# DETERMINATION OF CADMIUM IN COMMON SPICES FROM SELECED MARKETS IN SOUTH-EASTERN NIGERIA.

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***ABSTRACT***

*Food spices sold in Nigerian markets are often exposed to diversity of conditions and environments before they reach the consumers. There is no doubt that along the route from the producers to the users, as well as during processing, these commodities, could become contaminated with sand and grits, dust, smoke, particulates, pathogens and heavy toxic metals. In this research, the degrees of contamination with cadmium were determined in fifty common food spices bought from three major markets in Southeastern Nigeria. Two grams of ground spice samples were digested using 2:1 $HNO_3/HCLO_4$ mixture and analysis of cadmium (Cd) metal were carried out using a GBC Avanta ver. 2.02 atomic absorption spectrophotometer. Results show that range of detectable values (µg/g of the fruits, vegetables, other natural spices and processed spices for cadmium were (0.02 – 3.1), and (0.03 – 93.28) respectively. One way analysis of variance showed that the mean concentrations of Cd in each selected common spice are all the same since the P-value 0.678 is not less than 0.05 ( i.e. $P > 0.05$). The mean concentration of Cd in the various spices are the same with respect to location since the P-value (0.221) is greater than 0.05 (i.e. $P > 0.05$). The mean concentration of Cd in each processed food spices are the same at $P > 0.05$ while the mean concentration of Cd in the various processed food are the same with respect to location at $P > 0.05$. The level of Cd was below the FAO/WHO recommended limits for metals in common spices. The daily human intake of cadmium have also been computed and was observed to be below recommended values by FAO/WHO.*

**Key words:Cadmium, Southeastern Nigeria, Atomic absorption spectrophotometer, Food spices, Contamination.**

## 1. INTRODUCTION

The wide spread contamination of the environment by heavy metals in the past three decades has raided public and scientific interest due to their dangerous effects on human health. This had led researchers to study heavy metals contamination of the air, water, soil and foods including spices in order to mitigate their harmful effects and to determine food safety for human consumption.

Food spices are used as diet components often to improve colour, aroma, palatability and acceptability of food. Most natural spices consists of rhizomes, barks, leaves, fruits, seeds and other parts of plants [Sharma, 2000]. The addition of spices that may be contaminated with

traces of heavy metals may result in accumulation of these metals in human organs and lead to different health hazards. Trace of heavy metals above the permissible level may result in illness in humans and animals. Contamination of plants and processed spices could occur through air, water and soil during cultivation and during industrial processing and packaging [Funtant et al, 2008]. In view of this therefore, we conducted studies to determine the concentration of cadmium contamination in food spices.

Some of the spices sold in southeastern Nigeria markets are purchased from the northern part of the country. Food spices contribute protein, vitamins, iron, calcium and other nutrients to the human diet [Thompson, 1990]. Metal accumulation in common spices, may pose a threat to human health [Turkdoga et al, 2003; Damac-Popramam and Sawicka–Kpusta K, 2003]. The consumption of heavy metal-contaminated food can seriously deplete essential nutrients in the body causing or contributing to a number of diseases [Arora et al, 2008]. At present, there is little information about the safety of these spices with respect to heavy metals contamination in southeastern Nigeria. Hence the present research was taken up to determine the dry matter levels of Cd in fifty selected common spices that are sold in three major markets in southeastern Nigeria.

## 2. EXPERIMENTAL

Fresh vegetables and other spices of plant origin were purchased from Onitsha, Enugu and Nnewi markets in southeastern Nigeria. They were identified and classified according to their common and botanical names by the Department of Crop Science, University of Nigeria, Nsukka.

**Analyses**:

Reasonable quantities of fresh leafy and non-leafy spices were washed with tap water and dried at room temperature. The samples were placed in the watch glass and dried in an oven temperature of 105 $^{o}$C for six hours until constant weight was maintained. The dried samples were ground with wooden mortar and pestle and kept in acid leached nylon bags in desiccators prior to digestion. The processed and dried samples were ground, packaged and left for analysis. Thereafter, 2.00 g of each ground sample was placed in 20 $cm^3$ of $HNO_3/HCLO_4$ (2:1) mixture in a beaker covered with Petri dish and digested on electric hot plate. The digest was diluted to 50 $cm^3$ with de-ionized water. Analyses for cadmium were carried out using a GBC Avanta ver. 2.02 Atomic Absorption Spectrophotometer equipped with air-acetylene flame.

**Data Analysis**

**Daily intake of heavy metals from common spices**

The daily intake of heavy metals through the consumption of common spices tested was calculated according to the equation [Qui et al, 2004].

Daily intake of metals (DIM) = DSC x VMC

DSC = daily spice consumption; VMC = mean vegetable metal concentrations (mg/day, dry weight). Where daily vegetable consumption was taken as 98g of vegetables per person per day as set by the FAO/WHO (1999), for heavy metal intake based on body weight for an average adult (60 kg body weight)

## 3. RESULTS AND DISCUSSION

The mean concentration of trace metal in fruits, vegetables and other natural spices are shown in Table 1.

Table 1: Mean concentration (n-3) of trace metal in all the samples (fruits, vegetables and other natural spices (dry weight (µg/g) from the various markets.

| Botanical names | Common name | Cd values |
|---|---|---|
| Solanum anomalum | Buba anara | 0.34 ± 0.3 |

| | | |
|---|---|---|
| Pisum sativum | Akidi | 1.25 ± 1.8 |
| Musa sapientum | Banana | 0.14 ± 0.1 |
| Doncas carrota | Carrot | 0.27 ± 0.1 |
| Cucumis sativus | Cucumber | 0.25 ± 0.1 |
| **Botanical names** | **Common name** | **Cd values** |
| Solonum mologena | Garden egg | 0.18 ± 0.1 |
| Phaseoluse vulgari | Green beans (pas) | 0.25 ± 0.1 |
| Amaranthus hybridus | Green vegetable | 0.60 ± 0.4 |
| Lpomea batata | Irish potatoes | 1.018 ± 0.1 |
| Abelmosihus macnzphylla | Okro | 0.24 ± 0.1 |
| Allium cepa | Ordinary onious | 0.23 ± 0.1 |
| Carica papaya | Pawpaw | 0.13 ± 0.1 |
| Aranos conosus | Pineapple | 0.10 ± 0.1 |
| Musa paradisaca | Plantain | 0.16 ± 0.1 |
| Citrus cinensis | Sweet orange | 0.21 ± 0.1 |
| Solanum tuberosum | Sweet potatoes | 0.12 ± 0.0 |
| Lycopersicon esculenton | Tomatoes | 0.34 ± 0.1 |
| Pentaclethra macrophyll | Ukpaka | 0.17 ± 0.0 |
| Gongronema letifolium | Utazi | 0.15 ± 0.1 |
| Citraillus valgaris | Water melon | 0.31 ± 0.1 |
| Allium cepa | White onions | 0.22 ± 0.0 |
| Ocilimum gratisimum | Curry leaves | 0.30 ± 0.1 |
| Monodova mycistica | Efu | 0.18 ± 0.1 |
| Mandora mynstica | Ehulu | 0.31 ± 0.1 |
| Allium sativum | Garlic | 0.25 ± 0.2 |
| Zingber officinule | Ginger | 0.25 ± 0.2 |
| Pipeguineense | Mkpulu uziza | 0.34 ± 0.1 |
| Myristica fraginace | Nut meg | 0.23 ± 0.0 |
| Piper nigium | Red pepper | 0.21 ± 0.1 |
| Ocimium americanus | Scent leaves | 0.49 ± 0.3 |
| Thymus vulgaria | Thyme | 0.23 ± 0.0 |
| Xylopia aethiopica | Uda | 0.17 ± 0.1 |

Range: 0.10 – 1.25; WHO FAO 2001: 0.4 µg/g; P-value: P > 0.05.

Cadmium was detected in 91.7% of the fruits, vegetables and other natural spices with a range from 0.02 µg/g in *Gongronema letifolium* sample from Nnewi to 3.1 µg/g in Gansa from Onitsha, while 9.2% of the samples exceeded the cordex standard WHO 1999/FAO 2001 µg/g (0.4 µg/g). The high concentration of Cd is an indication of the contamination of the Nigerian environment by cadmium. The mean concentration of cadmium of this study is higher than 0.000mg/kg reported in Shuaibu and Ayodele, [2013] for vegetables, higher than 0.000mg/kg reported in Okoye [2001] for fruits and also higher than 0.36 mg/kg reported in Ladipo et al., [2011] for vegetables. However, the mean concentration of Cd in similar with the value 0.11 – 0.37mg/kg reported in Orish, et al., [2012] with exception of 1.74 mg/g in Pisum sativum. The concentrations of cadmium in all the detectable samples were under the maximum permissible concentration (0.4 µg/g) of WHO 1996/FAO, [2001]

Table 2: Mean concentration of cadmium (µg/g dry weight) in fruits, vegetables and other natural spices from each market.

| **Metal** | **Enugu** | | **Nnewi** | | **Onitsha** | |
|---|---|---|---|---|---|---|
| | Fruits and vegetables | Other natural spices | Fruits and vegetables | Other natural spices | Fruits and vegetables | Other natural spices |
| Cd | 0.29 ± 0.10 | 0.28 ± 0.15 | 0.41 ± 0.20 | 0.30 ± 0.18 | 0.10 ± 0.05 | 0.50 ± 0.20 |

The data in Table 2, shows that one way analysis of variance has no significant difference in the mean concentration of cadmium in the various samples at ($P > 0.05$). The concentrations of cadmium in fruits and vegetable samples from Nnewi were higher than the values obtained from the various spice samples from Enugu and Onitsha.

**Table 3:** Mean concentration of Cadmium (µg/g) (dry weight) in processed spices.

| **Common Name** | **Concentration of cadmium (Cd)** |
|---|---|
| Benny | 1.51 ± 1.0 |
| Fried rice seasoning | 1.18 ± 1.0 |
| Maggi star | 2.74 ± 1.2 |
| **Common Name** | **Concentration of cadmium (Cd)** |
| Mixed spices | 0.16 ± 0.1 |
| Nut meg | 0.39 ± 0.2 |
| Onga | 0.21 ± 0.4 |
| Pepper | 0.08 ± 0.1 |
| Eshallot | 0.20 ± 0.1 |
| Steak seasoning | 0.55 ± 0.1 |
| White magi | 0.98 ± 0.7 |
| Range | 0.1 – 2.70 |
| WHO 1996.FAO 2001µg/g | 0.4 |
| P-value 0.157 | P > 0.05 |

In the processed spices of this study, cadmium was detected in 93.3% of the samples. The detected level ranges from 0.03 µg/g in shallot samples from Onitsha to 3.28 µg/g in Benny sample from Nnew. The mean concentration ranges from 0.1 to 2.7 µg/g and 46.7% of the samples exceeded the cordex standard WHO 1996 and FAO 2001 µg/g (0.4 µg/g) for food samples. The values of cadmium in the processed spices are higher than the values found in fruits, vegetable and other natural spices. The higher level of cadmium could be attributed to the contamination from the processing additives and packaging processes. The mean concentration of trace elements in processed spices from each market are shown in Table 4 below.

Table 4: Mean concentration of cadmium µg/g in processed spices from each market

| **Metal** | **Enugu** | **Onitsha** | **Nnewi** |
|---|---|---|---|
| Cadmium (Cd) | 1.06 ± 0.1 | 0.77 ± 0.70 | 1.69 ± 1.3 |

The concentrations of cadmium in the processed samples from Nnewi were higher than values obtained from various processed spice samples from Enugu and Onitsha.

One way analysis of variance showed that the mean concentration of cadmium in each selected common spices are the same at $P>0.05$. The mean concentration of cadmium in the various

spices are not the same with respect to location at P<0.05. The mean concentration of cadmium in various spices purchased from Enugu and Nnewi are significantly higher than those purchased from Onitsha. Probably, sources of high cadmium levels as found in this study may have included various industrial activities such as electroplating, plastics and paint products /industries.

Significant quantities are released during the smelting of raw sulphide ores. In addition, the exposure of consumers and the related health risks are usually expressed in terms of the provisional tolerable daily intake. The FAO/WHO [1999] have set a limit for the heavy metal intake based on the body weight for an average adult namely, 60 kg body weight as shown in Table 5

**Table 5:** Estimation of heavy metal intake through consumption of vegetables in Southeastern Nigeria.

| Heavy metal | Mean conc. Mg/g | Daily intake (µg/dry) | WHO/FAO limit (µg) |
|---|---|---|---|
| Cadmium (Cd) | 0.60 | 58.8 | 60 |

Source: b = Shuaibu et al.,[2012].

The average diet per person per day of common fruits and vegetable spices is 98 g. If the mean level of cadmium (24.5 mg/g) found here is consumed daily, the contribution of heavy metal intake for an average human being from the spice diets were calculated and presented as shown in Table 5. It can therefore be concluded that our estimated daily intakes for cadmium studied here is below those reported by FAO/WHO, which had set a provisional tolerable. Daily intake PTDI limit for heavy metal intake based on body weight for an average adult (60 kg body weight) for cadmium. Table 5, with exception of Pisum sativum who's PTDI (122.5) exceeded the PTDI limit. Two third of our estimated daily intake for cadmium in processed spices studied here is below those reported by FAO/WHO PTDI limit.

**Validation of Method Used**

This method has been used and published by Prof P. Okoye my supervisor

## 4. CONCLUSION

The results reported here confirm that the food spices obtained from three major markets in Southeastern Nigeria contained reduced or trace amounts of cadmium. The results show some disproportionate concentrations of these pollutants, which may have arisen from air borne particulate deposition as the food spices are often exposed at stalls etc. furthermore, the methods of preparation/processing may also contribute. Furthermore, the level of cadmium obtained did not appear to pose any serious health hazard problem of concern yet

## 5. RECOMMENDATIONS

We recommend that people living in contaminated areas should not eat large quantities of vegetables to avoid excess accumulation of heavy metals in the body. Regular monitoring of these toxic heavy metals from fruits vegetables and other natural spices is essential to prevent excessive buildup of cadmium in the food chain as the spice samples are transported from different locations.

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