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Research Article

THE EFFECTS OF FOOD ADDITIVES ON LEACHING OF ALUMINIUM, CADMIUM, CHROMIUM AND LEAD FROM ALUMINIUM POT (LOCALLY AND INDUSTRIALLY MADE)

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Abstract

Nigeria and other emerging nations' households are rife with aluminum kitchenware. Aluminum's pathological effects on the human body have recently come under scrutiny because it can leach off utensils over time and has been linked to several clinical problems, including anemia, dementia, and osteomalacia. While some studies support the safety of using aluminum foil or cooking utensils, others contend that doing so may result in dangerous quantities of aluminum in the body. However, research has revealed that the amount of aluminum that leaches from cooking utensils depends on a variety of variables, including pH, temperature, and the kind of cooking. Orally consumed aluminum in healthy controls is absorbed from the GI tract and excreted by the kidney at a rate of 0.1%–1%. Despite the metal's propensity, the metal tends to accumulate in tissues and may cause them to become dysfunctional, the literature indicates that people with chronic renal insufficiency are more likely to experience this concern. This study reveals the potential effect of Al, and some heavy metals leaching from Al utensils with the aid of some selected additives.

Keywords: Heavy metals, Utensils, Poisoning, Aluminum, and Food.

INTRODUCTION

Most homes in Nigeria contain aluminum (Al) in one of its many forms. In both poor and rich nations, aluminum foil is frequently used in cooking and food packaging, as well as aluminum wrought utensils for mass cooking in army and dorm messes (Bamji and Kaladhar, 2000). Concerns about aluminum's safety in humans have been raised as a result of its extensive use for such a long time. According to some recent research, the leaching of aluminum from cookware and foil may result in diseases like anemia, dementia, and osteomalacia (Yang *et al.,* 2014; Kawahara *et al.,* 2007). Aluminum metal may be used to create utensils thanks to a few unique physical and chemical characteristics. It is lightweight because its density of 2.7 g/cm3 is less than one-third that of steel (7.83 g/cm3). Alloys containing aluminum as the main metal with additions of manganese, copper, and zinc have high strength. These alloys also resist oxidation that occurs over time. Aluminum forms an inert and colorless aluminium oxide deposit on the exposed surface when it is exposed to air, preventing further oxidation. Additionally, aluminum can withstand corrosion from a variety of other chemical and physical agents as well as corrosion from water, salt, and other environmental agents when it is properly alloyed and anodized (Gupta *et al.,* 2019). Aluminum is so coveted for its light weight, strength, durability, good welding, and chemical resistance. Some of the ways that people are exposed to aluminum are through food additives, water, and cooking equipment made of aluminum. There is evidence to support the claim that using aluminum foil or cooking with aluminum utensils is safe (Ranau *et al.,* 2001; Soni *et al.,* 2001). Contrarily, other research imply that it might result in dangerous quantities of aluminum in people (Weidenhamer *et al.,* 2017; Stahl *et al.,* 2017).

Numerous studies have demonstrated that aluminum leaches from cooking utensils, however, the extent of this phenomenon varied depending on the pH, temperature, cooking medium, food composition, contact time, and the presence of fluoride, sugar, salt, and organic acids (Al Juhaiman, 2012). Studies have been conducted to gauge how much aluminum is evaporating off cookware and to estimate how much aluminum is present in cooked meat extracts (lamb, chicken, and fish), liquid fresh vegetables, and tomato, onion, potato, green beans, and carrot extracts. The utensils' surfaces were examined using a scanning electron microscope. The amount of aluminum that leached from aluminum cookware into various samples varied and depended on the composition of the aluminum, the type of extracts used (for example, tomato extract leached more aluminum due to its acidic nature), the water's quality, table salt, temperature, and immersion time (Al Juhaiman, 2010). In wealthy nations, cooking and storing food in aluminum foil is a primary source of aluminum exposure. Fish fillets baked and grilled in aluminum foil were found to have levels of aluminum that were estimated (Nayak *et al.,* 2010). According to their findings, aluminium leached from the aluminium foil into the food, but the amount of leaching varied depending on the time and temperature of heating, the food's composition and pH, the presence of other materials like salt and organic acids, and the metal's ability to dissolve due to chemical reactions. They came to the conclusion that, with a PTWI of 1 mg/kg body weight (aluminum's PTWI was 1 mg/kg body weight until 2010), consuming food prepared in aluminium foil posed no health risk to consumers. Aluminum is distributed in the whole of food chain as a result of its high presence in nature. the aim of this study is to investigate the relationship between some selected food additives and the leaching of Aluminium, Chromium, Cadmium, Lead from Aluminium pot (locally and industrially made).

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MATERIALS AND METHODS

Equipments

The equipment used is Thermo Fisher's AAS (atomic absorption spectrophotometer)

Apparatus include

Chemical balance, Pyrex beaker, Whatman filter papers, crucibles, volumetric flask, ashing oven, test tubes, measuring cylinder, evaporating dish, fume cupboard, plastic hand gloves, electric hot plate, tong, plastic sample bottles.

Sample collection

Sample of locally and industrially made aluminum pots was obtained from Panteka and Kaduna central market respectively. Sample food additives (maggi, onga and ajino motto) was purchased at the central market, Kaduna, Nigeria.

Leaching experiments

A portion (5g) each of food additives (maggi, onga and ajino moto) was separately dissolved in 100 cm3 distilled water to make a solution of approximately 5% of substance maggi, onga and ajino moto. 5g of aluminum utensils was separately immersed into the solution and heated for 1hour. The procedure was repeated for 1.5 hour, and 2 hours respectively. The sample after cooling was filtered into a 100 cm3 volumetric flask. The resulting mixture was separately digested using the method described by Hornwitz (1980). The digested solution was then transferred into plastic sample bottles and analyzed using AAS.

Determination of Metals in Digested Samples

The digested food additives and aluminum utensil samples was analyzed for heavy metals. The concentration of the metals was determined using Atomic Absorption Spectrometry (AAS). The work was carried out at Department of Chemistry, Nigeria Defence Academy, Kaduna, Nigeria.

RESULTS AND DISCUSSION

Table 1 the results of concentration level of Aluminum (µg/l) in industrially sourced Aluminum Pot

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Food additives	Time of heating 1 hour	Time of heating 1.5 hour	Time of heating 2 hour	Food additives
Locally made	Maggi	0.033	0.055	0.069
Aluminum	Onga	0.527	0.355	0.649
Pot	Ajino	0.335	0.341	0.349
Industriallysourced	Maggi	0.053	0.036	0.050
Aluminum	Onga	0.130	0.149	0.180
Pot	Ajino	0.210	0.290	0.273

From the result above Onga and Ajino mottos aids the dissolution of Aluminum more than Maggi, for example when locally source Aluminum Pot was heated with Onga for 1 hour 0.53µg/g of Aluminum was detected compared to 0.03µg/g and 0.34 µg/g detected when maggi and Ajino were heated with same Pot for 1hour. 0.65µg/g of Aluminum was detected when locally sourced Aluminum Pot in Onga were heated to 2 hours compared to 0.18 µg/g detected when industrially sourced Aluminum pot in Onga were heated for the same hour. Also when industrially made aluminium pot sample was heated with maggi, onga, and ajino moto 0.05ug/g, 0.13ug/g and 0.21ug/g was detected. From the result above locally made Aluminum Pot leaches more Aluminum them industrially made Aluminum pot. This shows that people using Onga and Ajino motto with aluminum cooking utensils (both local and industrial are more prone for consuming more leached aluminium. Continuous consumption of Aluminum can lead to neurological toxicity as reported by (Abercrombie & Fowler, 1997). This shows that people using locally made pot are more likely to contact diseases related with gradual accumulation of aluminum, in the body. Also, Aluminum follow regular pattern of increase with time for both locally and industrially made pot with Maggi, Onga and Ajino motto for example, when locally made aluminum pot was heated for 1hr, 1½ hours and 2 hours with Ajino moto, 0.335µg/g, 0.341 µg/g and 0.349 µg/g was detected respectively. From the study the results show that leached Aluminum concentrations are within the acceptable level as reported by (Nnorom *et al.,* 2007), in rice is 110 µg/g, in tomatoes is 45 µg/g and in water max is 15 µg/g.

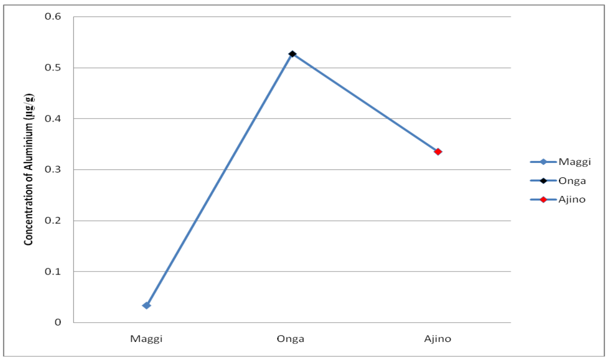

Figure 1. Concentration of Aluminum after heating locally made aluminum pot withfood additives for 1 hour

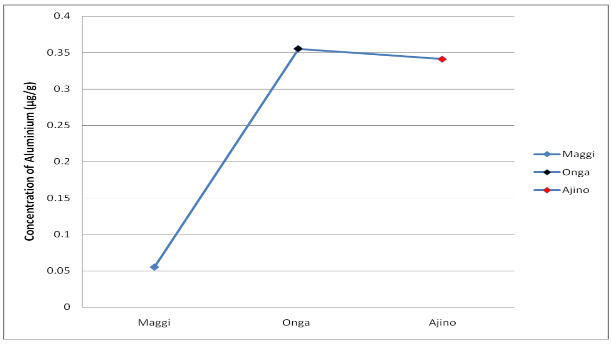

Figure 2.Concentration of Aluminum after heating locally made aluminum pot withfood additives for 1.5 hour

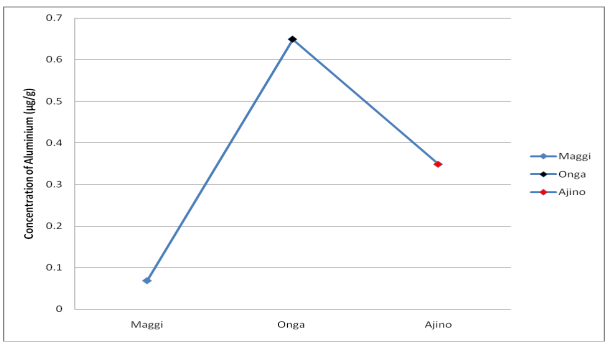

Figure 3. Concentration of Aluminum after heating locally made aluminum pot with food additives for 2 hours

The significance of determination is 0.186 as the highest for heating using locally made aluminum, therefore, about 18% of the variation when compared to other data. We have 95% Confidence Interval of 1.0762 upper in 2 hours of heating, followed by 0.9170 upper in 1 hour of heating and 0.7314 upper in 1 and half hour of heating respectively. The regression equation appears to be very useful for making predictions since the value of t2 is relatively closer to 1. The slope of the graph shows that Maggi additive has the lowest concentration of aluminium in spite of the time of heating and Onga has the highest concentration of aluminium followed by the Ajino. Therefore, it shows that Onga has the highest effect of Leaching compared to Maggi and Ajino when heated with locally made aluminium pots for all the hours.

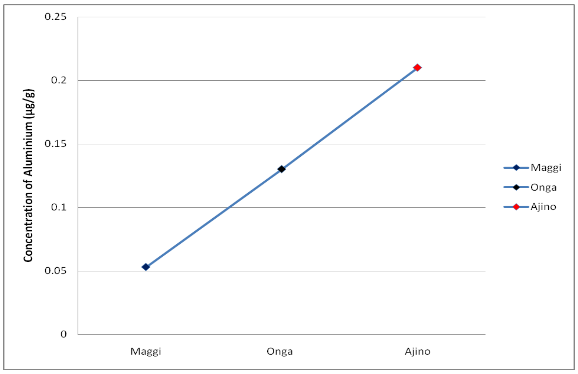

Figure 4. Concentration of Aluminum after heating industrially made aluminum pot with foodadditives for 1 hour

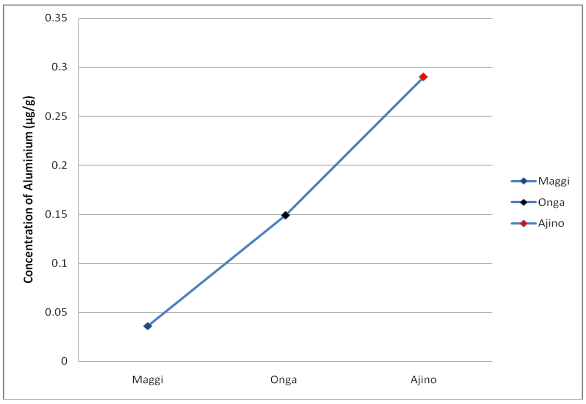

Figure 5. Concentration of Aluminum after heating industrially made aluminum pot with foodadditives for 1.5 hour

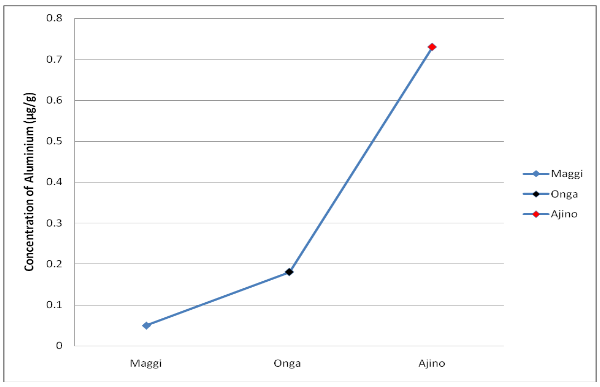

Figure 6. Concentration of Aluminum after heating industrially made aluminum pot with food additives for 2 hours

The significance of determination is 0.158 as the highest for heating using Industrially made aluminium, therefore, about 15% of the variation when compared to other data. We have 95% Confidence Interval of 0.4713 upper in 1 and half hour of heating, followed by 0.4414 upper in 2 hours of heating and 0.3287upper in 1 hour of heating respectively. The regression equation appears to be very useful for making predictions since the value of t2 is relatively closer to 1. The slope of the graph shows that Maggi additive has the lowest concentration of aluminium in spite of the time of heating and Ajino has the highest concentration of aluminium followed by the Onga. Therefore, it shows that Ajino has the highest effect of Leaching compared to Maggi and Onga when heated with Industrially made aluminum pots for all hours.

Conclusion and Recommendation

In conclusion, aluminum pots both locally and industrially manufactured and the selected foods additives contain insignificant heavy metals in varying proportions and can risk person to ingestion of a large number of heavy metals and aluminum and subsequently leading to diseases as shown in the literature. The results of the analysis of food additives (Maggi, onga, and amino motto) and aluminum pots indicate that Al, Cd, Pb, and Cr leached into food cooked in aluminum pots. Also, onga was found to leach more aluminum than Maggi and ajino's. The concentration levels of the alloying metals were found to be slightly higher than the ones stated by (ATSDR, 2012) but were insufficient to constitute a health hazard. Finally, although the concentration level of Al in the food additives and the aluminum pots was below the toxic level, it is important to note that the metals are deposited in the body organs such as the brain, kidney, liver, and spleen (Mohammad *et al.,* 2011). Where they accumulate until the toxic level is reached for the symptoms to manifest. It is recommended that further research work should be carried out on the part this study did not cover such as cooking with acidic and salty dishes. Also, enamel coated steel should be used as cooking pots or utensils because of lesser leaching.

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