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Traditional Utensils: Potential Sources of Poisoning by Heavy Metals

S. Dabonne, B.P.K. Koffi, E.J.P. Kouadio, A.G. Koffi, E.A. Due and L.P. Kouame
Laboratory of Biochemistry and Food Science and Technolgy, University of Abobo-Adjamé 02 BP 802 Abidjan 02 (Côte D'Ivoire)

Abstact: A research study was conducted to show some traditional utensils as potentials sources of poisoning by heavy metals. Milled rice was cooked in a traditional aluminum pot to assess the level of contamination of food by the utensil when cooking. Results showed that aluminum content of cooked rice increased from 1.6 to 18.1 mg/g, more than 11 times (ATT = 11.31). It was also demonstrated that protective layer of inert material present in modern utensils was a good way to protect food from contamination while cooking. Analysis of the mineral composition of an other traditional utensil made of clay showed a high content of aluminum (87.5 mg/g) showing that it is also a potential source of food contamination by aluminum.

Key words: Food safety, intoxication, pot craft, toxic minerals

INTRODUCTION

Monitoring the presence of heavy metals in foods intended both for human and animal is of interest because of their toxic effects (Cabrera *et al.*, 2003). Although they can be found in high concentrations in the body, a number of heavy metals such as aluminum, beryllium, cadmium, lead and mercury have no known biological function. Others, such as arsenic, copper, iron and nickel are considered essential at low concentrations but are toxic at high levels (Rignell *et al.*, 2009; Chen *et al.*, 2009). In general, heavy metals disrupt basic metabolic functions in two ways. On the one hand, they disrupt the functioning of vital organs and glands such as the heart, brain, kidney, bone or liver and secondly they move nutrients that are essential minerals and they prevent them from fulfilling their biological function. For example, aluminum as a chelator has the ability to capture and prevent the uptake of essential elements and thereby disrupt the proper use of many of them such as calcium, zinc or copper (Couzy and Mareschi, 1988). This metal is heavily involved in the onset of Alzheimer's disease (Harrigton, 1994). It is responsible for the alteration of neurons (Crapper *et al.*, 1976; Miu and Beng, 2006; Bharathi *et al.*, 2008). Environmental pollution is a major cause of the presence of heavy metals into the food chain (Nnorom *et al.*, 2007). Food can be contaminated during the different stages of agricultural production, particularly in the soil where heavy metals may be naturally present (Zhuang *et al.*, 2009). The transformation is also a major source of food contamination by heavy metals (Anderson *et al.*, 1992). Indeed, the transformation process requires the use of utensils and ingredients that are responsible for the presence of heavy metals in food (Cabrera *et al.*, 2003). Located at the end of the chain of food preparation, packaging and cooking utensils contaminate food based on materials used in their design. This is the case of aluminum used for bleaching rice (Guerardi, 1999).

In Côte d'Ivoire, as in most developing countries, much of the urban population and almost all rural population still use traditional cooking utensils. Examples are the clay and aluminum pots. Unlike modern utensils, traditional one do not have a protective layer of inert material to prevent contamination of food.

This study aims to determine the transfer rate of aluminum in the food during cooking in aluminum pot craft and secondly the heavy metal content of a traditional cooking utensil made of clay.

MATERIALS AND METHODS

Equipment used: The aluminum (Fig. 1A) pot comes from a traditional forge located in Abobo, a district of the capital Abidjan. A modern aluminum pot (Fig. 1B) with a protective layer of inert material was purchased. The clay utensil (Fig. 1C) comes from a manufacturing site located at Katiola, a city in northern Cote d'Ivoire. Milled rice was used for determining the rate of transfer of aluminum during cooking.

Determination of aluminum transfer: One and a half liters of demineralized water is boiled in the aluminum pot and then 1 kg of rice (RCT: Rice Cooked in Traditional utensil) is added for cooking at low heat during 20 min. One kg of rice (RCM: Rice Cooked in Modern utensil) is also cooked using the same protocol in the modern

Corresponding Author: Soumaila Dabonne, Laboratory of Biochemistry and Food Science and Technolgy, University of Abobo-Adjamé 02 BP 802 Abidjan 02 (Côte D'Ivoire). Tel: + 225 08 68 68 46, Fax: + 225 20 30 43 00

Fig.1: Photographs of equipment used. A: Traditional aluminum pot without a protective layer of inert material, B: Modern aluminum pot with a protective layer of inert material, C: Clay utensil

aluminum pot possessing a protective layer of inert material. On hundred grams of uncooked rice (UCR: UnCooked Rice) and 100 g each previously cooked rice are dried at 105ºC until constant weight in a ventilated oven. Five grams of each sample of dried rice are incinerated in a muffle furnace at 550ºC for eight hours. The aluminum content of the ash obtained is determined by the method of AOAC (1990) using atomic absorption spectrophotometer. The transfer rate of aluminum by each type of utensil to food is evaluated by the Eq. (1) and (2).

$$ATT = RCT \,/\, URC \quad (1)$$
$$ATM = RCM \,/\, URC \quad (2)$$

ATT: Aluminum Transfer by Traditional utensil, ATM : Aluminum Transfer by Modern utensil

Determination of metal content of a traditional cooking utensil made of clay: A fragment of 5 g of the clay utensil is dissolved by the method of Mehdi *et al.* (2003). The resulting solution is analyzed by atomic absorption spectrophotometry for the detection and quantification of heavy metals.

Three trials were conducted for each analysis and averages and standard deviation were calculated.

Table 1: Aluminum content of raw rice and rice cooked in modern and traditional utensils

	URC	RCM	RCT
Ash content (g/100g de MS)	0.93±0.03a	0.95±0.02a	1.24±0.10b
Aluminium content (mg/g MS)	1.6±0.4a	1.7±0.3a	18.1±1.4b

RCT: Rice Cooked in Traditional utensil; RCM: Rice Cooked in Modern utensil; UCR: UnCooked Rice
Values are mean of 3 determinations ±S.D. Values with different letters in lines differ significantly ($p<0.05$)

Table 2: Level of transfer of aluminum from utensil to rice

ATT: RCT / URC	ATM : RCM / URC
11.31a	1.06b

ATT: Aluminum transfer from traditional utensil; ATM: Aluminum transfer from modern utensil
Values are mean of 3 determinations ±S.D. Values with different letters in lines differ significantly ($p<0.05$)

Table 3: Metal content of the utensil made of clay

Metals	Al	Fe	Cu	Zn	Pb	Cr	Ni
Content mg/g	87.5±02a	28.9±03b	<0.1c	<0.1c	<0.1c	<0.1c	<0.1c

Values are mean of 3 determinations ±S.D. Values with different letters in lines differ significantly ($p<0.05$)

RESULTS AND DISCUSSION

Table 1 shows the ash content of different samples of rice. With respectively 0.93 and 0.95%: UnCooked Rice (UCR) and Rice Cooked in Modern utensil (RCM) have the same ash content. In contrast, the Rice Cooked in Traditional utensil (RCT) with a rate of 1.24% has significantly ($p<0.05$) higher ash content. Samples URC and RCM with respectively, 1.6 and 1.7 mg/g of dry matter have also the same levels of aluminum. RCT has a higher ($p<0.05$) content of aluminum with 18.1 mg/g dry matter. Results obtained with URC and RCM are closed both for the rates of ash and aluminum (ATM = 1.06). This result demonstrates the effectiveness of the protective layer of inert material, whose role is to prevent the contamination of rice by the aluminum coming from the utensil. However, the levels determined in samples URC (1.6 mg/g) and RCM (1.7 mg/g) are significantly higher than average levels found in foods that are lower than 0.005 mg/g dry matter (Rifat, 1994; EFSA, 2008). The rice used for this study is milled rice. One explanation for the strong presence of aluminum could be the treatment of bleaching of rice done by aluminum salts. The presence of aluminum in the culture medium and the natural phenomenon of metal accumulation in some plants (Harrigton, 1994; Zhuang *et al.*, 2009) could also contribute to this high level that does is not originate from the cooking utensils.

The results also revealed a high contamination of cooked rice in traditional utensil made of aluminum. In fact, after cooking the aluminum content of rice increased from 1.6 to 18.1 mg/g, more than 11 times (ATT = 11.31) (Table 2). The traditional pot is therefore directly responsible for this contamination.

The analysis of the clay forming the utensil made of this material reveals a strong presence of aluminum (87.5 mg/g) and iron (28.9 mg/g). Other metals, like copper, zinc, lead, chromium and nickel are present at contents below 0.1 mg/g (Table 3). This traditional utensil is very commonly used in Côte d'Ivoire. It is used both for cooking and consumption of food. Its metals content shows that it is also a potential source of food contamination by aluminum. Its high content (87.5 mg/g) is due to the chemical composition of the site that provided the clay used for the manufacture of the utensil. In fact, aluminum is one of the most abundant elements in the earth' crust. It is present in soil and water (Keith *et al.*, 2002; Liang *et al.*, 2009). The analysis also revealed the presence of several other metals among which there are elements such as lead, chromium and nickel, which are potentially toxic to humans. Whatever with low concentrations, these metals like aluminum present a risk for the consumer especially in the prolonged exposure materialized by the daily use of kitchen utensils.

CONCLUSION

This study highlights the potential toxicity of two traditional utensils. These utensils are therefore a real source of contamination by heavy metals for people in poor countries who use them daily. In conclusion, this study shows that cooking utensils can be a source of contamination by toxic metals.

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