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Comparative Proximate Analysis of Five Commercially Sold Maggi as Condiments in Gwagwalada, North Central, Nigeria

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ABSTRACT

Determination of the proximate, nutritionally valuable mineral in five samples of food seasonings label as, A, B, C, D, & E food condiments readily consumed in Nigeria were obtained from Gwagwalada Central Market Abuja. Investigating the concentrations of some mineral elements such as, iron (Fe), zinc (Zn), and two heavy metals, cadmium (Cd) and lead (Pb) were carried out using AA320N Atomic Absorption Spectrophotometer (AAS) after acid digestion with 2:1 HNO₃/HClO₄. The result shows that all samples contained high levels of protein (13.63% ±0.53%) with mean value moisture, ash, fat, fiber, and carbohydrate for all samples levels being (3.94%±0.64%), (57.51% ±4.27%), (5.11% ±0.20%), (0.02% ±0.00%) and (18.41% ±0.41%) respectively. Sample D has high Fe concentration with (0.04 ±0.01 µg/g) and Sample B & C has low Fe concentration with (0.01 ±0.00 µg/g). Sample D & E has high Zn concentration with (0.03 ±0.01 µg/g) and sample A, B & C has low Zn concentration with (0.02 ±0.01 µg/g). In cadmium, sample A has the high concentration (0.03±0.01µg/g), sample B & D has the low Cd concentration (0.02 ±0.00 µg/g). Sample D had the high Pb concentration (0.05 ±0.00 µg/g), sample C had the low Pb concentration (0.02±0.01 µg/g). In conclusion, Fe, Zn, Cd and Pb were both present in low concentrations in all the samples analyzed. The presence of Cd and Pb in the food seasonings even at low concentration could prove fatal through bioaccumulation. The low level of the toxic metals, Pb and Cd indicates that these products meet the safe limits specified by most food standards.

Keywords: bouillon, bioaccumulation, condiments, heavy metal, mineral elements, proximate

1. INTRODUCTION

Wide variations in concentrations of trace metal have been reported in bouillon cubes, mixed spices, natural plant spices and nuts [1-3]. Natural food spices such as pepper and mustard have been reported to contain significant quantities of some trace metals [4, 5]. These trace metals in spices and medicinal plants play vital role as structural and functional components of metalloproteins and enzymes in living cells [6, 7]. Zinc is a metal with great nutritional importance and is particularly necessary in cellular replication and the development of the immune response [8, 9].

Similarly, iron plays an essential role in many metabolic processes including oxygen transport, oxidative metabolism, and cellular growth. In human beings, it is absorbed primarily in the duodenum, transported through the blood stream and extracellular fluid bound to transferrin, and stored intercellular predominantly in the form of ferritins [10, 11]. In African, the current quest for easy to prepare or fast foods has brought with it a progressive loss of important components of the African food culture. African's richly enormous variety of food spices and condiments are today gradually being replaced by the large number of bouillon cubes in the market [11-14].

Dawadawa, an alkaline fermentation product of African locust beans (*Parkia biglobosa*) has been an important food condiment in the west/central African region and is used to enhance or intensify meatiness in soups, sauces and other prepared dishes [11, 15]. The preservative and flavor characteristics of this type of fermented foods are derived in part from the liberation of ammonia and increased pH, concurrent with protein hydrolysis to free amino acids and peptides [16]. Colouring agents often contain lead (Pb) and cadmium (Cd) salts and may contribute to food contamination [17].

The high level of especially Fe in the curry powder, beef seasoning and chicken seasoning may be as a result of intentional fortification of these products with iron (Fe) by the industries or from the cumulative contributions of the raw materials used. Human intake of a given element has been observed to be directly or indirectly related with the intake of other nutrients, particularly minerals and vitamins [15, 18, 19]. Micronutrients play very important roles in different metabolic processes and their excess or deficiency may disturb normal biochemical function of the body [20]. Zinc deficiency can result in poor growth, difficulty in wound healing, loss of appetite, undesirable skin changes, and adverse effects on the immune system and associated with sexual maturation, fertility, immunity, taste and appetite [20, 21]. Iron deficiency anemia (IDA) is a major cause of low birth weight and maternal mortality and has been re-recognized as an important cause of cognitive deficit in infants and young children [22, 23]. IDA is one of the major public health problems in the world, especially in Asia and sub-Saharan African countries [8, 9, 22].

However, both an inadequate supply of iron (Fe) to the body tissues and an excessive accumulation within the body lead to significant morbidity [18, 24]. Monosodium glutamate (MSG) is widely used as a flavor enhancer in Asia and has been successfully fortified with ferric orthophosphate and ferrous sulfate encapsulated in zinc stearate [6, 14, 25]. Trace metals composition of foods is of interest because of their essential or toxic nature [18, 24, 26]. The accumulation of heavy metals can have middle term and long-term health risks, and so due to this there is a need for food composition data to provide data for epidemiological studies, for proper intake of these nutrient as well as strict and periodic surveillance (close observation) of these contaminants is therefore advisable [11, 27, 28].

In this study compare the proximate analysis of five commercially sold food seasoning as condiments in Gwagwalada Abuja, to determine the moisture content, ash content, crude fibre, carbohydrate, total nitrogen and crude protein as well as metal analysis of the food seasoning using AA320N Atomic Absorption Spectrophotometer (AAS). The result will compliment available baseline data on food composition and will be useful in estimating dietary intake of these metals in the general Nigerian population.

2. MATERIALS AND METHODS

Variety of food seasoning was purchased randomly from Gwagwalada central market Abuja, the five commercial sold food seasoning cubes were label as, A, B, C, D, and E. The samples analysis was done in Chemistry laboratory of University of Abuja mini campus, Nigeria. The food seasoning was properly kept avoiding spoilage in a dried container.

2. 1. Test for moisture content

A clean and well labeled dishes that has been oven dried was weighed as W_1 , then samples were added into these dishes and weighed as W_2 , the dishes and content was transferred into thermo setting oven at 105 °C for 24hours. After that the dishes was taken to desiccator to cool for one hour and weigh as W_3 ; the % of the moisture content was calculated using Eq. 1.

$$\% \text{ moisture content} = \frac{\text{loss in weight}}{\text{weight of sample before drying}} = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \quad (1)$$

2. 2. Test for total ash

A well labeled crucibles was placed in a muffle furnace for 15 minutes at 350°C, it was removed and cooled in a desiccator for one hour, and then weighed as W_1 , sample was added into the crucible and then weighed as W_2 and the placed inside the muffle furnace at temperature from 200 °C to 450 °C to avoid incomplete ash; the sample was properly ashed until it become whitish in colour. The crucibles were removed cooled and moisten with few drops of distilled water, dry on water bath and return to the furnace, after which the crucibles were removed, it then weighed as W_3 , the % of the total ash was calculate from Eq. 2.

$$\% \text{ total ash} = \frac{W_3 - W_1}{W_2 - W_1} \times 100 \quad (2)$$

2. 3. Test for crude fibre

In determining the fibre content 5g of deflated sample was transferred into the conical flask, then 200 ml of boiling 1.25% H_2SO_4 was added to the sample and could boil for one-minute, cooling finger was used to maintain constant volume.

Then filter paper was used to filter it, it was rinsed well with hot distilled water and then the soluble material was separated back into the flask with spatula. 200 ml of boiling 1.25% KOH and a few drops of vegetable oil was added to the separated material in the flask and allowed to boil for one minute, and then boil gently for 30 minutes with cooling finger.

Next it was filtered again and washed with hot distilled water which was repeated four times with hot water and twice with methylated spirit; after the drainage of the residue, it was serve into the crucibles, dry in the oven at 105 °C and cool in desiccator which was weighed as W_2 ; the weight of the sample itself was recorded as W_1 . These crucibles were placed in the muffle furnace at 300 °C for 30 minutes, then transferred into desiccator and allowed to cool to room temperature, which was weighed as W_3 . The % of the crude fibre is calculate by Eq. 3.

$$\% \text{ crude fibre} = \frac{W_2 - W_3}{W_1} \times 100 \quad (3)$$

2. 4. Test for nitrogen and crude protein

Nitrogen content was determined using micro kjeldahl method. The method entails the estimation of the total nitrogen to ammonium salt by digestion after distilled H_2SO_4 into Boric acid (H_2BO_3) and back titrating with a strong acid. About 0.5g of the sample was weighed into 50 ml kjeldahl flask, a few gas regulators (anti-bumping granules) was added, one-gram (1g) of mixed catalyst was prepared using 140g of potassium sulphate, 10g of copper sulphate and 2g of selenium powder or a half (1/2) tablet of selenium catalyst, five milliliter (5 ml) of conc.

H_2SO_4 is carefully added and mixed gently with the content of the flask. Heat on a heater start with a low heat for about 15 minutes, increase to medium heat for about 30 minutes again and finally at high heating until digested, and the flask was rotate at intervals until the digest is clear the mixtures turns grey white and the heat is turned off, the flask is allowed to cool, its contents is then transferred quantitatively into a 100 ml volumetric flask, the kjeldahl flask is then rinsed with distilled water and the residue therefore poured into the volumetric flask, the digestion in the flask is then made up to the mark. 5 ml of the digest was placed into a micro-kjeldahl distillation apparatus and excess concentrated NaOH was added to make the solution strongly alkaline. Ammonia was distilled into 5ml of boric acid indicator in a titrating flask. Above 45ml of the distillate was collected. Titration was done with 0.01M HCl. The end point of the titration was grey white. The % of the nitrogen is calculate using Eq. 4.

$$\% \text{ nitrogen} = \frac{\text{Average acid titre value} \times 14}{\text{Grains of sample} \times \text{mole of acid}} \times 100 \quad (4)$$

Crude protein can be determining by multiplying the % nitrogen content of the food by factor 6.25

2. 5. Test for carbohydrate content

This was determined using the difference method described by AOAC (2005). The sum of various proximate composition was gotten and subtracted from 100, the resulting value gives the percentage carbohydrate content.

2. 6. Test for metal analysis

Minerals analyzed by dry ash 1g of the sample at 550 °C in a furnace. The ash obtained was dissolved in 10% HCl, filtered with filter paper and made up to standard volume with deionized water. Fe, Zn, Cd and Pb were determined using AA320N Atomic Absorption Spectrophotometer (AAS) after acid digestion with 2:1 $HNO_3/HClO_4$.

3. RESULTS AND DISCUSSION

The result obtained from the analysis of five commercially sold food seasoning as condiments of food seasonings which are label as, A, B, C, D, and E in determination of its comparative proximate analysis.

Table 1 shows the nutritional compositions of different food seasonings; the result shown that the % moisture content and standard deviation, for Sample A with 4.003 ± 0.98 , Sample B with 3.403 ± 0.10 , Sample C with 4.487 ± 1.27 , Sample D with 2.376 ± 0.34 , and Sample E with 5.452 ± 0.53 . From table 1, sample E has the high % value of moisture content of 5.452 ± 0.53 and sample D has the low value of 2.376 ± 0.34 .

Table 1. % moisture content (mean) and \pm standard deviation.

Sample	% Value and \pm SD
A	4.003 ± 0.98
B	3.403 ± 0.10
C	4.487 ± 1.27
D	2.376 ± 0.34
E	5.452 ± 0.53

Table 2 shows the result obtained from % ash content and standard deviation, for sample A has 54.71 ± 6.73 , sample B 54.76 ± 1.52 , sample C 56.08 ± 6.20 , sample D 68.68 ± 3.41 and sample E has 53.31 ± 3.49 . From the result show in table 2 sample D has the high % value of ash content of 68.68 ± 3.41 and sample E has the low value of 53.31 ± 3.49 . Table 3 shows the nutritional compositions mean of different food seasonings with their standard deviation and table 4 shows the mineral compositions of all different food seasoning samples, such as iron, zinc and two heavy metals lead and cadmium with their standard deviation.

Table 2. % Ash content (mean) and \pm standard deviation.

Sample	% Value and \pm SD
A	54.71 ± 6.73
B	54.76 ± 1.52
C	56.08 ± 6.20
D	68.68 ± 3.41
E	53.31 ± 3.49

Table 3. Nutritional compositions of different food seasonings (mean) and \pm standard deviation

Proximate composition	% Value and \pm SD
Moisture content	3.94 \pm 0.64
Ash content	57.51 \pm 4.27
Crude fat	5.11 \pm 0.20
Crude fiber	0.02 \pm 0.00
Crude protein	13.63 \pm 0.53
Carbohydrate	18.41 \pm 0.46

Table 4. Concentration of mineral element and heavy metals ($\mu\text{g/g}$) is food seasonings in Gwagwalada central market.

Sample	Fe	Zn	Cd	Pb
A	0.04 \pm 0.00	0.02 \pm 0.01	0.03 \pm 0.01	0.03 \pm 0.01
B	0.01 \pm 0.00	0.02 \pm 0.01	0.02 \pm 0.00	0.03 \pm 0.01
C	0.01 \pm 0.00	0.02 \pm 0.01	0.02 \pm 0.01	0.02 \pm 0.01
D	0.04 \pm 0.01	0.03 \pm 0.01	0.02 \pm 0.00	0.05 \pm 0.00
E	0.02 \pm 0.01	0.03 \pm 0.01	0.02 \pm 0.01	0.03 \pm 0.00

For iron concentration, sample D has the highest iron concentration (0.04 \pm 0.01 $\mu\text{g/g}$), follow by sample A (0.04 \pm 0.00 $\mu\text{g/g}$), sample E (0.02 \pm 0.01 $\mu\text{g/g}$), sample B and C has the lowest (0.01 \pm 0.00 $\mu\text{g/g}$) respectively.

For Zinc concentration, sample D and E has the highest Zinc concentration (0.03 \pm 0.01 $\mu\text{g/g}$) respectively, then samples A, B and C which has the lowest Zinc concentration with (0.02 \pm 0.01 $\mu\text{g/g}$) respectively.

For cadmium concentration, sample A has the highest Cadmium concentration (0.03 \pm 0.01 $\mu\text{g/g}$), follow by samples C and E with values (0.02 \pm 0.01 $\mu\text{g/g}$) respectively, and then samples B and D which has the lowest concentration of (0.02 \pm 0.01 $\mu\text{g/g}$) respectively.

For lead concentration, sample D has the highest lead concentration of (0.05 \pm 0.00 $\mu\text{g/g}$), follow by samples A and B with (0.03 \pm 0.01 $\mu\text{g/g}$) respectively, and the sample E with (0.03 \pm 0.00 $\mu\text{g/g}$) and sample C with lowest lead concentration of (0.02 \pm 0.01 $\mu\text{g/g}$).

Iron, Zinc, Cadmium and Lead were both present in low concentration in all the samples analysis. The present of cadmium and lead in all the food seasoning even at low concentration could prove fatal through bioaccumulation in the tissues with time, thereby altering various biochemical parameters in the liver and kidneys [4, 11, 21], Accumulation of these minerals elements by excessive consumption can lead to long-term health risk. The heavy metals on the other hand have different effects on organisms, depending on the stage of development of the organism.

Some of these effects of heavy metals are: carcinogenicity, neurotoxicity and reproductive failure metal such as cadmium derives its toxicological properties from its chemical similarity to Zinc (an essential micronutrient for plants, animals, and man). Cadmium therefore replaces Zinc (Zn) in many of the reaction where Zn plays a role as a co-factor, thereby disrupting cellular activities. Lead on the other hand, manifests its toxicity in neurological, hematological, renal, endocrine and reproductive system. Lead inhibits several if the enzymes involved in haembiosynthesis especially of synthesis of aminolaevulinic acid by aminolaevulinic acid synthesis to porphobilinogen [4].

According to Ansari et al. [2] seasoning is used to prepare foods and some of these seasoning is believed to aid uterus contraction in pregnant women. There is need for periodic assessment of the food seasoning concentration, the world health organization [22] has therefore set an acceptable limit of $0.0\mu\text{g/g}$ for cadmium and lead in food seasoning and $0.4\mu\text{g/g}$ for calcium, potassium and sodium; therefore, the national agency for food and drug administration control (NAFDAC) has adopted these limits.

In summary, all the food seasoning samples analyzed for heavy metals has values above the acceptable limit of $0.0\mu\text{g/g}$, for cadmium range from $0.02 \pm 0.00 \mu\text{g/g}$ to $0.03 \pm 0.01 \mu\text{g/g}$ and lead range from $0.02 \pm 0.01 \mu\text{g/g}$ to $0.05 \pm 0.00 \mu\text{g/g}$ for all the samples, the bioaccumulation of this little but very significant concentration of lead in tissues of man can affect the activities of some enzymes like δ -aminolerulinic acid (involved in haem biosynthesis), superoxide dismutase (SOD), catalyse, glutathione s-transferase (GST) and glutathione. This accumulation may lead to reactions which generate reactive oxygen species (ROS) thereby leading to oxidative stress. Lead toxicity is known to inhibit the action of these enzymes because they have free sulphhydryl groups.

This is particularly noted with the precursors of heam, and leads to a decrease in heam synthesis, and hence to anemia. Irrespective of the way a lead compound enters the body, it first penetrates the initial cellular barrier before reaching the intercellular fluid. The compound then penetrates the capillary blood vessels and thus enters the circulatory system which distributes it throughout the body [7, 9]. Majority of the lead compounds do not cause damage at the point where they enter the body, the absorption process is the beginning of the path consisting of distribution, biotransformation, accumulation and elimination of the lead compounds. In order to provoke symptoms of poisoning, lead and its metabolite must first penetrate a target organ which is susceptible to its action, and at the same time the concentration of the toxic must be sufficiently high and appears at the site at a definite time, the target organ is the point of anatomical preference for the appearance of the symptoms of poisoning by lead or its compounds [1, 4].

The health implication of cadmium in man is that it shares the same oxidation state and structural similarity with Zinc which is a beneficial heavy metal and because of this, Cd readily replaces Zn in many reactions where Zn acts as a cofactor, thereby disrupting the cellular and enzymes activities. Following oral exposure of cadmium, the metal is transported in the blood

by the erythrocytes or bound to low molecular weight proteins (e.g metallothionein), cadmium is taken up by liver cells, and is slowly released back into the plasma. Because of the small size of cadmium-metallothionein complex, it passes freely through the glomerulus, and into the renal tubule [11, 21, 23]. Cadmium bound to metallothionein is efficiently taken up in the tubule by the pinocytosis; within the renal tubular cells, the pinocytosis vacuoles fuse with lysosomes which degrade the metallothionein, thereby freeing the cadmium. The cadmium then combines with the newly synthesized metallothionein produced by the tubular cells and accumulates in the kidney for along time. Yousuf and El-Shahawi [27], Umedumet al. [7] says that metallothionein is inducible in the liver and kidney by the cadmium, and other metals; and that cadmium is stored in the kidney and liver and very little is eliminated from the body until renal toxicity occurs.

According to Nnorom et al. [23] and Ngunoon et al. [24] says that upon the renal excretion increases and levels of cadmium diminish in the liver, particularly in the kidney. From the result, iron and zinc in the food seasoning were below the NAFDAC limit of 0.4µg/g and can be supplemented from other food sources especially fruits

4. CONCLUSIONS

The determination of the proximate, nutritionally valuable minerals in five samples of food seasonings labeled as sample A, B, C, D and E food condiments readily consumed in Nigeria which were obtained from Gwagwalada central market Abuja showed that they contained high level of protein 13.63% ±0.53% with the mean value for all samples of moisture 3.94% ±0.64%, ash 57.51% ±4.27%, fat 5.11% ±0.20%, fiber 0.02% ±0.00%, and carbohydrate 18.41% ±0.46 % levels. The presence of Pb and Cd in the sampled food seasoning even at the low concentrations may lead to bioaccumulation in the tissues with time, thereby altering various biochemical parameters in the liver and kidneys. Since the food seasonings are of vegetables origin, it is most likely that Pb and Cd were taken up by plants from the soil. Fe and Zn in the food seasoning were below the NAFDAC limit of 0.4 µg/g which can supplemented from other food sources especially fruits. The frequency and regularity of consumption and popularity of these products demands periodic surveillance to avoid contamination. This result will complement available data on food composition in Nigeria.

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