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Nutritional and Elemental Characterization of Local Forest Spices used among Itsekiri Ethnics, Nigeria

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Abstract: Although spices are added to food in small quantities for their flavour and aroma, they also have impact on the health of consumers. This study aimed at ascertaining the nutritional and elemental composition of the most preferred forest spices used amongst Itsekiri ethnics in Delta state, Nigeria. The most preferred spices were determined through questionnaire administration to 143 users and sellers. Crude protein, fat, fibre, ash and moisture content were analyzed using the standard methods of the Association of Official Analytical Chemists (AOAC). Elemental analysis was done using PIXE accelerator to detect the heavy metals (Mg, Al, Si, Cr, Fe, Zn, Mn & Cu) in the five most preferred local spices. One way ANOVA was used to separate the means of the elements while mean comparison was done with LSD. The five most preferred spices include *Monodora myristica*, *Xylopiaa ethiopica*, *Parinari excelsa*, *Aframomum subsericeum* and Ighereje (Itsekiri local name). *Xylopiaa ethiopica* had the highest Crude protein (16.83%) while *Parinari excelsa* had the lowest percentage crude protein (11.67%). *Monodora myristica* had highest moisture content (10.8%) while *Xylopia aethiopica* had the lowest (6.52%). Elemental analysis revealed magnesium as the highest in concentration for Ighereje (3079.03ppm). Silicon and manganese were found to be higher in *Aframomum subsericeum* with 1488.2ppm and 148.9ppm respectively. Overall, the spices were found to contain significant nutrients required for good health. However, the concentrations of some elements in the spices per 1 kg samples were higher than the WHO/FAO maximum permissible daily limit which could make the spices not safe for daily consumption. But very little quantity are needed as flavourant (usually below 50g/family NOT individual), therefore consumption of the forest spices may be deemed safe for consumption.

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INTRODUCTION

Nutrients are substances in food that provide nourishment and are vital to the proper functioning of the body; they include carbohydrate, protein, vitamin, fats and minerals. However, as important as they are, some minerals are only needed in small quantities, which should not exceed established limits above which there can be increase in the risk of certain diseases or related health issues in the body (Wada, 2004; Willis *et al.*, 1996). Both the deficiency and excess of these minerals may cause adverse effects in the body (Ulla *et al*., 2012). Nutritional analysis of food encompasses evaluation of moisture, ash, crude fat, crude protein and fibre contents (Nano, 2019). Factors such as climate, ground water and industrial effluents pollution can affect composition of elements in plants and subsequently influence the nutritional quality of plants negatively (Varallyai *et al*., 2015).

Spices are vegetable products which may be derived from bark, buds, flowers, fruits and seeds; commonly employed in food for their flavouring, colour imparting and aroma giving properties (Ameh *et al.*, 2016; Olife *et al.*, 2013). They are also utilized as preservatives in foods, beverages and rich in minerals (Green *et al*., 2012). They are employed, usually ground and added to food, though in small quantities, but with a large impact on it (Spruce, 2018). Wide range of spices is utilized across various ethnic groups in Nigeria for aromatic and therapeutic values. Some of the commonly used local spices in southern Nigeria include *Piper guineensis, Monodora myristica*, *Xylopia aethiopica and Aframomum melegueta.*

The people of Itsekiri stock are a distinctive and special riverine tribal group. They are naturally fishermen and skillful traders dwelling in the Niger Delta region of Nigeria. The conventional native land presently comprises three local government areas (LGA) in Delta state: Warri south, Warri north and Warri south-west. The 2006 population census for the three LGAs were Warri south (311,970), Warri north (136,149) and Warri south-west (116,538) totalling 564,657 (FGN, 2009).

The flora of Delta state ranges from the mangrove swamp to the evergreen forests and the savannah by the coast, in the middle and the northeast regions, respectively. The Itsekiri folk occupy more coastal areas than upland areas, which makes fishing to dominate their local economy. Common tree species in the area include *Rhizophora racemosa Avicennia spp*. *Tetrapluera tetraptera, Elaeis guineensis, Cocos nucifera, Khaya grandifolia*, and *Monodora myristica*. Some of these species serve as spices that used in meal preparation locally. Examples include the fruits of *T. tetraptera* and *M. myristica* seeds. The use of spices in meals cannot be over-emphasized as it is as common as food itself and therefore its safety cannot be over stretched, therefore creating the need for evaluation of the nutritional content and safety through elemental analysis of the local spices used among the Itsekiri ethnics in Nigeria.

MATERIALS AND METHODS

Study area

Two out of the three local government areas occupied by the Itsekiri ethnics were selected for the study. The study area consists of eight communities in two local government areas of Delta state dominated by Itsekiri namely; Warri south and Warri north LGAs (Figure 1). The two LGAs; Warri south and Warri North (about 67% of Itsekiri population) were purposively selected for sample collection. Four communities in each local government area were randomly selected further for questionnaire administration to identify frequently used local spices.

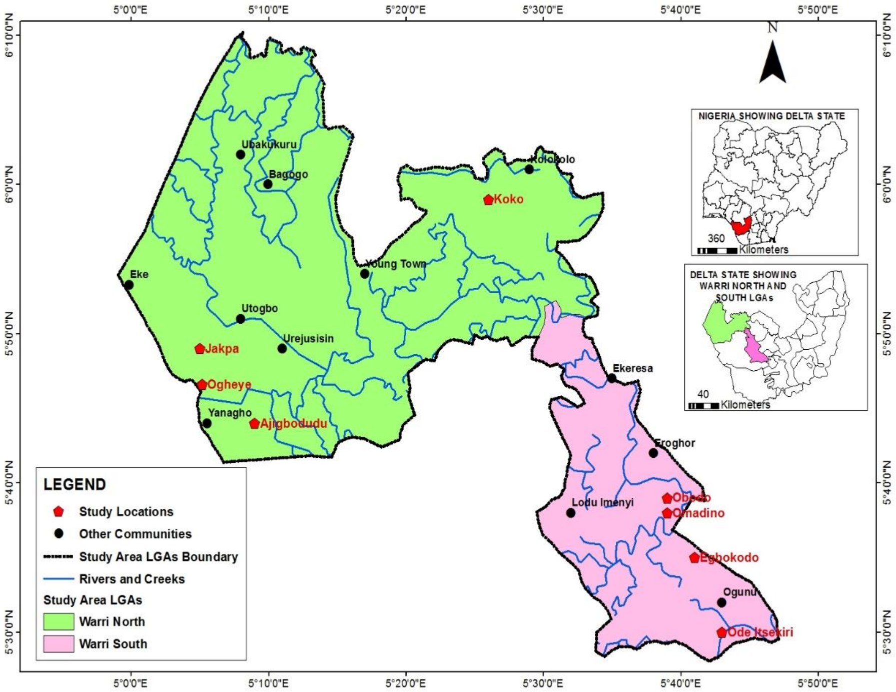

Fig 1: Map of the study communities in the selected LGAs

Data collection

Semi-structured questionnaire was used to obtain the required information about the locally grown and consumed spices in the Itsekiri localities. One hundred and forty-three (143) questionnaires were administered among local spices sellers and consumers in the eight communities. The questionnaires administered were distributed in the communities as follows: Warri south: Obodo (20), Omadino (20), Egbokodo (20), and Ode-Itsekiri (13). Warri north: Ajigbodudu (20), Koko (20), Ogheye (15), and Jakpa (15).

Samples of the spices grown in the communities were collected and they were ranked according to their use value. The five most frequently consumed spices in the communities were selected and analyzed in the laboratory for nutritional and elemental composition.

Data analysis

Frequency index

Frequency index (FI) which is an expression of the percentage of frequency of mentioning for single botanical species by informants (Hoffman and Gallaher, 2007) was used to determine the most widely used spices and it is expressed mathematically as FI = number of informants who cited the species / total number of informants x 100. Upon collection of the spice samples, Laboratory analyses were carried out to determine the nutritional and elemental composition of the preferred spices.

Proximate analysis

Collected samples were washed, dried at room condition, preserved in colourless zip-lock polythene bags and conveyed to the laboratories for analysis. Nutritional evaluation was carried out at the Institute of Agriculture Research and Training (IART), Ibadan, Oyo State. The fruits were analyzed according to the Official methods of analysis described by the Association of Official Analytical Chemist (A.O.A.C., 18th EDITION, 2005). All analyses were carried out in triplicates. Ash contents, moisture contents, and crude protein were evaluated using the method of Macrokjeldahl while determination of crude fats and crude fibers was carried out by employing standard methods following AOAC.

Characterization of Heavy metals

Elemental analysis was carried out at the Centre for Energy Research and Development (CERD), Obafemi Awolowo University (OAU), Ile-Ife, Osun state, Nigeria. The Particle Induced X-Ray Emission (PIXE) analysis were carried out using NEC 5SDH 1.7MV Pelletron Accelerator, equipped with a radiofrequency charge exchange ion source, which is equipped to provide proton and helium ions. Using 2.5 MeV proton beam obtained from CERD ion beam analysis (IBA) facility. The end-station of NEC 5SDH 1.7MV Pelletron Accelerator consists of an Aluminum chamber of about 150cm diameter and 180cm height. This has four ports and a window. Port 1 at 165° is for the RBS detector, Port 2 at 135° is for PiXE detector, port 3 at 30° is for the ERDA detector, the window at 0° is for PIGE. The chamber has a sample ladder that can carry 11(eleven) 13mm diameter sample. Port 2 at 135° which is for PiXE detector was used in analysis of heavy metal composition of the samples. The end station has a turbo pump and a variable beam collimator to regulate beam size, and an isolation value. Apple leaves were used as the certified standard for the quantitative analyses of the fruits. It was used for the determination of the H-value of the samples. The measurements were carried out with a beam spot of 4mm in diameter and a low beam current of 3-6nA. The irradiation was for about 10-20 minutes. A Canberra Si(Li) detector Model ESLX 30-150, Berryllium thickness of 25µm, with full width half maximum (FWHM) of 150eV at 5.9keV, with the associated pulse processing electronics and a Canberra Genie 2000 (3.1) MCA card interfaces to a PC were used for the X-rays data acquisition. With respect to the beam director, the sample's normal was located at 0° and the Si (Li) detector at 45°. The PIXE set-up was calibrated using some pure element standards and NIST geological standard, NBS278.

The computer code GUPIXWIN (Maha and Ahmed, 2015) was used for the analysis of the PIXE data. This provide a non-linear least square fitting of the spectrum, together with subsequent conversion of the fitted X-ray peak intensifies into elemental concentrations, utilizing fundamental parameter methods for quantitative analysis.

Each powdered sample (0.25g) was transferred into a 50 ml flask to which 6.5 ml of a mixture of HNO3, H_2SO_4 and $HClO_4$) (5:1:0.5) was added and thereafter boiled. Afew drops of distilled water was added and allowed to cool. The digested samples were separately transferred into a 50 ml volumetric flasks and the volume was made up to 50 ml with distilled water. This was filtered and the filtrate was analyzed for the elements of interest with Atomic Absorption Spectroscopy (AAS).

Table 1: Common local spices used by the Itsekiri ethnicity

Local spices	English Name	Scientific name	Family name	Parts used
Iwo	African nutmeg	*Monodora myristica* (Gaertn.) Dunal	Annonaceae	Seeds
Umeni/Banga stick	Liquorice stick	*Glycyrrhiza glabra* L.	Leguminosae	Stem
Gbafilo	Rough skin plum	*Parinari excelsa* Sabine	Chrysobalanaceae	Seed
Egidije/Uda	Grain of selim	*Xylopia aethiopica* (Dunal) A. Rich	Annonaceae	Fruit
Beletetie	-	*Heinsia crinita* (Afzel.) G. Taylor	Rubiaceae	Leaves
Ataiko	-	*Aframomum subsericeum* (Olive. & D. Hanb.) K. Schum	Zingiberaceae	Seeds
Ighereje	-	-	-	Seeds
Iyanyan	-	*Tetrapleura tetraptera* (Schum. &Thonn.) Taub.	Leguminosae	Pod
Effirin	Scent leaf	*Ocimum gratissimum* L.	Lamiaceae	Leaves
Jejeleme	Lemmon grass	*Cymbopogon citratus* (DC.) Stapf	Poaceae	Leaves
Iweti	Tea leaf	*Camellia sinensis* (L.) Kuntze	Theaceae	Leaves
Orugbogbigbe	Dry bitter leaf	*Vernonia amygdalina* Delile	Compositae	Leaves

Table 2: Consumers preference of local spices among Itsekiri ethnics

Spice	Warri South				Warri North					
	Obodo	Omadino	Egbokodo	Ode-Itsekiri	Ajigbodudu	Koko	Ogheye	Jakpa	Total	FI
M. myristica	4	9	9	10	9	6	7	5	59 (1st)	41.3
X. aethiopica	3	4	8	6	3	10	5	5	44 (2nd)	30.8
A. subsericeum	10	5	4	9	-	2	8	2	40 (3rd)	28.0
P. excelsa	-	2	2	2	7	5	4	2	24 (4th)	16.8
**Ighereje*	6	3	4	-	2	4	1	1	21(5th)	14.7
H. crinata	7	2	3	2	-	-	2	1	18	12.6
T. tetraptera	-	-	2	1	5	5	-	2	15	10.5
C. icaco	-	1	3	-	-	-	2	5	11	7.7
G. glabra	-	-	-	1	1	1	-	3	7	4.9
O.gratissimum	-	1	2	-	-	-	-	-	3	2.1
C. sinensis	-	-	-	-	1	-	-	-	1	0.7

FI = Frequency index, *: botanical name of spice could not be identified

RESULTS

Identification of local spices

Twelve (12) local forest spices were cited to be commonly used by the Itsekiri ethnicity in Nigeria (Table 1).

Consumers' preference in the use of local spices

Table 2 shows the preference of consumers in the use of the local spices which affects the popularity of the spices among the various communities of study.

In each community, the consumers were asked to state three most preferred spice they use and the values above represent the number of consumers in which each spice ranked either first, second or third in his/her preference list in the various communities. Some spices even though used, did not score first, second or third place based on the consumers' choice. The people's top five choices are highlighted in Table 2 and were selected for proximate and elemental analysis.

Choice of Spices

Five spices most preferred are *Monodora myristica* (FI = 41.3%), *Xylopia aethiopica* (FI =30.8%), *Aframomum subsericeum* (FI =28.0%), *Parinari excelsa* (FI =16.8%) and Ighereje (FI =14. 7%) (Table 2). A possible reason for this could be the fact that these spices constitute the major ingredients for the preparation of native Itsekiri meals like Banga soup, Epuru (yam and plantain pepper soup) and also Ogolo-ekpo which they prepare quite often.

Nutritional content of preferred spices used by the Itsekiri ethnic group

The nutritional analysis of *M. myristica, X. aethiopica, P. excelsa, A. subsericeum* and Ighereje, shows that the spices contain significant amount of nutrients per gram of ground spices. *X. aethiopica* had the highest amount of crude protein (16.83%) and *P. excelsa* had lowest percentage of protein (11.67%), *P. excelsa* also ranked lowest in crude fat with 3.12% while *X. aethiopica* maintained the highest rank with 7.23%. *X. aethiopica* and *P. excelsa* were highest in crude fibre and ash content with 14.76% and 7.23% respectively, while lowest fibre and ash were found in *A. subsericeum* (7.15%) and Ighereje (4.15%) as shown in Table 3.

Concentration (ppm) of heavy metals in five (5) most preferred spices among Itsekiri ethnics

Mean concentrations of various elements in the five preferred spices elucidated in Table 4 showed that *Ighereje* had the highest concentration of Magnesium (3079.03ppm) while *P. excelsa* had the lowest (1193.8ppm). *A. subsericeum* contained highest Silicon (1488.2ppm), Manganese (148.9ppm) and Copper (15.2ppm). *M. myristica* was lowest in Silicon (85.67ppm), Manganese (11.07ppm) and Copper (6.67ppm). *Ighereje* had highest Aluminum concentration of (111.23ppm) whereas *M. myristica* had the lowest (59.10ppm). Chromium ranged from 8.37ppm in *P. excelsa* to 61.63ppm in *Ighereje*. *Ighereje* also had the highest mean concentration of iron (284.13ppm). *P. excelsa* had lowest concentration of Iron (72.53ppm) but had the highest concentration of Zinc (44.83ppm). *X. aethiopica* had the lowest concentration of Zinc (8.07ppm). There was no significant difference between the mean values of Aluminum, Zinc and Copper in all the spice samples investigated.

Table 3: Nutritional content (%) of preferred spices by Itsekiri ethnics

Nutrients (%)	Plant Species (Mean ± SD) n = 3					
	M. myristica	*X. aethiopica*	*P. excels*	*A. subsericeum*	Ighereje	
Crude protein	$11.83{\pm}0.06^d$	$16.83{\pm}0.05^a$	$11.67{\pm}0.10^e$	$13.92{\pm}0.04^b$	$12.18{\pm}0.10^c$	0.135
Crude fat	$3.49{\pm}0.03^d$	$7.23{\pm}0.02^a$	$3.12{\pm}0.02^e$	$5.17{\pm}0.02^b$	$3.88{\pm}0.01^c$	0.031
Crude fibre	$7.85{\pm}0.03^c$	$14.76{\pm}0.03^a$	$13.13{\pm}0.03^b$	$7.51{\pm}0.03^d$	$5.00{\pm}0.03^e$	0.052
Ash	$4.250.02^d$	$5.77{\pm}0.02^b$	$7.23{\pm}0.02^a$	$4.31{\pm}0.02^c$	$4.15{\pm}0.04^e$	0.043
Moisture	$10.82{\pm}0.05^a$	$6.52{\pm}0.05^e$	$8.13{\pm}0.02^c$	$7.03{\pm}0.06^d$	$8.22{\pm}0.04^b$	0.080

Mean with different alphabet are significantly different at p<0.05

Table 4: Concentrations (ppm) of heavy metals in five most preferred spices consumed among Itsekiri ethnics

Nutrients (%)	Plant Species (Mean ± SD)					LSD
	M. myristica	*X. aethiopica*	*P. excelsa*	*A. subsericeum*	Ighereje	
Mg	$2178.87{\pm}175.24^b$	$1972.03{\pm}520.26^{bc}$	$1193.80{\pm}317.70^c$	$1675.57{\pm}113.32^{bc}$	$3079.03{\pm}722.85^a$	787.78
Al	59.10±6.24	89.50±52.35	89.97±57.27	69.67±9.88	111.23±86.62	NS
Si	$85.67{\pm}4.04^b$	$241.63{\pm}94.18^b$	$214.73{\pm}74.65^b$	$1488.20{\pm}533.75^a$	$604.03{\pm}707.55^b$	727.65
Cr	$35.83{\pm}2.68^b$	$20.90{\pm}5.57^{bc}$	$8.37{\pm}4.37^c$	$19.80{\pm}2.61^{bc}$	$61.63{\pm}25.27^a$	21.56
Fe	$152.50{\pm}17.12^b$	$116.40{\pm}50.07^{bc}$	$72.53{\pm}31.73^c$	$87.83{\pm}15.73^c$	$284.13{\pm}33.01^a$	58.35
Zn	21.40±18.72	8.07±0.96	44.83±51.52	15.50±3.82	26.97±6.24	NS
Mn	$11.07{\pm}2.55^b$	$136.13{\pm}67.70^a$	$18.83{\pm}5.43^b$	$148.90{\pm}16.96^a$	$40.13{\pm}2.16^b$	57.02
Cu	6.67±0.72	9.70±7.20	8.57±1.88	15.20±0.57	14.93±8.81	NS

Mean with different alphabet are significantly different at p<0.05, NS = No significant difference at α = 0.05

DISCUSSION

The results from the nutritional analysis of the spices preferred by the Itsekiri people (*M. myristica, X. aethiopica, P. excelsa, A. subsericeum* and *Ighereje*) show that they contain significant amounts of nutrients. Cultures around the world rely on herbs and spices to add flavour and zest to food. The ability to add flavor, aroma as well as nutrients to food is of great advantage.

Protein has been proved to be an essential ingredient for the survival of human beings, it is required for growth and development of tissues (Petrusan *et al*., 2016), *X. aethiopica* had the capacity to supply crude protein, fibre and fat in human diet, it ranked second in utilization locally among the Itsekiri ethnics. In addition to nutrient values, enticing aroma produced by *X. aethiopica* make it a ready candidate local spice during fish pepper soup preparation in homes and relaxation bars across West African sub region. Utilization of *M. myristica, X. aethiopica, T. tetraptera and P. excelsa* as common local spices for soup and comminuted meats (such as suya meat) have been recorded in Cameroun, Nigeria, , Ghana and other west tropical Africa (Djiazet *et al*. 2019; Egharevba and Gamaniel, 2017; Darkwa, 2013; Nduku and Ben-Nwadibia, 2005)

The values obtained for the fibres are desirable because adequate intake of dietary fibre can lower serum cholesterol level, risk of coronary heart disease and breast cancer (Theuwissen and Mensink, 2008). The moisture content range of the spices was relatively low; from *X. aethiopica* (6.52%) to *M. myristica* (10.8%). Lower moisture content hinders the growth of microorganisms and increases shelf life. The level of the crude fat which was relatively low would prevent fat related disease such as obesity (Theuwissen and Mensink, 2008).

The crude protein in *X. aethiopica* is about sixteen times higher than the one reported in Abia state of Nigeria (Omeh *et al.,* 2014). Other reports of those found in the South East of Nigeria showed 12.09 and 9.27% (Nwocha *et al*., 2018; Okonkwo and Ogu, 2014). However, the crude protein in *P. excelsa* is higher than the one reported for the plants collected in Benin, Nigeria (3.9%) (Enabulele and Ehiagbonare, 2011). However, high crude fibre in *X. aethiopica* is similar to that of Abia State (14.51%) (Omeh *et al.,* 2014).

Elemental analysis of the spices shows that they contain some important mineral elements. All the analyzed spices (per kg) were grossly above the recommended daily intake. Magnesium levels were high for all the spices analyzed (1193.8– 3079.03 ppm), the recommended daily intake is 220 mg/kg (FAO/WHO, 2004) which shows that magnesium content in all the spices was above permissible limits. Higher doses of magnesium in the body can lead to flushed skin, nausea or vomiting, general muscle weakness and respiratory compromise (Del Gobbo *et al*., 2013; Kass *et al*., 2012; Peacock *et al*., 2010).

Zinc concentration in the spices ranged from 8.07 ppm in *M. myristica* to 44.83 ppm in *P. excelsa*. This shows that the Zn level is within the permissible level. Recommended daily intake (RDI) of 50mg (WHO, 2005 and 2006) shows that the spices falls within the RDI; hence, the spices may be considered to be safe for consumption. Excessive Zinc intake can cause anemia and copper deficiency. Zinc is one of the vital elements which facilitate homeostatic control in the cell in order to prevent its accumulation in excess in the body. On the other hand, an excess of Zn leads to deficiency of copper as well as apoptosis of the cell which is implicated in suppressed immune response (Plum *et al*., 2010; Krupanidhi *et al*., 2008).

Iron is a vital component of haemoglobin which is found in may enzymes in man. It is found available in high amounts in red blood corpuscles and muscle tissue. In excess, it can result in hepatotoxicity and eventually acute liver failure, Iron deficiency as well as anaemia (Daram and Hayashi, 2005). Iron concentration in the spices was from 72.3 ppm in *P.excelsa* to 284.13ppm in Ighereje which exceeds RDI of 15mg/day (WHO, 2007a and 2007b). A limit of 91 and 28 mg/day was also set for male and female, respectively (FAO/WHO, 2004) which makes *P.excelsa* and *A. subsericeum* to be safe for male only.

Aluminum ranged from 59.1ppm in to 111.23ppm which far exceeds the tolerable weekly intake of 1mg/kg (Aguilar et al., 2008) and the provisional tolerable weekly intake of 2 mg/kg for an adult (FAO/WHO, 2011). Toxic levels of Al may result to abnormalities of the bone as well as negatively affecting hematopoiesis but these effects are relatively mild unless there is iron deficiency (Krewski *et al*., 2007).

Copper is an essential element necessary for the body, it aids in bone formation, ion metabolism and nervous system function, its mean concentration ranged from 6.67ppm in *M. myristica* to 15.2ppm in *A. subsericeum*. The level of Cu in *X. aethiopica, M. myristica*a and *P. excelsa* was below the recommended upper limit of 10 mg/day (FAO/WHO, 2004). Copper is present in several human transcription factors and enzymes but if taken in excess can lead to liver damage and Wilson's disease. Low level of intake is associated with aneurysms, blood vessel damage, hernias, and nosebleeds among several others (Araya *et al*., 2006).

Excess Manganese in the body may hinder Iron adsorption in the body but at lower levels, it helps in wound healing, carbohydrate and cholesterol metabolism (NIH, 2021). The highest concentration of Manganese was 148.9ppm in *A. subsericeum* and the lowest was 11.07ppm in *X. aethiopica*. Only *X. aethiopica* falls within the recommended daily intake of 11 mg (FAO/WHO, 2004).

Manganese is a vital constituent of metalloenzymes that oxidize cholesterol and fatty acids (Rehnberg *et al*., 1982). In deficient amount, it can result to bleeding disorders, while an excess of it mayresult in speech disorders, leg cramps, and encephalitis (Agostoni et al., 2013).

Generally, these spices are consumed in little quantities, it will therefore be difficult to consume up to 1 kg per day which makes the spices likely safe for consumption,

CONCLUSION

The common spices consumed by Itsekiri people of Delta State, Nigeria showed appreciable amounts of nutrients. The concentrations of most elements per kg in the various spices were higher than the WHO/FAO maximum permissible daily limit. Spices are usually consumed in lower quantities such as 20 – 50 mg per family daily. However, since these spices are consumed in small quantities, it will be difficult to consume up to 1kg per day and therefore makes the spices safe for consumption.

Conflict of Interest:

The authors declare that there is no conflict of interest.

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