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Evaluation of the Heavy Metals Level in Selected Industrially Packaged Food Spices

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Keywords

Heavy Metals, Spices, Atomic Absorption Spectrophotometer, WHO

The heavy metals content of common food spices were determined using the Atomic Absorption Spectrophotometric method in comparison with acceptable standards. The results obtained showed differences in metal concentration according to the plant parts (seed, leaf and rhizome). The concentration (mg/kg) on dry basis were: (0.025 – 0.138), (0.337 – 2.323), (0.050 – 0.401), (1.175 – 16.04), (0.055 – 1.374), (0.055 – 0.956), (0.488 – 7.294) for the metals; Cd, Cr, Cu, Fe, Ni, Pb and Zn respectively. Most of the metal levels in the spices were acceptable because they were below the standard limit approved by World Health Organization (WHO). Therefore, it could be said that consumers of these spices would not be exposed to any risk associated with the daily intake of spices containing the aforementioned metals with regards to those that complied with the WHO acceptable limit.

Introduction

The widespread of contamination with heavy metals in the last decades has raised public and scientific interest due to their dangerous effect on human health (Gilbert, 1984). This has led researchers all over the world to study the pollution with heavy metals in air, water and food to avoid their harmful effects and to determine their permissibility for human consumption. (Geert *et al*., 1989). Spices are dried parts of plants, which have been used as dietary components often to improve colour, aroma, palatability and acceptability of food as well as influence digestion and metabolism. They consist of rhizomes, barks, leaves, fruits, seeds and other parts of the plant. (Wahid *et al*., 1998). Natural food spices such as pepper and mustard have been reported to contain significant quantities of some trace metals (Gupta *et al.,* 2003). These trace metals in spices and medicinal plants play vital roles as structural and functional components of metalloprotiens and enzymes in living cells (Ansari *et al.,* 2004).

The addition of spices that may be contaminated with trace and heavy metals to food as a habit may result in accumulation of these metals in human organs and lead to different health issues both in the middle and long terms (Kabeltz *et al*., 2004).

Heavy metals are those metals with atomic weights of between 63.546 to 200.590g (Kennish *et al*., 1992) and specific weight higher than four. For example, Cd, Pd, and Co which possess very toxic effects even at low concentrations. These metals may reach and contaminate plants, vegetables, fruits and canned foods through air, water and soil during cultivation, harvesting or processing procedures (Husain *et al*., 1995, Foley *et al.,* 2002, Ozores *et al.,* 1997).

Thus several studies were done to determine the concentration of heavy metals in spices, dry fruits and plant nuts and their dangerous effects. (Al-Eed *et al*., 1997). Subjecting oneself to trace and heavy metals above the permissible level affect the human health and could result in illness to human foetus, abortion, pre-term labor and mental retardation to children. Adults may also experience high blood pressure, fatigue, kidney and brain troubles. (Schumann, 1990). The average amount of metal found in a spice can vary from spice to spice or place of production. Natural food spices such as pepper have been reported to contain significant quantities of some trace metals (Chizzola *et al*., 2003). The presence of essential metals like copper, zinc, nickel and iron in spices and medicinal plants are very useful for the healthy growth of the body and play vital roles as structural and functional components of metalloproteins and enzymes in living cells (Selim *et al*., 1994) though very high levels are intolerable. Due to the significant amount of spices consumed, it is important to know the toxic metal contents in these spices. (Oehme, 1989). Food composition data is important in nutritional planning and provides invaluable information for epidemiological studies (Wahid *et al*., 1998). There is often little information available about the safety of those plants and their products in respect to heavy metal contamination. Hence, periodic surveillance of these contaminants is therefore advisable in order to be able to guard and guide the consumers against the imminent health risks associated with these heavy metals which is the major aim of this work.

Materials and Methods

Samples Collection and Preparation

Seven factory packaged spice samples were collected in the month of March, 2013 from the permanent site of Nnamdi Azikiwe University, Awka, Anambra State and was kept sealed until required for the experiment. These spices represent the most widely used taste enhancers in Nigeria. The species were classified according to parts of plant used as shown in Table 1.

Table 1. *Scientific and common names of studied spices*

Common Name	Scientific Name	Family	Local Name	Used Part
Thyme	*Thymus Vulgaris*	Labiatea		Leaves
White Pepper	*Piper Nigrum*		Famwisa	Seeds
Nutmeg	*Myristica Fragrance*	Myridticaceae		Bulb
Rosemary	*Rosmarinus Officinalis*		Masala Powder	Seeds
Curry Powder				
Garlic	*Allum Sativum*			Bulb
Ginger	*Zingiber Afficenalis*	Zingiberaceae	Akakaduro	Rhizomes

Sample Preparation and Digestion

Samples were oven dried at 80^0C for 12hours to remove inherent water molecules and were kept for further analyses.

Wet digestion of the dried samples was done according to the method described by Jones and Case, 1990. 0.5g of the dried sample was weighed into a digestion flask followed by the addition of 3.5ml of 30% H_2O_2 and heated until a clear solution was obtained. The clear solution was subsequently filtered using a whatmann filter paper and made up to 50ml with de-ionized water. A blank solution was also prepared for comparison.

Heavy Metal Determination

The heavy metals analysis was carried out on the digestion sample using Atomic Absorption Spectrophotometer model Varian AA 280 using appropriate cathode lamps.

Results and Discussion

The concentration of both essential metals (Cr, Cu, Fe, Ni, Zn,) and heavy metals (Cd and Pb) in the selected species are as shown in table 2

Table 2. *Concentration of the heavy metals in the samples in mg/kg*

Spices	Cd	Cr	Cu	Fe	Ni	Pb	Zn
Thyme	0.138	1.025	0.190	6.898	0.918	0.801	1.398
White Pepper	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Nutmeg	0.083	0.787	0.365	5.561	0.679	0.488	1.518
Rosemary	0.117	1.002	0.238	4.856	1.020	0.747	7.294
Curry Powder	0.062	0.638	0.174	4.293	0.611	0.372	1.057
Garlic	0.120	2.323	0.248	16.040	1.374	0.956	1.043
Ginger	0.062	0.905	0.401	8.847	0.740	0.435	2.236
WHO standard	0.200	30.0	20.0	300	50.0	10.0	50.0

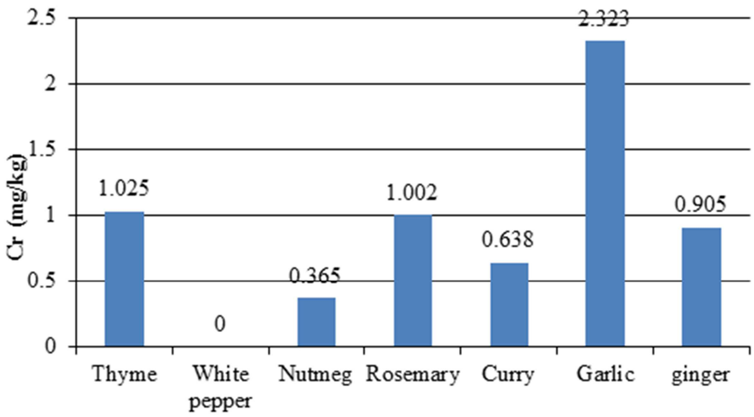

Fig 1. *Chromium concentration*

Chromium content of spices ranged between 0.00mg/kg for white pepper and 2.323mg/kg for Garlic as shown in fig.1. The daily intake was much less than the maximum permissible limit. Chromium intake from spices has no effect on health if it is taken in trace amount but can be toxic at high level.

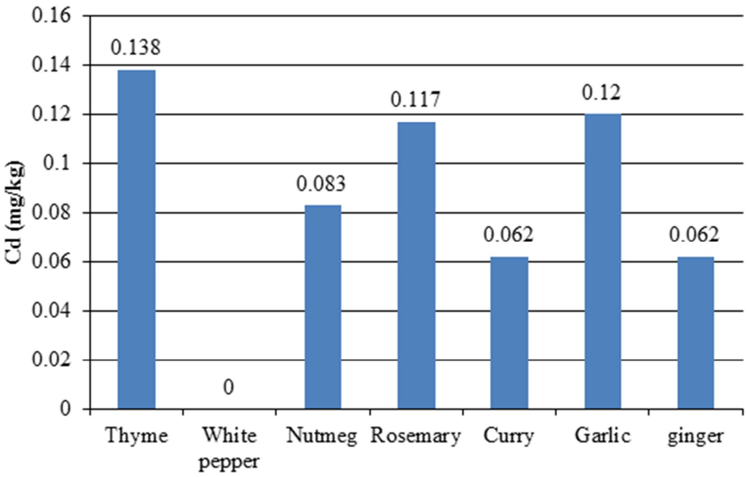

Fig 2. *Cadmium concentration*

Cadmium content of the selected spice samples ranged between 0.00mg/kg for white pepper and 0.138mg/kg for thyme as shown in fig.2.. The daily intake being much less than maximum permissible limit, (0.200mg/kg) cadmium is considered tolerable hence without detrimental health effects at this current level. However, too much cadmium in food spices may lead to high blood pressure, liver disease, nerve or brain damage, gastrointestinal effects, nausea and vomiting (Lou and Garry, 1991).

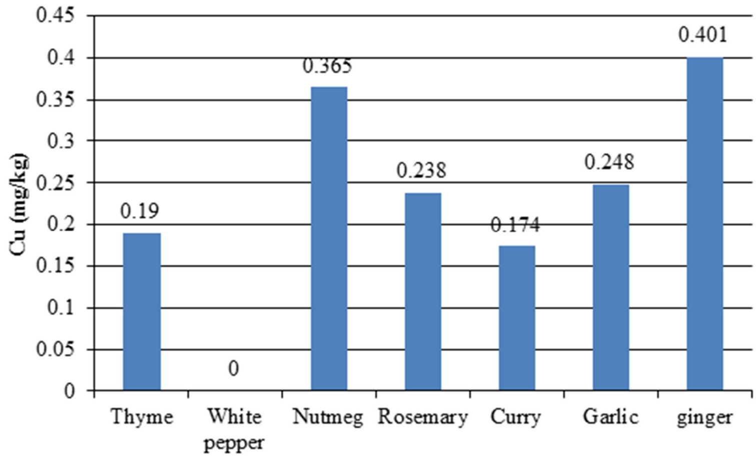

Fig 3. *Copper concentration*

The copper content of the various spices ranged between 0.00mg/kg for white pepper to 0.401mg/kg for ginger as shown in fig.3. The daily intake was much less than maximum permissible limit. Therefore, copper is considered tolerable. Copper intake from spices has no effect on health if it is taken in trace amount but can be toxic in high levels.

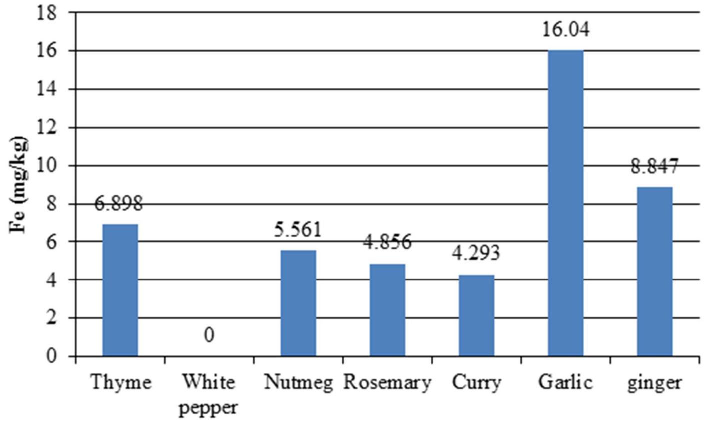

Fig 4. *Iron concentration*

Iron an essential element plays an essential role in many metabolic processes including oxygen transport, oxidative metabolism and cellular growth. The WHO limit of Iron is set at 300mg/kg. However, the range of iron in the selected spices ranged from 0.00mg/kg for white pepper to 16.040mg/kg for garlic as in fig 4. The above values being below the WHO limit maybe considered tolerable.

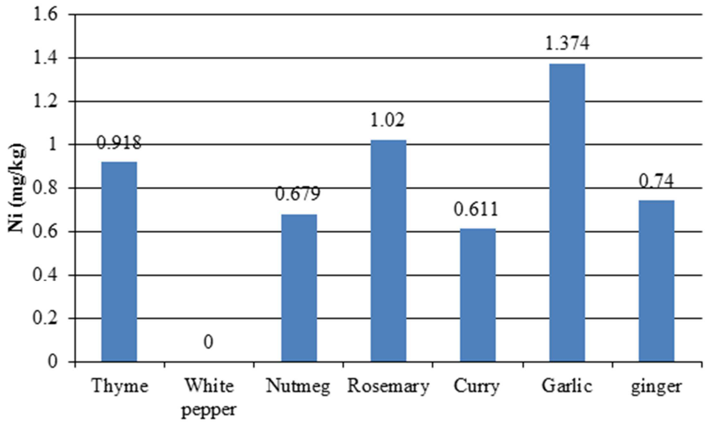

Fig 5. *Nickel concentration*

In the case of Nickel, there was varied level in concentration for all samples ranging from 0.00mg/kg for white pepper to 1.374mg/kg for Garlic as shown in fig 5.. Daily intake values were found to be much lower than maximum permissible level values so there is no effect on health due to Nickel intake from these selected spices.

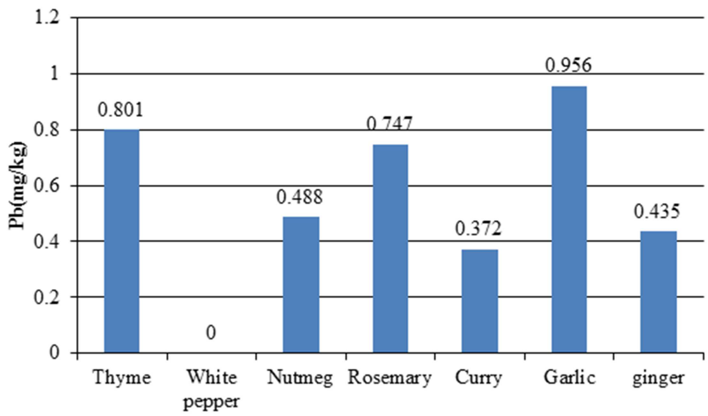

Fig 6. *Lead concentration*

Lead another toxic metal had concentration ranging from 0.00mg/kg for white pepper to 0.956mg/kg for Garlic as shown in fig.6.. Daily intake values were found to be much lower than the maximum permissible limits (10.0mg/kg). As such, Lead content of these selected spices are considered tolerable.

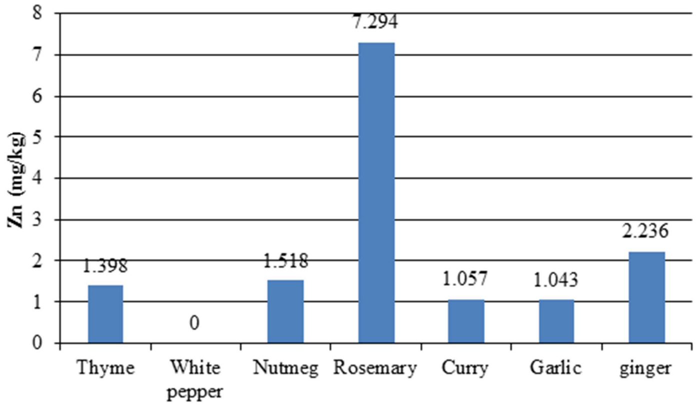

***Fig 7.** Zinc concentration*

The WHO limit of zinc is set at 50mg/kg while in the selected spices we had a range between 0.00mg/kg for white pepper to 7.294mg/kg for rosemary as in fig 7. The above values being below the limit may be considered tolerable with rosemary recommended for patients suffering with the deficiency of Zinc as it showed very high Zinc content in comparison with other spices. Aside this, zinc is a metal with great nutritional importance and is particularly necessary in cellular respiration and the development of the immune response. It is also a cofactor of over 200 enzymes involved in metabolic pathways but its high levels in human body can be toxic due to its interference with copper metabolism (Durrani *et al., 1998*).

Conclusions

The results of this study have shown that the majority of the spices commonly used are contaminated with heavy metals at various levels of contamination with white pepper having no trace of any metal whatsoever. Based on the conformation of the selected spices to the permissible level of heavy metals stipulated by the WHO, it could be ascertained that these spices are safe for human consumption.

Recommendations

It has been recommended that:

1. More work should be done on other common spices to determine their safety for human consumption.

2. There should be thorough control for imported food stuff to ensure compliance with stipulated standards to avoid associated health issues with the excessive consumption of spices contaminated with these heavy metals.■

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