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Physicochemical properties and some heavy metal content in some spices and seasonings sold in a market near Obajana Cement Company Kogi State, Nigeria

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Abstract

Seasonings and spices are used daily and frequently to enhance the taste of meals. Their use may be of concern because they may be contaminated by heavy metals during cultivation, processing and handling. There is therefore the need to ascertain the safety of the spices/seasonings added as additives to meals as often as possible. A total of 10 samples, each a composite were randomly sampled from the sellers at Obajana central market in Kogi State. The levels of iron (Fe), zinc (Zn), copper (Cu), lead (Pb) and nickel (Ni) in the samples were processed and determined using atomic absorption spectrometry. The physicochemical properties were determined using the pH meter, oven and muffle furnace. Findings revealed that the spices and seasonings were slightly acidic except potash with average pH of 10.5±3.5. The result of the analysis showed that the average values of Cd of 0.50 mg/kg, 0.35 mg/kg and 0.33 mg/kg in ginger, potash and pepper respectively exceeded regulatory standard limits. All other metals concentration of spices and seasonings are within the regulatory standard. Therefore, the seasonings/spices when consumed will pose no threat to human health. This also shows that the cement factory located at Obajana do not have negative impact on food items at the market at least for now.

Keywords: Spices, Seasonings, Physicochemical, Cement company, Obajana market.

Introduction

Spices are dried parts of plants, which are mainly added as ingredients to food. There role is mainly to add flavour, colour or as a preservative in food. They impart aroma that results from complex mixtures of volatile compounds, e.g. monoterpenes and sesquiterpenes and their oxygenated derivatives, which usually occur in low concentrations[1-3].

Their major active ingredients include salts and monosodium glutamate[4]. Their role is mainly for seasoning and not for nutrition purpose as they contain aromatic vegetable substances[5]. They are made of rhizomes, barks and other componets of the plants[6]. These plants can be contaminated with heavy metals easily through environmental pollution[7]. Contamination could result from the soil from which they are cultivation, source of irrigation water used, where the spices are processed and stored.

There have been reports indicating wide variations in the concentrations of trace metals in seasoning cubes, mixed spices, natural plant spices and nuts[6-8]. There has been report that food spices are widely used especially on outdoor foods mainly for edibility enhancement[9]. Colorants which are added to some of these flavour enhancers may contain contaminants in form of some trace metals. In the United States, two families were reported to have been poisoned by consuming lead-contaminated spices used in a family's food preparation[10].

Spices generally improve taste of food. Additionally, spices combat food borne microorganisms and reduce food poisoning, involve in antioxidant function and antimicrobial activity as well[11]. Spices are also known to possess substances of medicinal values[12]. These benefits from spices are as a result of the presence of phytochemicals[5,11].

Seasonings and spices are flavour and taste enhancers that are used sparingly but frequently in our daily meals. Since they are always added to food, their conformity to regulatory standard must always be ascertained from time to time. At Obajana market the traders always display these spices and seasoning for buyers and considering the nearness of the market to the cement factory, could there be additionally impact of contamination resulting from the cement factory. Contaminated of these spices and seasonings may result from the soil or aerial depositions as these spices are often spread and dried on the ground or on roof tops. The exposure to metals is a possibility. This study aim to determine heavy metal level in some spices and seasonings and their physicochemical properties sold at Obajana market, Kogi State Nigeria.

Materials and methods

Study area: The area of study for this research is the central market at Obajana Industrial layout, Obajana, Kogi State. This area is chosen as a result of the proximity of the cement company to the market.

Collection of samples: A total of 10 samples each of maggi (cubes), potash, pepper, ginger, garlic, locust beans, salt, sugar, curry and thyme were collected. Each samples a composite.

Sample analysis: pH Determination: A 0.5g of each samples were carefully weighed out into ten separate beakers using weighing balance, 30ml of distilled water was added to the samples and allowed to dissolve to a relatively good extent of disparity. The pH reading was then taken carefully to avoid complications and ensure error free reading.

Ash Content Determination: A 2.0g of finely grinded dried samples were weighed into a porcelain crucible using an analytical balance after taking the weight of each of the porcelain crucible. The sample was placed on an electric inside the fume cupboard to drive off most of the smoke. The sample was then transferred into a preheated muffle furnace at 600^0C and heated for 2hours. The crucible plus the samples were then transferred into a desiccator to cool. The resultant ash obtained was weighed and the percentage of ash was calculated as follows;

Weight of crucible =Wt_1
Weight of crucible + sample = Wt_2
Weight of Ash + crucible = Wt_3

$$= \frac{Wt_3 - Wt_1}{Wt_2 - Wt_1} \times 100\%$$

$$\text{Therefore Ash\%} = \frac{Weight\ of\ ash}{Weight\ of\ samples} \times 100\%$$

Determination of moisture content: A 2.0g of each sample was weighed into 10 different porcelain crucibles, dried using electric oven at 105^0C to obtain a constant weight and tabulated. The percentage moisture content was determined

$$\text{The percentage moisture content} = \frac{Wt_1 - Wt_2}{Wt_1} \times 100\%$$

Where: Wt_1= fresh weight of the sample, Wt_2 = final weight of oven dried sample,

Elemental Content Analysis: Procedure for Digestion: Metals in dry samples were extracted with a 3:1 mixture of HNO_3 and $HClO_4$. A 0.5g powdered fruit and vegetable sample was weighed into a 100 ml beaker. A10ml acid mixture of HNO_3 and $HClO_4$ was added to the sample in the beaker, and this was allowed to stand for few minutes. The mixture was heated at 70^oC until a transparent solution was obtained[13]. A sample blank digestion was also carried out. The digested plant samples and blank were analyzed for Cd, Cu, Ni, Pb, and Zn using a Buck Scientific (model 200A) flame atomic absorption spectrophotometer.

Instrument Calibration and Sample Reading: The equipment was calibrated with commercial stock standards of the metals to be run. Working standard solutions were prepared by diluting a volume of a stock standard solution of 1000 ppm concentration of each of the metals to required concentrations in standard volumetric flasks. These were used to calibrate the AAS. The absorbance values of blank and working standard solutions were measured using a Buck Scientific (model 200A) flame atomic absorption spectrophotometer. The spectrophotometer of 0.2nm slit width was operated in the air-acetylene flame mode. The lamps for heavy metals (Cd, Cd, Cu, Ni, Pb, Zn) were operated at wavelengths specified by the manufacturer's manual. A blank reading was subtracted from those of analyte samples and the corrected absorbance values obtained.

Quality Assurance: Strict adherence to quality assurance procedures and precautions were followed to ensure that result obtained are reliable. Hence the use of double distilled deionised water throughout. Reagents used were analytical grade and glassware was properly cleaned. Reagents blank determinations were used to correct the instrument readings.

Results and discussion

Physicochemical parameter: The result of the pH, moisture and ash content are shown in Table-1. The spices and seasonings were generally slightly acidic except potash with average pH of 10.5±3.5. Locust beans had the lowest pH value of 5.5±1.4. The pH value of food materials are modified by the presence of spices which can help digestion[14]. The average moisture content ranged from 0.90±0.14 in potash to 3.60±0.23 in locust beans. Although the locust beans had higher moisture content, the range of moisture content observed indicates that their shelf-life will be elongated and deterioration in quality as a result of microbial activity may be limited. The average percent of ash content ranged from 35.2±1.2% in garlic to 81.9±0.9 % in sugar. The ash content is the inorganic minerals left after the burning of food organic content. The ash content is the measure of the mineral content of any given food[15] and high ash content indicates high inorganic mineral content[16].

Mineral Content Analysis: The results of mineral content analysis are shown in Figure-1 to Figure-10.

Lead: The mean level of Pb ranged from 0.01 mg/kg in ginger to 1.08 mg/kg in locust beans. Average concentrations of Pb in spices and seasonings do not vary widely. All observed values are within regulatory permissible limit of 10 mg/kg WHO/FAO and Maximum Permissible Limit (MPL)[17]. Therefore, the Pb levels will be tolerable at the moment and pose no harm. Lead is toxic and accumulated levels of Pb in man have been reported to cause severe anemia, permanent brain damage, neurological disorders, reproductive problems, diminished intelligence and a host of other diseases[18]. Average concentration of 0.44, 0.03 and 0.01 for garlic, curry and pepper respectively in this study are significantly lower than 6.45, 12.9 and 11.7 (mg/kg) for garlic, curry and pepper respectively as reported for spices in FCT Abuja[1]. The range of values obtained in this study is similar to values reported for similar work carried out in markets in Kumasi metropolis of Ghana[18].

Cadmium: Cadmium content of spices and seasonings as shown in Figure-2 ranged from 0.02 mg/kg in curry powder to 0.5 mg/kg in ginger. A concentration of 0.68 mg/kg had been reported for ginger in previous study in Nigeria[1]. The observed levels of metals in this study are within standard regulatory limit of 0.3 mg/kg as given by WHO/FAO except 0.50 mg/kg, 0.35 mg/kg and 0.33 mg/kg in ginger, potash and pepper respectively[19]. Excess Cd ingestion targets certain organs in the body for destruction and such organs include kidneys, lungs, brain, placenta and bones[20].

Table-1: Physicochemical properties.

Species	pH	Moisture	Ash content
Pepper	5.73±0.75	1.54±0.06	41.7±0.99
Maggi cube	6.80±0.25	2.43±0.11	51.2±1.4
Potash	10.5±.35	0.90±0.14	46.7±0.85
Ginger	6.99±0.18	2.22±0.11	54.4±1.8
Curry	6.34±0.17	1.06±0.06	59.5±0.7
Thyme	5.9±1.1	1.09±0.11	40.8±0.8
Garlic	6.54±0.16	2.18±0.06	35.2±1.2
Salt	6.53±0.15	1.77±0.22	66.3±0.6
Sugar	6.520.39	1.72±0.02	81.9±0.9
Local beans	5.5±1.4	3.60±0.23	55.2±1.6

Nickel: The level of nickel in spices and seasonings analysed shows that the level ranged from 0.21 mg/kg in thyme to 1.94 mg/kg in garlic. All observed concentrations are within standard regulatory limit of 50 mg/kg WHO/FAO. Therefore no health risk is anticipated from consumption of spices and seasonings from that area at present. The range of concentration is also significantly different compared with the work of Umar and Zubair which have reported the concentration range of 2.3 mg/kg to 8.2 mg/kg for spices and seasonings from FCT-Abuja, Nigeria[1].

Copper: Results in Figure-4 showed the range of metal concentrations in different species. Copper concentration ranged from below detection limit in potash to 4.26 mg/kg in salt. The observed concentration of Cu in garlic, locust bean and curry are 3.56, 2.84 and 1.47 (mg/kg) respectively. All the investigated samples concentrations are within regulatory WHO/FAO limit (50 mg/kg) for Cu in spices and seasonings. Hence Cu concentrations of the samples do not pose health issues at the moment and are therefore tolerable. Previous work had reported a range of 3 mg/kg to 11 mg/kg for Cu levels in some spices[21]. The observed Cu concentration of 2.84 mg/kg in locust beans is significantly lower than 13.3 mg/kg reported by Onianwa *et al.* and 20.4 mg/kg of previous work[22, 1]. It has been reported that an excess of copper can to block vitamin C leading to oily skin loss of skin tone and the result is a dark pigmentation of skin mostly in the face. Hair loss in women has been attributed to excess of copper[23]. However, deficiency in copper is known to cause hematological manifestations, such as myelodysplasia, anemia, leukopenia (low white blood cell count) and neutropenia.

Iron: The concentration of Fe observed in this study shows that the highest concentration of 26.6 mg/kg was found in thyme and the lowest was 0.01 mg/kg in pepper. Similar concentration of 0.01 mg/kg was found in salt and curry. The order of concentration was thyme > locust beans > garlic > ginger > potash > magi cube > sugar. The levels of Fe in all samples determined are within WHO/FAO regulatory standard limit of 300 mg/kg. The tolerable level of Fe in food is relatively high. The results of this study for ginger (11.8), garlic (21.1), pepper (0.01), locust beans (21.9) and curry (0.01) in mg/kg are significantly lower than from ginger 1265.8), garlic (115.3), pepper (191.2), locust beans (186.8) and curry powder (520.2) in mg/kg as reported[1]. However, the mean values of Fe in this study compare well with mean values of ginger (2.88), garlic (1.38), pepper (4.94), locust beans (1.10) and curry (2.48) in mg/kg reported in Kumasi, Ghana[18]. The low level of Fe spices and seasonings in this study therefore is of no concern to human health.

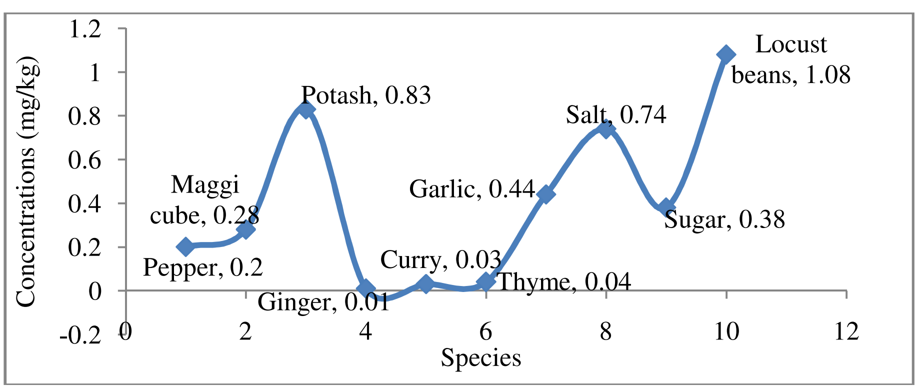

Figure-1: Average level of Pb in spices and seasonings.

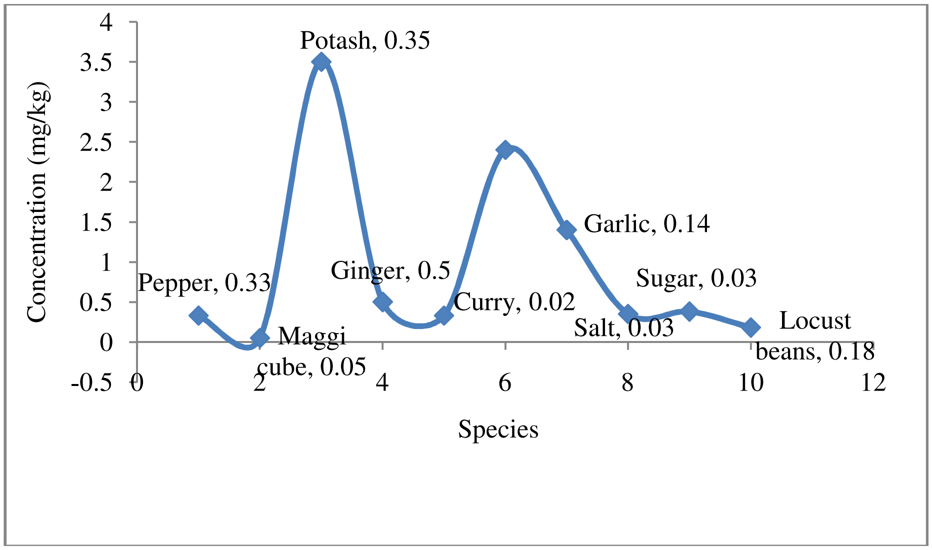

Figure-2: Level of Cd in spices and seasonings.

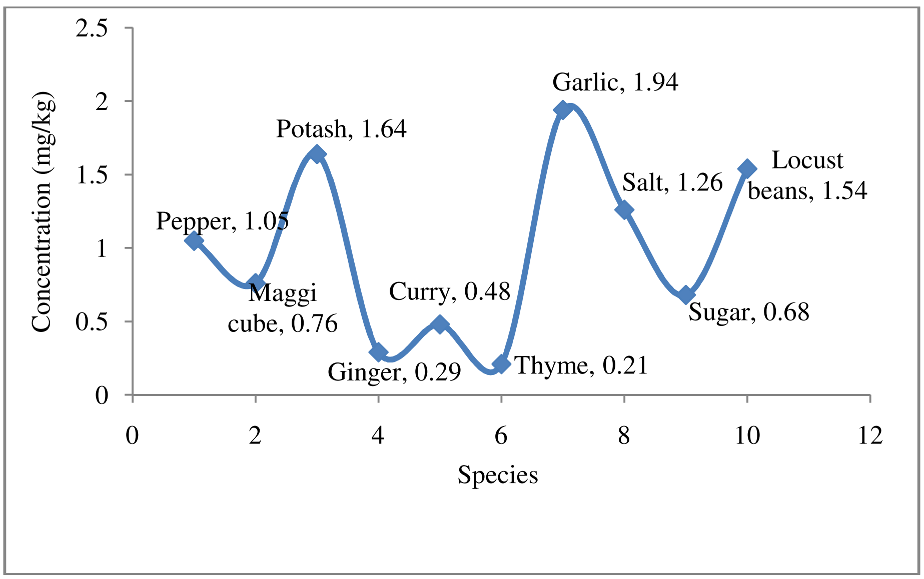

Figure-3: Level of Ni in spices and seasonings.

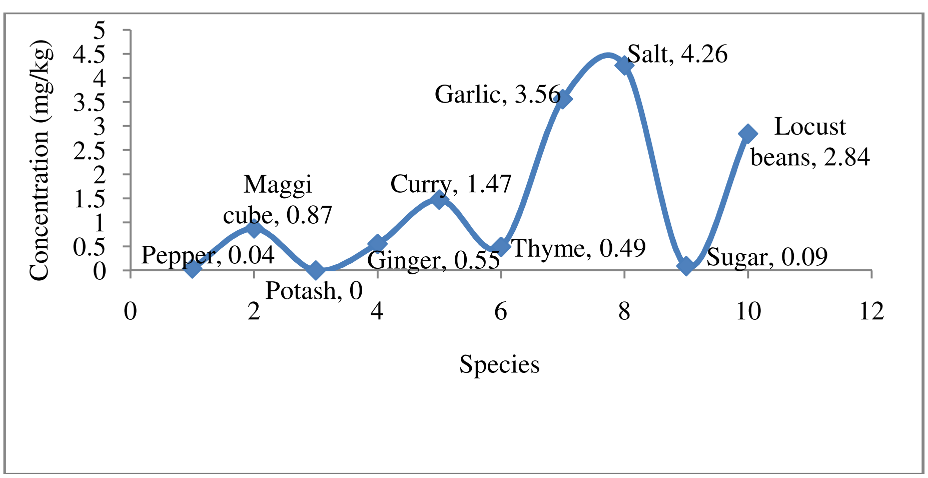

Figure-4: Levels of Cu in spices and seasonings.

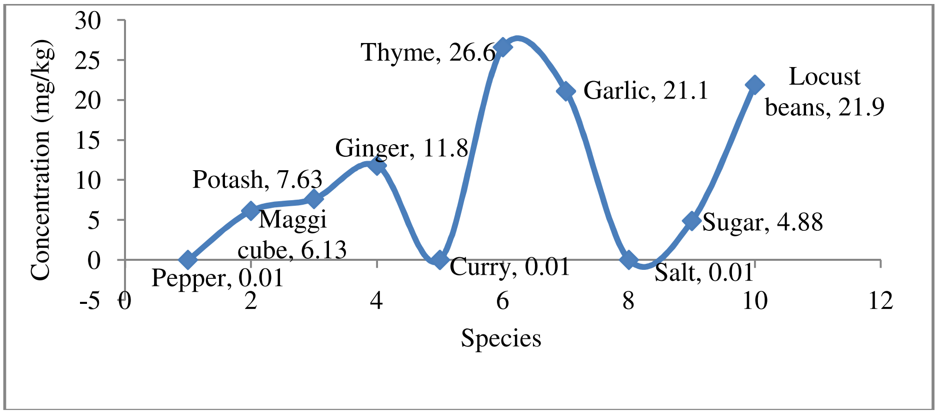

Figure-5: Level of Fe in spices and seasonings.

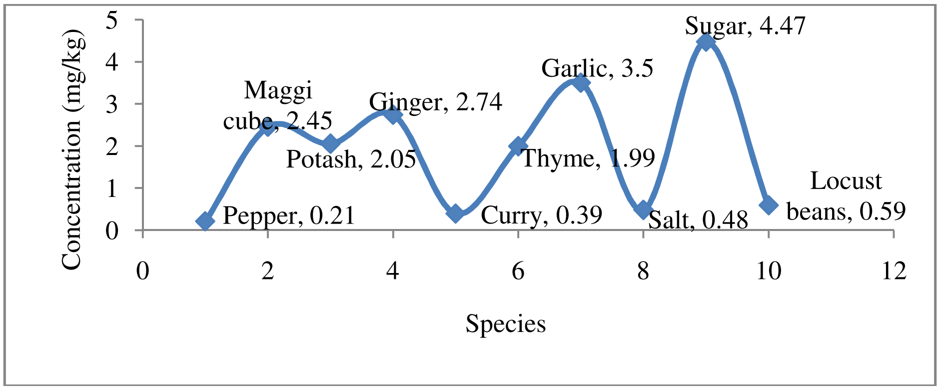

Figure-6: Level of Zn in spices and seasonings.

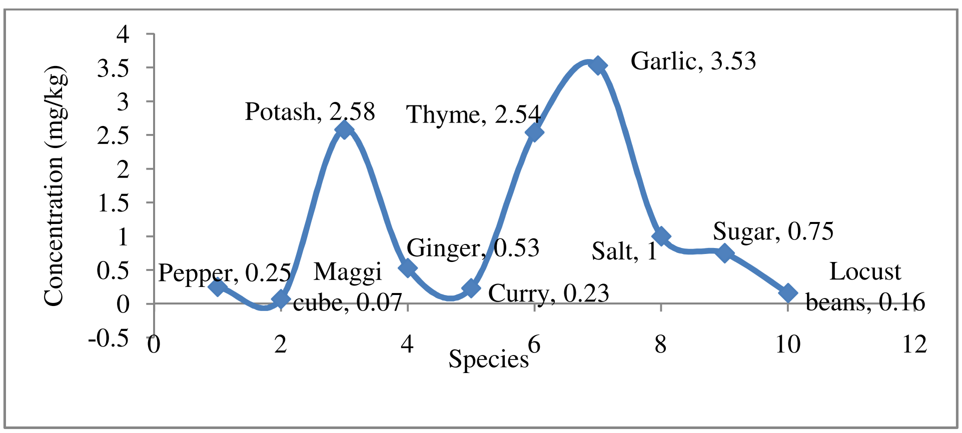

Figure-7: Level of Co in spices and seasonings.

Zinc: The average concentration of zinc in spices and seasonings are shown in Figure-6. The average concentration ranged from 0.21 mg/kg (pepper) to 4.47 mg/kg (sugar). Overall average of 1.9±1.5 mg/kg of spices and seasonings in this study is significantly lower than 22±23 mg/kg reported in previous Nigeria study and 132.98 mg/kg in Egypt[22, 24]. This study results are also lower than those reported for spices in FCT Abuja[1]. The relatively low level of the essential element, Zn, in this study did not corroborate the result of Onianwa *et al*. and therefore did not actually reflects the normal composition expected of plant-derived products[12]. Zinc has been reported to be an essential element that enhance growth and with a recognized action in some enzymes by participating in their structure or their catalytic and regulatory action[18].

Cobalt: The concentration of cobalt in spices and seasoning ranged from 0.07 mg/kg in magi cube to 3.53 mg/kg in garlic. Cobalt do not have much nutritional value save as an integral part of vitamin B_{12}. However, it has not been reported that the intake of cobalt is ever limiting in the human diet, and there is no necessity for RDA[25].

Conclusion

The concentration of metals in spices and seasoning are relatively low and did not exceed the permissible levels. However, the level of Cd in some seasonings and spices did exceed permissible levels and there could be a risk of using such spices. Special attention of continuous monitoring of the concentration of heavy metals in seasonings and spices should be taken seriously because of the growing interest all over the world on the use of seasoning and spices.

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