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Level of heavy metals in fresh and canned foods consumed in North Central Nigeria

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Heavy metals level in some selected fresh foods and their canned products were investigated in this work. Samples were collected, digested by standard method and the metal level determined using Atomic Absorption Spectrophotometer (AAS). The results showed that nickel (Ni) level was generally low (0.0003 to 0.0044 mg/kg) in all foods investigated. There was no significance difference in the levels of cadmium (Cd), lead (Pb), copper (Cu) and nickel (Ni) in fresh and canned foods. However, there was a striking difference in the levels of zinc in the fresh and canned foods. Zinc (Zn) level was found to be generally high, ranging from 0.0526 to 1.5472 mg/kg in canned food and 0.17841 to 6.41113 in the fresh food samples. It was also observed that the Zn concentration in the fresh food samples were about five times the concentration found in the canned food products. Food contamination may therefore, not necessarily be associated with the canning materials. It may however, be linked to the source of the products and other environmental factors. The detected levels of Ni and Cu did not exceed the toxicological reference values established by World Health Organization (WHO). However, Pb and Cd levels are alarming and calls for concern. Pb values ranges from 0.0951 to 0.2852 mg/kg in fresh food samples and ranged between 0.01051 and 0.2852 mg/kg in canned food products while Cd varied from 0.0073 to 0.1919 mg/kg and 0.0091 to 0.297mg/Kg in fresh food samples and canned products respectively.

Key words: Food contamination, food safety, environmental pollution, toxicology, heavy metal poisoning.

INTRODUCTION

Foods contain a wide range of metallic elements such as sodium (Na), potassium (K), iron (Fe), (Ca) calcium, (Cu) copper and (Zn) zinc. Many of these metals are essential in living organisms. Nevertheless, a considerable number of them are harmful to plants, animals and man even at low concentration. This is particularly true of heavy metals such as mercury (Hg), arsenic (As), copper, cadmium (Cd) and lead (Pb). Toxicological and environmental experts have shown concern for the increasing cases of food contamination with these heavy metals over the years as reported in several literatures (Ray, 1994; Oehlenschlager, 2002; Damek-Poprawa et al., 2003; Yargholi et al., 2008).

Canned fish is widely consumed in many parts of the world because of its low saturated fat and omega fatty acids that support good health (Ikem and Egiebor, 2005). Fish are constantly exposed to chemicals in polluted and contaminated waters. The effects of these heavy metals on human health have also been reported (Munoz-Olivas and Camara, 2001). Canned foods such as sardines, geisha, and tomato paste are packed in tin or steel cans, an air-tight container for distribution, storage or preservation. High levels of metals may be found in canned foods due to corrosion and leaching of the metals from unlacquered cans, or from tin foils used in packaging. These canned containers have a high potential of releasing metals into the foods.

The most frequently used form of packaging for canned fishery products is tinplate, fabricated into two and three pieces of cans of a wide variety of shapes and sizes. Tinplate consists of a base plate of low-carbon mild steel, onto each surface of which is electrolytically deposited a
layer of tin. Base plate gauge varies, depending on the size of the cans which are to be manufactured and their intended application; however, it is usually between 0.15 and 0.30 mm thick. Tin is applied to provide sacrificial protection of the steel base. The tin layer gradually dissolves and passes into the surrounding solution, while the steel layer beneath remains protected.

Recently, the high cost of tin has made attractive the production of Tin-Free Steel (TFS) in which the conventional tin and tin oxide layers are replaced by chromium and chrome oxide layers. Since the introduction of TFS, there has been development of a third system using neither tin nor chromium but nickel as a coating material for the steel base. In canned fishery products (and with other pertinacious packs such as meat and corn), it is customary to use sulphur resistant (SR) lacquers using neither tin nor chromium but nickel as a coating material for the steel base. SR lacquers have a milky appearance. The reason for the inclusion of white zinc oxide, SR lacquers have a milky appearance. The reason for the inclusion of the zinc is that it reacts with the sulphur compounds, released from the proteins during thermal processing to form zinc sulphide (ZnS) precipitates which cannot readily be detected against the background of the opaque lacquer.

Prolong consumption of unsafe concentrations of heavy metals through foodstuffs may lead to the chronic accumulation of heavy metals in the kidney and liver of humans causing disruption of numerous biochemical processes, leading to cardiovascular, nervous, kidney and bone diseases (FAO, 2001). In order to ensure that these maximum permissible limits are not exceeded, routine surveillance of levels of these toxic metals in food is a necessity. The objective of this study is to investigate the level of these metals in fresh and canned foods largely and frequently consumed in North central, Nigeria.

### MATERIALS AND METHODS

#### Sample collection

Fresh samples of meat and fishes labeled A to E as well as, canned products labeled F to K were purchased from selected retail outlet within the north central Nigeria. The samples were oven dried with close monitoring to reduce the moisture content and to ensure the samples were properly dried and preserved for further processing.

#### Sample preparations and analyses

A portion (1.0 g) of the dried samples was digested with a 20 ml of a mixture of concentrated HNO₃, Perchloric acid and concentrated H₂SO₄ in a kjeldahl flask in a fume cupboard as described in literature (AOAC, 1984). The digest was then allowed to cool and made up to the 500 ml with distilled water. Aliquots of the diluted solution were analyzed for heavy metals, using Atomic Absorption Spectrophotometer (AAS) (Perkin Elmer Analyst AA6800). All analysis was performed in triplicates using an air-acetylene flame.

### RESULTS AND DISCUSSION

Table 1 and 2 shows the mean concentration of Pb, Cu, Zn, Cd and Ni in fresh and canned foods respectively. It

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**Table 1. Concentration in mg/kg of selected heavy metals in some fresh foods.**

<table>
<thead>
<tr>
<th>S/no</th>
<th>Fresh foods</th>
<th>Cd (mg/kg)</th>
<th>Cu (mg/kg)</th>
<th>Pb (mg/kg)</th>
<th>Ni (mg/kg)</th>
<th>Zn (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>0.0073</td>
<td>0.3000</td>
<td>0.1601</td>
<td>0.0003</td>
<td>4.0357</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>0.0106</td>
<td>0.7559</td>
<td>0.1251</td>
<td>0.0005</td>
<td>4.4651</td>
</tr>
<tr>
<td>3</td>
<td>C</td>
<td>0.0073</td>
<td>0.0558</td>
<td>0.0951</td>
<td>0.0006</td>
<td>1.7841</td>
</tr>
<tr>
<td>4</td>
<td>D</td>
<td>0.1919</td>
<td>0.0113</td>
<td>0.2952</td>
<td>0.0044</td>
<td>6.4113</td>
</tr>
<tr>
<td>5</td>
<td>E</td>
<td>0.0141</td>
<td>1.9143</td>
<td>0.1101</td>
<td>0.0005</td>
<td>6.1038</td>
</tr>
</tbody>
</table>

**Table 2. Concentration in mg/kg of heavy metals in some canned foods.**

<table>
<thead>
<tr>
<th>S/no</th>
<th>Canned foods</th>
<th>Cd (mg/kg)</th>
<th>Cu (mg/kg)</th>
<th>Pb (mg/kg)</th>
<th>Ni (mg/kg)</th>
<th>Zn (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>0.0297</td>
<td>0.0965</td>
<td>0.2852</td>
<td>0.0396</td>
<td>0.0526</td>
</tr>
<tr>
<td>2</td>
<td>G</td>
<td>0.0097</td>
<td>0.0686</td>
<td>0.1051</td>
<td>0.0573</td>
<td>0.3075</td>
</tr>
<tr>
<td>3</td>
<td>H</td>
<td>0.0118</td>
<td>0.0558</td>
<td>0.1601</td>
<td>0.0052</td>
<td>0.6573</td>
</tr>
<tr>
<td>4</td>
<td>I</td>
<td>0.0103</td>
<td>0.0671</td>
<td>0.1201</td>
<td>0.0406</td>
<td>1.1726</td>
</tr>
<tr>
<td>5</td>
<td>J</td>
<td>0.0091</td>
<td>0.2329</td>
<td>0.1701</td>
<td>0.0167</td>
<td>1.5472</td>
</tr>
<tr>
<td>6</td>
<td>K</td>
<td>0.0115</td>
<td>0.2065</td>
<td>0.1301</td>
<td>0.0115</td>
<td>1.2813</td>
</tr>
<tr>
<td>7</td>
<td>WHO limit</td>
<td>0.0030</td>
<td>2.0000</td>
<td>0.0100</td>
<td>0.200</td>
<td>3.0000</td>
</tr>
</tbody>
</table>
is observed (Table 1) that fresh tomatoes (sample E), has higher concentration of Zn ions than the canned tomatoes (Samples J and K). The concentration of Zn metal in the fresh tomatoes (6.1038 mg/kg) is about five times that observed for the canned counterpart of samples J and K (1.5472 and 1.2813 mg/kg respectively). The concentration of Zn metal in the canned tomatoes falls below the permissible limit set by World Health Organization (WHO).

However, the levels the metals in fresh tomatoes collected are higher than the standard and calls for concern. The high level of this metal in fresh food may not be unconnected with environmental factors such as polluted soil and polluted waste water used for irrigation of the farms. Similarly, Zn levels in the fresh meat and fish samples (samples A, B, and D) were above the permissible limit set by World Health Organization (WHO). The Zn concentrations were also higher in the fresh sample than the canned products, having concentration in range of between 0.0526 and 1.1726 mg/kg (Table 2). These were below the permissible limit.

The levels of Ni in all the samples were generally low and were found to be below the WHO permissible limit of 0.2 mg/kg. The Ni concentrations ranged from as low as 0.0003 to as low as 0.0006 mg/Kg in fresh foods and from 0.0052 in fresh foods to 0.0573 mg/Kg in canned samples.

The Cu levels in both the fresh and canned samples were below the permissible limit of 2 mg/kg. Cu concentrations ranged from 0.0113 to 1.9143 mg/kg in the fresh food samples while it varies from 0.0558 to 0.2329 mg/kg in canned products. Copper is released into the environment primarily through mining, sewage treatment plants, solid waste disposal, and industrial waste-water.

The experimental data also shows that the more harmful heavy metal of Pb and Cd concentrations was found to be above the standard of World Health Organization (WHO) (Table 2). Pb concentrations were highest in samples D and F and lowest in sample G (0.1051 mg/kg) among the canned samples.

Sample D had the highest Cd concentration (0.1919 mg/kg) among the fresh samples. The maximum levels of Cd permitted by WHO was 0.003 mg/kg. The concentration of cadmium in the canned and fresh food samples ranged between 0.0091 to 0.0297 and 0.0073 to 0.1919 mg/kg respectively. Cadmium may accumulate in the human body and may induce kidney dysfunction, skeletal damage and reproductive deficiencies (Commission of the European Communities, 2001).

It has been reported that the average contents of trace metals in canned anchovies and canned rainbow trout are 22.467 and 11.605 mg/kg for zinc; 1.145 and 0.541 mg/kg for copper; 0.019 and 0.001 mg/kg for cadmium, and 0.188 and 0.167 mg/kg for lead, respectively (Mol, 2011). Waqaf (2006) reported the level of Cd in canned foods as 0.018 and 0.016 mg/kg respectively, which closely agreed with this finding. The concentration of lead (Pb) (0.1201 to 0.2952 mg/kg) obtained in the present study was higher than those reported in canned tuna in the Literature (Ikem and Egiebor, 2005; Cakli et al., 2007). Soldering is a source of lead contamination in the canning process. The monitoring of lead contamination in canned fish is therefore, important for human health.

Conclusion

In this study, the levels of copper, cadmium, lead and nickel and zinc in fresh and canned food samples were investigated. The result of the analysis showed that these heavy metals were present in the selected canned and fresh foods. Considerable differences were found in the levels of these metals among the samples. The levels of Ni and Zn were incompliance with legislation. However, Pb and Cd call for concern as they were found to be above permissible acceptable limit set by World Health Organization (WHO).

The canned samples generally, recorded lower concentration of heavy metals as compared with the fresh food samples and could be considered safer for consumption. Consumption of fishes grown in rivers and fish ponds within the study area should be avoided in order to prevent Cd or Pb poisoning due to accumulation over time. Irrigation of the tomato farms with wastewater could also pose health challenge to the public as shown by this investigation.

It was therefore imperative to monitor comprehensively and periodically heavy metals in both canned and fresh foods in this area in order to advise and safeguard the health of the populace.

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