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HEALTH RISK ASSESSMENT OF METAL CONTENT IN TUMERIC (Curcuma longa) CULTIVATED IN MARO FARMLANDS KAJURU LGA, KADUNA STATE, NIGERIA

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ABSTRACT

Turmeric powder (Curcuma longa) is a yellow powder obtained by grinding dried matured rhizomes. Curcuma longa is utilized in culinary and cosmetic preparations, as well as medicinal formulations. It's available in Kajuru LGA, Kaduna state, Nigeria's Maro ward. The purpose of this study was to carry out a health risk assessment of Na, Mg, K, Ca, and Fe metals in turmeric cultivated within Maro, Chibiya, Karamai, and Angwan Gamu farm lands. Using the Perkin Elmer pin AAcle 900H, four *Curcuma longa* samples were obtained from diverse fields and subjected to AAS analysis following wet digestion to assess metal contents. The data was examined statistically using analysis of variance (ANOVA). Ca>Mg>Na>K>Fe were found to be the most abundant metals in Curcuma longa. The maximum level advised by the World Health Organization for all elements was not exceeded (WHO). At P>0.05, there were substantial differences in metal content in Tumeric across all farmlands. Consumers of Curcuma longa cultivated in Maro will not be exposed to any potential health problems because the Target Hazard Quotient (THQ) value of all metals was less than one and the Hazard Index (HI) value for Fe metal was less than one. It was suggested that more research be done on the health risks of other metal content in Curcuma longa rhizome.

Keywords: *Curcuma longa* powder, metal concentration, Health risk assessment

INTRODUCTION

Tumeric (*Curcuma longa)* is a perennial rhizomatous herbaceous plant in the Zingiberaceae ginger family. It's a tropical and sub-tropical perennial herb that can be found all over the world. According to Sahdeo and Bharat (2011), there are 134 species of Curcuma. Because of its pungency and excellent productive potential, only curcumin longa is cultivated in Maro. Atale pupa in Yoruba, Gangamau in Hausa, Nwandumo in Ebonyi, Ohu boboch in Enugu (Nkanu East), Gigir in Tiv, Magina in Kaduna, Turi in Niger State, and Onjonigho in Cross River (Meo tribe) are some of the native names (Olatunde et al., 2014). The plant is mostly grown in Bangladesh, China, Thailand, Cambodia, Malaysia, Indonesia, the Philippines, and Nigeria's tropical regions.

Curcuma longa is grown by ginger farmers in the southern part of Kaduna state in Nigeria. Cultivation commenced lately after Ginger in 1927, in Kachia, Jaba, Kagarko, Zangon Kataf, Jama'a and Kajuru local government areas respectively. *Curcuma longa* is grown in Nigeria's nineteen states at the moment (Amadi et al, 2018).

Its pungent, bitter rhizome is frequently used in folk medicine and home remedies for diabetes, high cholesterol, abdominal aches, menstrual disorders, wounds, dermatitis, jaundice, inflammations, cancer signs, and as a blood purifier (Sawant and Godghate, 2013). Curcumin, an active component, is found in 70-76 percent of the powdered rhizome, which is yellow (Gopinathan et al., 2011). Curcumin is a potent antioxidant found in Curcuma longa that has a wide range of biological actions including free radical scavenging, cholesterol-lowering, anti-inflammatory, anti-platelet, antibacterial, and antifungal effects (Peter, 2000; Cooper et al., 1994). Calcium, potassium, phosphorus, iron, magnesium, manganese, and zinc are all found in *Curcuma longa* (Asagwara et al. 2018). Heavy metals and trace metals are found in *Curcuma longa*. Regular exposure to these metals causes bioaccumulation in human organs, which can lead to major health concerns.

Because of their essentiality or poisonous nature, trace metals are particularly significant in food composition. Environmental pollution is the primary source of heavy metal contamination in the food chain. Trace metal levels fluctuate depending on the food item and are reliant on their entry during the cultivation, transport, processing, and fortification of the food. In addition, other methods that are used to transform raw food into finished products can dramatically raise the total trace metal content of the meal. There is virtually little information on the metal concentrations in spices, particularly Curcuma longa, which is grown in Maro agriculture.

The metal content of Curcuma longa powder is vital to examine because the rhizomes are utilized as spices in the primary meal of the Maro people and Nigeria as a whole. Because Maro is a significant Curcuma longa producing village in the southern portion of Kaduna state, Nigeria, maintaining the quality of the products is critical.

MATERIALS AND METHOD

Sample Selection

In June 2021, rhizomes of Curcuma longa were collected from four (4) separate locations in Maro ward, Kajuru LGA, Kaduna state. In Maro ward, the study area included Maro, Chibiya, Karamai, and Angwan Gamu. Four (4) samples (each from a separate agricultural) were collected and tested for metals using Atomic Absorption Spectroscopy (AAS). The research area is depicted in Figure 1 below.

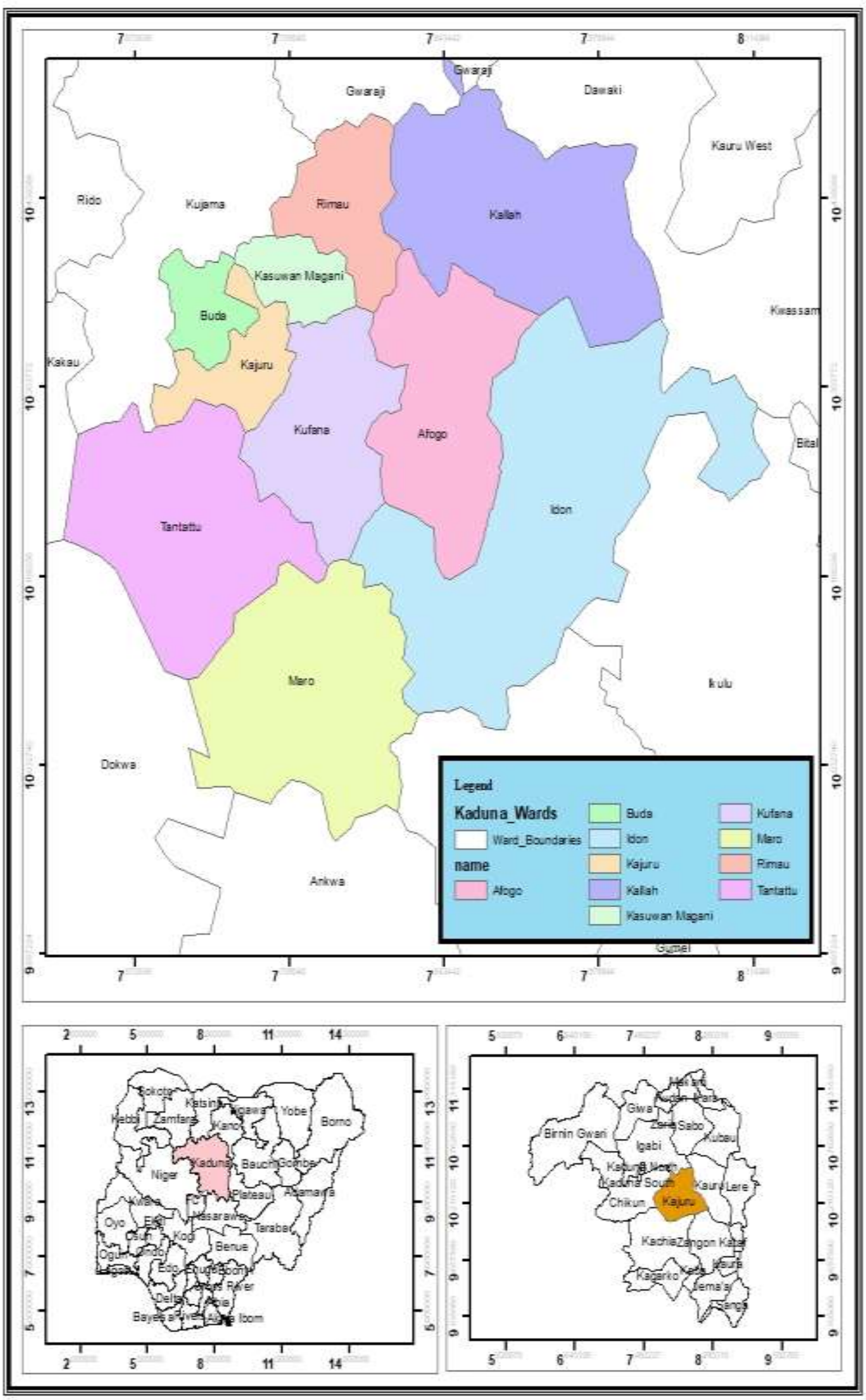

Figure 1: Map of Maro Farmland Showing the Study Area. (Source: GIS Geography Dept. ABU, Zaria, 2021)

Sample Preparation

Each Curcuma longa rhizome sample was washed with tap water and then distilled water in the laboratory. Curcuma longa from Maro farmland was labeled sample A, Curcuma longa from Chibiya farmland was labeled sample B, Curcuma longa from Karamai farmland was labeled sample C, and Curcuma longa from Angwan Gamu farmland was labeled sample D. Sample D was given to Curcuma longa. To make drying easier, the four samples were split into pieces. Separately, the samples were dried in the laboratory at room temperature. After 10 days, all the samples were dried. The samples were ground using mortar and pestle according to their labels and sieved to obtain a fine powder.

In an analytical balance, 1.0g of *Curcuma longa* powder was weighed and transferred to a 250ml conical flask. In a fume hood, 5 ml concentrated HNO_3 was added to each sample slowly at first, followed by 10 ml of 60% concentrated perchloric acid until foaming stopped. At 200 ºC for 80 minutes, a hot plate was used to heat the HNO_3 until it evaporated. The sample was heated to HClO4 white fumes. The digested samples were then cooled and filtered using filter paper before being quantitatively transferred to a 100.0 ml volumetric flask. The above procedure was repeated in triplicate for the remaining samples, yielding twelve digested samples.

Procedure

Statistical Analysis

The data were statistically analyzed using analysis of variance (ANOVA). The levels of these metals were then tested using a one-sample t-test to see if they exceeded the World Health Organization's (WHO) recommended maximum acceptable limit. Finally, the F (Fischer) test was employed to determine whether the metal concentration data acquired by AAS from different farmlands differed significantly.

Health Risk Assessment of Tumeric

The estimated daily intake (EDI) of metal, target hazard quotient (THQ), and Hazard Index (HI) were used to analyze the potential health consequences of metal consumption through spices. The EDI value of *Curcuma longa* is determined by element concentrations, daily consumption, and body weight. Equation (1) was used to calculate the EDI values of the metals studied.

$EDI = C_{metal} \times IR / BW$. .... (1)

where EDI is for estimated daily intake, C metal (mg/kg) stands for average weighted heavy metal concentration in spices, IR stands for average daily spice consumption (gram/day individual), and BW stands for average body weight (Kg) (Amer et al., 2019). Spice IR for adults is 10 g/day/person of dry weight, which is consistent with the research. The average adult body weight was 60.0 kg (Meseret et al., 2020). THQ was used to calculate non-carcinogenic risks associated with long-term exposure to pollutants in *Curcuma longa* using Equation (2).

$THQ = EDI / RfD$. .... (2)

RfD stands for reference dose levels (mg/kg/day) for each metal of interest. The RfD for Na, Mg, K, Ca were not specified (NS) and Fe 0.70 mg/kg per day (Hindawi, 2021). The HI was created to evaluate the overall non-carcinogenic risk to human health from multiple pollution exposures. As indicated in Equation (3), HI is the sum of all heavy metal hazard quotients in Tumeric.

$HI = THQ(Na) + THQ(Mg) + THQ(K) + THQ(Ca) + THQ(Fe)$ .... (3)

If the values of THQ/HI > 1 indicates that the population will pose potential adverse health effects, while if THQ/HI < 1, the population is unlikely to experience obvious adverse effect (Ghasemidehkordi et al., 2018; Khan et al.,2009; Mohammadi et al.,2019).

RESULTS AND DISCUSSION

The following are the findings of an analysis performed to quantify metals in Curcuma longa powder accessible in Maro ward, Kajuru LGA, Kaduna state, Nigeria. As a result, four different Curcuma longa farmlands were investigated. The analysis was performed on triplicate batches from each brand. AAS was used to assess the levels of the metals Sodium (Na), Magnesium (Mg), Potassium (K), Calcium (Ca), and Iron (Fe).

Estimation of Macro Metals

The metals (Na, Mg, K, Ca and Fe) contents in batch and location wise were determined by AAS are listed in Table 2 and 3 respectively.

Table 2: Metal Content in *Curcuma longa* by AAS

LOCATION	Batch	Na(mg/l)	Mg(mg/l)	K(mg/l)	Ca(mg/l)	Fe(mg/l)
A	**1**	1.352± 3.1	1.857± 4.2	0.616± 3.1	3.709± 8.8	1.393± 3.1
	2	1.352± 3.1	1.857± 4.2	1.617± 3.1	3.709± 8.8	1.293± 3.1
	3	1.371± 3.1	1.857± 4.2	1.486± 3.1	3.712± 8.8	1.299± 3.1
B	**1**	1.850± 4.3	1.526± 3.6	1.486± 3.4	2.524± 6.8	0.709± 1.6
	2	1.850± 4.3	1.526± 3.6	1.492± 3.4	2.524± 6.8	0.709± 1.6
	3	1.850± 4.3	1.626± 3.6	1.492± 3.4	2.524± 6.8	0.731± 1.6
C	**1**	1.998± 5.6	2.617± 6.2	1.714± 5.3	2.221± 5.2	1.063± 2.8
	2	1.998± 5.6	2.617± 6.2	1.914± 5.3	2.224± 5.2	1.263± 2.8
	3	2.998± 5.6	2.680± 6.2	2.914± 5.3	2.224± 5.2	1.287± 2.8
D	**1**	1.644± 3.8	3.352± 8.4	0.998± 3.3	3.180± 7.7	1.104± 2.7
	2	1.644± 3.8	3.452± 8.4	0.998± 3.3	3.280± 7.7	1.204± 2.7
	3	1.689± 3.8	3.852± 8.4	1.998± 3.3	3.290± 7.7	1.254± 2.7

Results means ± standard deviation of three determinations are calculated at ($p < 0.05$).

Table 3: Average Metal Content in Different *Curcuma longa* Farmland by AAS

LOCATION	Na(mg/l)	Mg(mg/l)	K(mg/l)	Ca(mg/l)	Fe(mg/l)
A	1.358± 3.1	1.857± 4.2	0.950± 3.1	3.710± 8.8	1.328± 3.1
B	2.183± 4.3	1.560± 3.6	1.488± 3.4	2.857± 6.8	0.716± 1.6
C	2.331± 5.6	2.638± 6.2	2.181± 5.3	2.223± 5.2	1.204± 2.8
D	1.659± 3.8	3.552± 8.4	1.331± 3.3	3.250± 7.7	1.187± 2.7

Results average mean ± standard deviation of three determinations is calculated at ($p < 0.05$).

The mean value of Na content in different locations in Curcuma longa ranged between 2.331 and 1.358 mg/l, according to the findings. Brand C had the highest mean level of Na, while sample A had the lowest mean value. According to the Literature, Na levels in spices have been reported in the ranged value (Millikan, 2012). In the case of Mg the highest mean concentration value was also found in sample D and the lowest mean concentration in sample B. The Mg levels ranged between 3.552-1.560 mg/l. Obtained levels of Mg in the relevant *Curcuma longa* samples were found to be within the acceptable limits which are also supported by the literature (Millikan, 2012).

Magnesium is a co-factor in enzymes that are involved in biochemical activities in the body, such as protein synthesis, muscle and nerve function, and blood glucose management (FAO/WHO, 1998). Curcuma longa has a K content ranging from 0.950 to 2.181 mg/l. Sample C had the greatest mean level, whereas sample A had the lowest for K. Sample A, on the other hand, has the lowest K level of the four samples at 0.950 mg/l. A comparable study conducted justifies the K content range in spices (Millikan, 2012). In the case of Ca, the situation is completely different, as the maximum concentration level was found in Curcuma longa rhizome, which ranged from 3.710 to 2.223 mg/l.

Sample A had the greatest average concentration, while sample C had the lowest. The body obtains calcium from bone tissues. To preserve their form and function, bones and teeth store the remaining 99 percent of the body's Ca. The Fe concentration of *Curcuma longa* samples ranged from 0.716 to 1.328 mg/l, according to the findings. Sample A had the greatest mean concentration and sample B had the lowest mean concentration. The World Health Organization recommends a somewhat high maximum acceptable level for Fe in spices (WHO).

Table 2: Summary of ANOVA

Source	SS	Df	Ms	F (Fisher)
Properties	9.04	4	2 .26	2.26/0.35=6.48
Error	5.19	15	0.35	
Total	14.23	19		

Table (t) value= 2.90

The metal content in *Curcuma longa* was compared using analysis of variance (ANOVA) at 95 % confidence level (P>0.05) in Table 4. Using F(Fisher), the value of F calculated (6.48) is greater than F- Table value (2.90), hence there is a significant difference in metal content in various farmland in Maro ward.

Health Risk Assessment

Table 5: EDI, and THQ Values of Metals in Different Locations in Maro Farmlands

Location	Na		Mg		K		Ca		Fe	
	EDI	THQ	EDI	THQ	EDI	THQ	EDI	THQ	EDI	THQ
A	0.2263	NS	0.3095	NS	0.1583	NS	0.6183	NS	0.2213	0.3161
B	0.3638	NS	0.2600	NS	0.2480	NS	0.4762	NS	0.1193	0.1704
C	0.3885	NS	0.4397	NS	0.3635	NS	0.3705	NS	0.2007	0.2867
D	0.2765	NS	0.5920	NS	0.2218	NS	0.5417	NS	0.1978	0.2826

N.S meaning Not specified.

HI=THQ (Na) + THQ (Mg) + THQ (K) + THQ (Ca) + THQ (Fe)

HI=N.S + N.S + N.S + N.S + N.S + 1.056

HI= 1.056

Na, Mg, K, Ca, and Fe have EDI values of 0.2263-0.3885, 0.2600-0.5920, 0.1583-0.3635, 0.3705-0.6183, and 0.1193-0.2213, respectively, based on table 5. The THQ values could not be calculated because the Rfd for Na, Mg, K, and Ca were not supplied. Except for Fe, where THQ values ranged from 0.1704 to 0.3161, all THQ values were less than one, showing that Curcuma longa consumption in such farming regions does not constitute a significant health concern. The HI values of all metals were 1.056, as can be shown. When the HI value is greater than 10, it is thought to have a substantial chronic health impact. As a result, the THQ and HI values revealed that the exposed population was safe.

CONCLUSION

Based on the findings, it can be stated that metals such as Na, Mg, K, Ca, and Fe are present in Maro ward in Kajuru LGA Curcuma longa. According to the statistical study, none of the metals exceeded the WHO's maximum acceptable limit. It was clear that the amount of metal in Curcuma longa fluctuates. The Ca content of the Curcuma longa samples was found to be higher, with values ranging from 2.223 to 3.710 mg/l, with site A (Maro) having the highest Ca concentration of 3.710 mg/l. This could be due to the presence of bones from deceased animals in the area. Mg is the second most abundant metal in *Curcuma longa*, with concentrations ranging from 1.560-3.552 mg/l, with the greatest concentration of 3.552 mg/l in location D (Angwan Gamu). The highest concentration of Na is found at site C (karamai), whereas the highest concentration of K is found at place C (karamai). With 1.328 mg/l of Fe, Location A (Maro) has the highest concentration. According to the statistical analysis, there was variance in the contents of metal levels among the different locations of each sample, but there was a substantial difference between particular farmlands. Ca>Mg>Na>K>Fe. As a result, the findings of the study indicate that those who consume Maro Curcuma longa pose no health risk. Future research should focus on determining the health risks of micro and toxic components in Curcuma longa in Kajuru LGA, Kaduna state.

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