead, arsenic, chromium, cadmium and mercury when consumed in high doses could be toxic to the body [9,10]. It is also expedient to mention that food crops could absorb different heavy metals from the soil depending on the physicochemical properties of the soil. [7]. Grinded food stuffs or soup ingredients are likely to have substantial amount of heavy metals emanating from the metal part of the milling machine, the paint used in coating the machine, the various machine parts that are suffering from ageing, wear and tear. [5,11,12]. A number of studies have been carried out in other countries [7,9,14-17]. In the light of this background, this study sought to determine the effect of the use of grinding stone and burr milling machine on the level of heavy metals in commonly consumed food stuff and soup ingredients both in wet form and powder form in Nigeria.

2.0. Materials and Method

This research was done in Akungba Akoko, Ondo State, Southwestern Nigeria. Akungba Akoko is situated on Longitude 5^{o}44’E and Latitude 7^{o}28’N of the equator. From 2006 national census, the population of Akungba Akoko was 15,579 [18]. It has average temperature of 26^{o}c and 28^{o}c and annual temperature of 1100-2000 mm. Akungba is a host to Adekunle Ajasin University, Akungba Akoko, Ondo State. Samples of maize, soya beans, beans, tomatoes, and combination of scent/herbal leaves vegetables (popularly known as Gbanuru leaves) were bought from two popular markets namely Okusa and Ibaka markets in Akungba Akoko. Samples were bought in triplicate from the two markets and stored in labelled polyethylene bags. These food items are either home grown or grown in the Northern or Eastern part of the country as marketers travelled to all these parts of the country to buy food items for sale in Akungba Akoko.

Cleaning of the grains (maize, beans and soya beans) was done by picking stones and unwanted materials out and blowing the chaffs away. All samples including fresh and dry tomatoes and scent leaves were washed with excess distilled water. The food samples were divided into four different

groups. The items in first group (maize, beans, soya beans, dry tomatoes and scent leaves), was sundried and grinded with burr machine into powder form as dry sample. The second group includes maize, beans, soya beans (soaked in distilled water to soften for a day), fresh tomatoes and scent leaves, were then grinded into paste form with burr mill machine as wet sample, distilled water was added in little quantity during the grinding process. The third group comprises of soya beans, beans, maize not inclusive, (soaked in distilled water for a day to get soften), fresh tomatoes and scent leaves, then grinded manually using grinding stone, distilled water was also added in little bits during grinding as wet sample. The grinding stone was not used in milling dry samples because of the hardness of the samples which was not easy to grind manually. The fourth group served as control. The burr milling machine and grinding stone were carefully washed with distilled water before use so that all unwanted material from previously grinded food items would be cleaned out. The samples were stored in polyethylene bag and taken to the laboratory for analysis. The burr milling machine and grinding stone are shown in the figures below.

0.5g of each prepared sample were digested with 10 ml aqua-regia solution at a temperature of 700^{o}c until a transparent solution was obtained. The filtrate from the resulting solution volume was topped up with distilled water into a 50 ml standard volumetric flask [2,19]. The digest were analyzed for metals using Atomic Absorption Spectrometer at Prof Julius Okojie Central Research Laboratory, Federal University of Technology, Akure, Nigeria.

Fig 1: Grinding Stone

Fig 2: Burr Milling Machine

3. Results and Discussion

Table 1 level of heavy metals (mgkg^{-1}) using various milling method in the food samples

Samples	Milling Method	Cu	Fe	Pb	Cd	Cr	Zn
Soya beans	Wet burr milling (WBM)	12.00	56.00	ND	ND	ND	27.00
	Dry burr milling (DBM)	12.50	119.50	1.00	ND	ND	37.50
	Grinding stone (GS)	16.50	16.50	ND	ND	ND	28.50
	Control	10.00	19.50	ND	ND	ND	21.50
Maize	Wet burr milling	16.00	83.50	ND	ND	ND	23.50

	Dry burr milling	4.00	66.50	0.50	1.0	ND	17.00
	Grinding stone	-	-	-	ND	ND	-
	Control	3.00	20.00	ND	ND	ND	17.50
Beans	Wet burr milling	17.00	38.50	ND	ND	ND	39.50
	Dry burr milling	12.00	68.50	ND	ND	ND	33.50
	Grinding stone	7.00	78.50	ND	ND	ND	23.50
	Control	6.50	26.50	1.50	ND	ND	18.50
Scent	Wet burr milling	23.00	269.00	3.00	ND	ND	22.00
Leaves	Dry burr milling	4.50	198.00	ND	ND	ND	7.50
	Grinding stone	7.50	60.00	2.50	ND	ND	13.50
	Control	ND	10.00	ND	ND	ND	2.50
Tomatoes	Wet burr milling	35.00	1525.00	ND	ND	ND	70.00
	Dry burr milling	8.00	215.50	ND	ND	ND	10.00
	Grinding stone	17.50	255.00	ND	ND	ND	190.00
	Control	7.00	65.00	ND	ND	ND	70.00

Table 2 the mean value of heavy metals ($mgkg^{-1}$) in the milling methods

Milling Method	Cu	Fe	Pb	Cd	Cr	Zn
Wet burr milling	20.6	394.4	3.00	ND	ND	36.4
Dry burr milling	8.2	133.6	1.00	1.0	ND	21.1
Grinding stone	12.13	118.75	2.5	ND	ND	68.88
Control	6.63	28.2	1.5	ND	ND	26.00

Table 1 shows the concentration of heavy metals in the food samples using three milling methods: burr milling in wet form (WBM), burr milling in dry form (DBM), and grinding stone. The control shows the true level of heavy metals in all the samples. Chromium was not detected in any of the samples using all the milling methods. This is a coherent result that indicated no risk of impurities from the milling equipment. Cadmium was detected at a small amount only in maize milled in powder form with burr mill. Lead was not detected in tomatoes samples in all milling methods. Considering the trend of heavy metals in various food samples; soya beans sample, the grinding stone had the highest copper content. The highest Iron and zinc contents was in soya beans milled in powder form. Maize samples grinded with burr mill in wet form had the highest Cu, Fe and Zn contents. In beans sample, the wet burr milling had the highest Cu and Zn contents while grinding stone had the highest Fe content. Scent leaves grinded with burr mill in wet form had the highest Cu, Fe and Zn contents. Tomatoes samples grinded with burr mill in wet form had the highest Cu and Fe contents while grinding stone had the highest Zn content.

From Table 2, the trend of heavy metals in the food samples was found as Fe > Zn > Cu > Pb > Cd. In all the samples, wet milling had the highest metals concentration except for Zn where grinding stone had the highest. The trend of heavy metals for the different milling method used were wet burr milling > grinding stone > dry burr milling for copper. Wet burr milling > dry burr milling > grinding stone for Iron. Wet burr milling > grinding stone > dry burr milling for Lead and grinding stone > wet burr milling > dry burr milling for Zn. The dry burr milling method had the lowest metal concentrations in all the samples except for Iron. Lead was only discovered in very few samples. The mean value of copper in the different milling method varies from 8.2 to 20.6 $mgkg^{-1}$. This is relatively higher than the control value of 6.63 $mgkg^{-1}$. The mean value of iron varied from 118.75 to 394.4 $mgkg^{-1}$. This is also higher than the control value of 28.2 $mgkg^{-}$

[1]. The mean value of zinc varied from 21.1 to 68.88 $mgkg^{-1}$. This is also higher than the control value of 26 $mgkg^{-1}$. Zinc and iron are important elements for organisms [20]. The metals concentration values were plotted against the food samples as shown in Fig. 3 to Fig. 7.

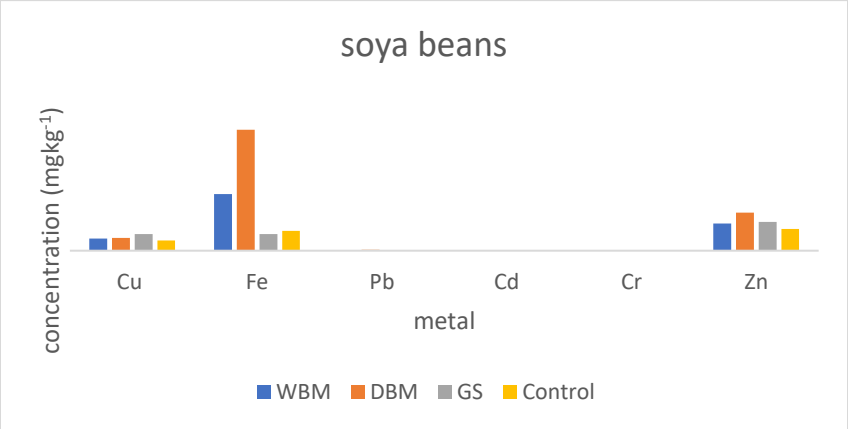

Fig 3. Concentration of the metals in soya beans

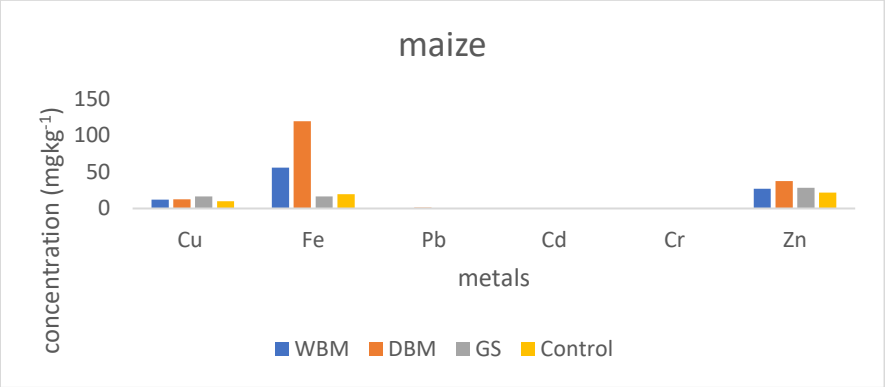

Fig 4. Concentration of the metals in maize

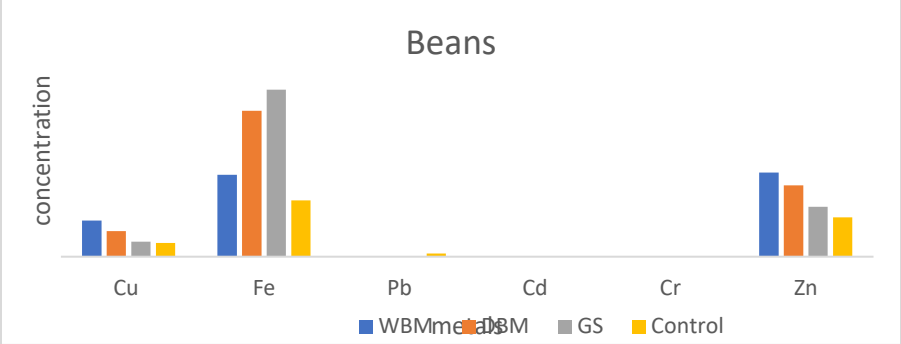

Fig 5. Concentration of the metals in beans

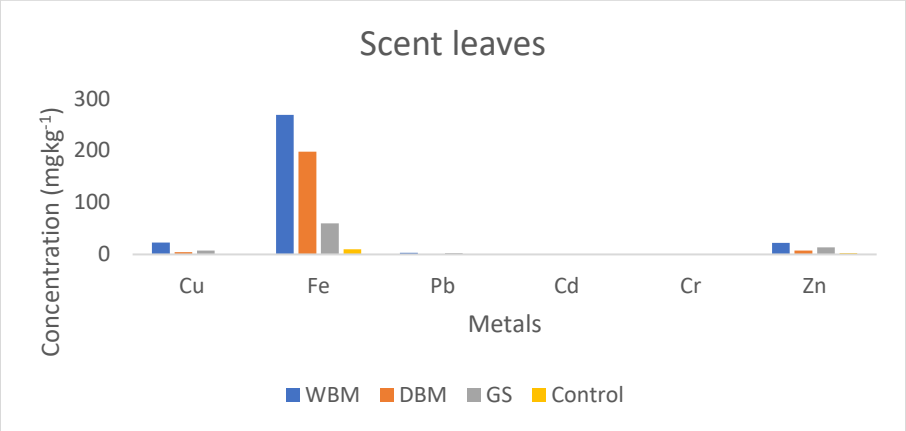

Fig 6. Concentration of the metals in Scent leaves

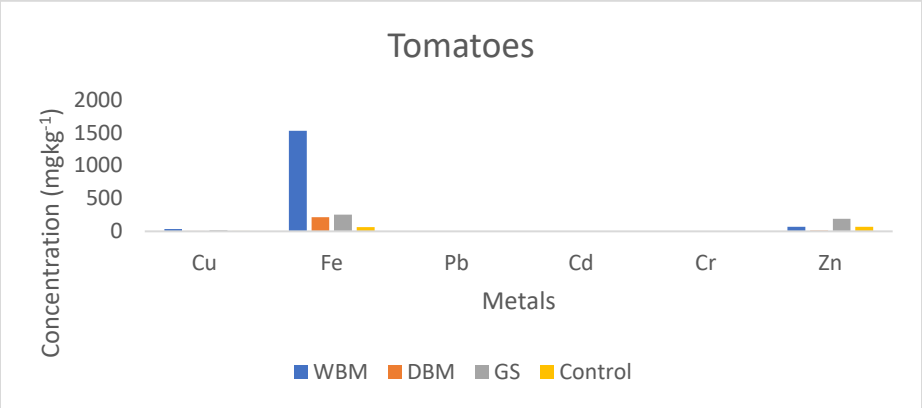

Fig 7. Concentration of the metals in Tomatoes

4.0. Conclusion

The effect of milling methods and machines on the level of heavy metals in food stuffs have been established. The study showed that no milling method or machine is completely free from heavy metal contamination. Grinding stone which was the oldest and traditional way of milling food items in Nigeria used to be believed to present no risk, however, in this study, the grinding stone present reasonable number of heavy metals in the milled food items but below that of burr mill machine. All samples had higher heavy metals concentration in comparison to the control value. Wet milling had the highest concentration of copper, iron, and lead. Therefore, all milling methods used in the study present some level of heavy metals.

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