



Original Research Article

IMPACT OF COOKING UTENSILS ON TRACE METAL LEVELS IN RAW AND HEAT PROCESSED BEANS

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ABSTRACT

White beans bought at Watt market in Calabar, Cross River State was analysed for levels of trace metals and possible contamination. The metals analysed were; iron (Fe), aluminum (Al), copper (Cu), chromium (Cr) and nickel (Ni). Results obtained showed that all metals were within the safe limit except Nickel which was present in relatively very high concentrations; 1.44, 2.62, 4.22 in uncooked, aluminium and stainless steel pots respectively. The highest mean concentration of Cu ($7.26 \pm 0.06\text{mg/kg}$) was indicated in beans cooked with aluminum pot. Results further revealed that, levels of metals in the food item cooked with aluminum pot were higher than their corresponding levels in food items cooked in stainless steel pot and uncooked ones. Cooking utensils can leach some quantities of trace metals into food during processing, hence resulting in slight increase in the concentration of these metals in processed foods.

INTRODUCTION

Studies have shown that the nature of cookwares, cooking process, storage and processing methods can increase trace metal levels in foods (Ebong *et al.*, 2010). Cabrera *et al* (2003) reported that the type of cooking utensil used might contribute some considerable amounts of trace metals into our foods by way of leaching in addition to the ingredients used. In Nigeria, the most commonly used cooking pots are those made of aluminum and stainless steel. The choice of these pots is because, they are the most trendy and cost-effective cookware commonly found in most

Nigerian markets in addition to the fact that they are easy to clean, have distinctive surfaces that cannot crack easily, difficult to rust and high life expectancy (Dan and Ebong, 2013).

Benjamin (2000) noted at the start of the 19th century that kitchen utensils were commonly made of copper, with various efforts made to prevent the copper from reacting with food (particularly its acidic contents) at the temperatures used for cooking, including tinning, enameling, and varnishing. He observed that iron had been used as a substitute, and that some utensils were made of earthenware. Similarly, copper

has good thermal conductivity and copper utensils are both durable and attractive in appearance. However, they are also comparatively heavier than utensils made of other materials, require scrupulous cleaning to remove poisonous tarnish compounds, and are not suitable for acidic foods. Copper pots are lined with tin to prevent discoloration or altering the taste of food. The tin lining must be periodically restored, and protected from overheating. Iron is more prone to rusting than (tinned) copper. Cast iron kitchen utensils, in particular, are however less prone to rust if, instead of being scoured to shine after use, they are simply washed with detergent and water and wiped clean with a cloth, allowing the utensil to form a coat of (already corroded iron and other) material that then acts to prevent further corrosion (a process known as seasoning). Furthermore, if an iron utensil is solely used for frying or cooking with fat or oil, corrosion can be reduced by not heating or cooking with water, and when washing with water it should be immediately dried to completely remove all water. Since oil and water are immiscible, since oils and fats are more covalent compounds, and since it is ionic compounds such as water that promote corrosion, preventing much contact with water reduces corrosion. For some iron kitchen utensils, water is a particular problem, since it is very difficult to dry them fully. In particular, iron egg-beaters or ice cream freezers are tricky to dry, and the consequent rust if left wet will roughen them and possibly clog them completely. When storing iron utensils for long periods, (Van, 1998) recommended coating them in non-salted (since salt is also an ionic compound) fat or paraffin. Iron utensils have little problem with high cooking temperatures, are simple to clean as they become smooth with long use, are durable and comparatively strong and hold heat well. However, as noted, they

rust comparatively. Aluminium is the best material for kitchen utensils. Aluminum's advantages over other materials for kitchen utensils is its good thermal conductivity, the fact that it is largely non-reactive with foodstuffs at low and high temperatures, its low toxicity, and the fact that its corrosion products are white and so do not discolour food they happen to mix into food during cooking. However, its disadvantages are that it is easily discoloured, can be dissolved by acidic foods (to a comparatively small extent), and reacts to alkaline soaps if they are used for cleaning the utensil, etc. Traces of certain metals can cause a variety of undesirable changes in foods during cooking and storage. Even at levels of only a few mg/kg, complexes can be formed between metal ions and organic compounds causing the development of colours (Reilly, 2002).

Beans are one of the most economically and nutritionally important indigenous African grain legumes produced throughout the tropical and subtropical areas of the world. Grains legumes or pulses are rich and low-cost sources of dietary proteins and other nutrients for a large part of world's population (Adepoju *et al*, 2018). This study seeks to assess the impacts of cook wares on the metal levels of beans processed using them, thereby creating awareness on the health implications associated with the application of cooking utensils in food processing.

MATERIALS AND METHODS

protein. The raw beans used for this study was bought from Watt market in Calabar South, Cross River State of Nigeria. Exactly 1kg of beans was washed with distilled water to remove dust particles and divided into three (3) equal parts each, two (2) of which were cooked differently in aluminum pot and stainless steel pot for 45 minutes using electric stove. The soft samples were then sieved to remove water, dried in oven at 105°C for 12 hours, then ground into fine powder. The uncooked part was oven dried at 100°C for

24 hours and grinded using mixer grinder (model 33750). These ground samples were labelled correctly and preserved for digestion and trace metal analysis.

Samples digestion and trace metal determination:

1g of each of the ground samples was weighed into a 125cm³ Erlenmeyer flask, 4cm³ of perchloric acid was added followed by 25cm³ conc. HNO₃ and 2cm³ conc. H₂SO₄, the mixture was left in a fume cupboard overnight. The content was continuously heated at 180°C for 10 minutes until dense white fumes appeared on the topmost part of the flask. The solution was heated again for another 10 minutes until a clear yellow solution was obtained. The resulting solution was allowed to cool, after which

40cm³ of distilled water was added, re-boiled for 30 seconds on the same plate at medium heat. The solution was cooled and then filtered with Whatman filter paper No. 42 into a 100cm³ Pyrex volumetric flasks and made up the volume with distilled water. The trace metal determination was done using Atomic Absorption Spectrophotometer (AAS) model GBC Aranta Pm.

RESULTS AND DISCUSSIONS

The mean levels of five trace metals analyzed for in cooked and uncooked beans using Aluminum and stainless steel pots are presented in Table 1. The results obtained recorded Cu as the metal with the highest concentration and Al with the lowest in both cooked and uncooked beans.

Table 1: Level of trace metals (mgkg⁻¹) in cooked and uncooked beans

Cooking Utensils	Mean conc. In mg/kg dry weight ± S.D				
	Fe	Al	Cu	Cr	Ni
Uncooked	2.12±0.23	0.09±0.00	4.34±0.32	0.31± 0.06	1.44± 0.01
Aluminum pot	2.88±0.15	0.16±0.02	7.26±0.06	0.52± 0.04	2.62± 0.03
Stainless steel	4.17± ,86	0.07±0.01	5.11±0.23	0.77± 0.14	4.22± 0.50

Iron is a mineral that is necessary for life. It plays a vital role in the formation of red blood cells which carry oxygen in the body. Low intake of Fe may cause anemia. However, at high doses, Fe is toxic and can cause severe vomiting, diarrhea, stomach cramps, etc. Iron recorded a mean value of 2.12, 2.88 and 4.17 in uncooked, aluminum pot and stainless steel pot respectively. These values are lower than the recommended safe limit of 13.7 to 20.5 mg/day. This means the mean concentration of beans in this study is within the safe limit.

Aluminum is the third most abundant element in the earth's crust, commonly present in soil, air and water (JECFA, 1982). Daily dietary aluminium intake ranges 2 – 6 mg/day in children to 6 – 14 mg/day in adults. The mean values of aluminium obtained in this study (0.09, 0.16, 0.07 in uncooked, aluminium pot and stainless steel respectively) are lower than the recommended daily dietary intake recommended by WHO. The

concentration of Al was higher in the aluminium pot as compared to stainless steel; this could be due to the nature of the aluminium pot as aluminium forms the major material used in the making of the pot.

Copper according to Codex (1995) is naturally present in most foodstuffs in the form of copper ions or copper salts. It is among the most effective of metal biochemical oxidizing agents. Copper though needed in our body can be harmful if present in excess amount as it acts as a hemolytic agent (Madaki and Asuquo, 2021). Copper recorded mean concentrations of 4.34, 7.26, 5.11 mg/kg in uncooked, aluminium and stainless steel pot respectively. The obtained results also indicated that, levels of metals in the food item cooked with aluminium pot were higher than their corresponding levels in food items cooked in stainless steel pot and uncooked ones. This finding is in line with the reports of Madaki *et al* (2021), who also recorded high values of

metal concentrations in rice cooked with aluminium pot. This confirmed that, aluminum cook wares may contain alloying elements such as magnesium, silicone, iron, manganese, copper and zinc (European Standard EN 601; European Standard EN 602). The high and low Cu levels reported for beans and rice respectively in this study is in agreement with results obtained by Onianwa *et al* (1999) in beans (6.87mg/kg).

Chromium is an essential trace metal. Intake of Cr may improve blood sugar control in people with type 2 diabetes. The adequate intake of Cr daily is 2.0 – 3.5 mg/day. This is higher than the mean concentrations of Cr obtained in this study; 0.31, 0.52, 0.77 in uncooked, aluminium and stainless steel pots respectively. This means the values of Cr obtained in this study are within the safe limit and does not portray metal poisoning. Cr is found in small amounts in a range of foods. However, Cr content varies even among the same types of food, likely due to mineral variations in the soil in which it was grown. Cr may also be inadvertently added into a food when it is processed with stainless steel cooking wares; this explains the high mean concentration of Cr in the stainless steel pot.

Nikel is an essential nutrient in some chemical processes in the body. The body needs nikel but in very small amounts. Ni is safe for adults up to 1 mg daily. Taking more than 1 mg daily is unsafe and can increase the chances of unwanted side effects. Long term exposure to Ni can develop lung disorders and cancer (JECFA, 1982). Ni uptake boosts when people eat large quantities of vegetables from polluted soils. Ni recorded mean concentrations of 1.44, 2.62, 4.22 in uncooked, aluminium and stainless steel pots respectively. These values are higher than the recommended daily dietary limit and could pose a risk. The high values of Ni in uncooked beans could be due to the quality of the soil where the beans were

cultivated.

CONCLUSION

This study has shown that different cooking utensils like aluminum pot and stainless steel pot which are commonly utilize in food processing have different impact on the metal levels of processed beans. The variations in the concentrations of the same metal in different cooking utensil may also be as a result of variations in enzymatic reactions with the food item examined. Although, the levels of iron and aluminum were within their safe limits, further studies should be done on other food items not assessed in this study to avoid metal toxicity in human.

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