

# The ways of food contamination by aluminum

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## Abstract

Aluminum foil is used broadly in food preparation, mainly due to its usage simplicity and manipulation in the kitchen. The simplicity of aluminum foil usage and manipulation can be seen through the facts that aluminum foil is protecting food from the direct influence of heat and consequently it is slowing or stopping food drying, or if food is cooked in water it stops dissolving. Since the usage of aluminum foil is growing the concerns about food contamination with aluminum is also increasing, and should be taken into consideration among present studies. At the present time there are not updated results about the presence of aluminum in food during preparation in aluminum foil, especially because many publically present food recipes (sources such as: internet and different culinary journals) include aluminum foil in dish preparation.

Keywords: *aluminum, food, diet, cooking.*

## Introduction

Aluminum is the third element the most abundant on the Earth. The main source of aluminum toxicity for humans is food. The amount of aluminum included in daily diet is affected by food included in diet. It leads to the conclusion that aluminum daily intake varies in dependence with country and population eating habits. Since certain additives can contain Al, state legislation about the usage of additives affects Al intake same as Al content in potable water (Yokel, 2012).

The intake aluminum limit in diet ranged from 7 mg/kg (in 1989) of body weight to 1 mg/kg of body weight (in 2006) and in 2011 the estimated limit calculated on kg of body weight is 2 mg/kg (WHO, 1989; Center for Food Safety, 2009; World Helath Organization, 2011). Daily intake of Al very greatly among human population in different countries due to factors: 1) Al contamination of food and water; 2) different diets; 3) different recipes that include aluminum utensils and aluminum foil in food preparation. For an example Aluminum daily intake among Chinese population is calculated to be around 10 mg (Wang, Su, and Wang 1994).

Aluminum (Al) is the neurotoxin agent since it accumulates in brain, bones and liver. Higher concentrations of Al have been connected with Alzheimer's disease, Parkinson's disease and diseases like dialysis encephalopathy, bone disorder and other disorders (Al Zubaidy et al., 2011; Al Juhaïman et al., 2014; Rittirong and Saenboonruang, 2018). The studies have been conducted to evaluate human exposure to Al via food and aluminum kitchenware (Al Juhaïman et al., 2014).

When food is packed following properties of packed food product should be taken into consideration due to aluminum contamination: pH, salt concentrations, chemical composition of the food, same as expected shelf life of the food (Zurlini and Montanari, 2017).

It should be stressed out that more attention to the issue concerning food intoxication with aluminum should be paid since its high toxicity and relation with serious human disease same as the fact of the presence of many recipes that include aluminum foil in meal preparation.

## Aluminum presence in the food

The reasons for aluminum presence in food can be overviewed by the board Al presence in the environment. Consequently, Al is absorbed by plants through soil and water; and it is

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included in the food chain. It was calculated that human's daily intake of aluminum from food ranges from 3.5 mg/kg to 10 mg/kg. Food additives also represents higher source of aluminum in human daily diet, while drinking water is estimated to represent the source as high as 0.1 m/kg (Yokel, 2012). Some of food additives containing aluminum are: aluminum metal (E173), aluminum sulfate (E520), aluminum sodium sulfate (E521), aluminum potassium sulfate (E522), aluminum ammonium sulfate (E523) (EC 1333/2008). One of the reasons why Al is present in food is also due to plant absorption of Al from soil and water (Jalbani et al., 2007).

The limit of aluminum content per week is estimated to be 1 mg/kg of body weight (EFSA, 2008). The studies have been conducted to estimate total aluminum intake in following countries: Canada and the Unites States, Europe (England and the U.K., France, Germany, Hungary, Italy, Netherlands, Portugal, Spain and the Canary Islands, Sweden, and Slovenia), Asia (China, India, Japan, and Taiwan), Australia and Brazil. The studies included following estimation methods: duplicate portion studies of composite diets, total diet studies, calculations based on the foods in a total diet study times their Al content, and market basket surveys. The aluminum intake ranges from 0.7 to 8.6 mg (Yokel, 2012). Higher Al intake was found to be among adolescents due to their higher total food intake same as the higher consumption of processed food (Yokel, 2012). Exposure to Al in the US is found to be mainly due to food additives (WHO, 1997). Aluminum daily intake among Chinese population is calculated to be around 10 mg (Wang, Su, and Wang 1994). In the Europe the situation is better due to less usage of food additives containing aluminum, especially in cereal grain products and processed cheese (Humphreys and Bolger, 1997). Aluminum is present also in staple food such as bakery products and it was found to range from 7.4 mg/kg to 70.2 mg/kg (Jalbani et al., 2007). In the study was evaluated that Al content in mixed human diet is around 10 mg/kg, while in citrus leaves is around 90 µg/g (Lopez et al., 2002). Aluminum content in food is very variable and it ranges from 0.1 mg/kg to 330 mg/kg (oysters) and from 332 mg/kg to 413 mg/kg (salads) (Scancar et al., 2004).

### **Aluminum food contamination during cooking**

Compared with the estimated Al daily intake, older literature data are indicating that cooking utensils contribute up to 2 mg of aluminum in diet (Jorhem Haeggglund 1992). The fact is that in many countries aluminum utensils are not in broad usage anymore, but the usage of aluminum foil is actually in constant growth. The recipes that include aluminum foil is presented and applied broadly due to its easiness of usage and manipulation. The issue is explained better due to the fact that the dissolution of Al is in high relation with pH, salt content, temperature and the presence of complexing agents (Wang and Wang, 1994; Al Juhaiman et al., 2014).

The increase of aluminum concentrations during cooking were noticed in following researches:

- Chinese noodles cooked in not treated pan (Inoue et al., 1988).
- Tomato juice cooked in not treated pan (Inoue et al., 1988).
- Ground beef, potatoes and tomatoes cooked in new, conditioned and old aluminum pans (Greger et al., 1985).
- Applesauce, beef, rump roast, cabbage, cauliflower, chicken, cod, eggs and ham cooked in conditioned aluminum pans (Greger et al., 1985).
- The increased leakage of Aluminum in the presence of cardamom and NaCl (Al Juhaiman et al., 2014).
- The increased leakage of Aluminum in the presence of ascorbic, citric, and tartaric acids with and without chloride ions (Al Mayouf et al., 2008).

- Increased Al concentrations in canned foods, drinks and beverages (Nicholas et al., 2013).
- The aluminum contents in canned fresh meat (bovine, veal and pork) were not extremely low (Arvanitoyannis, 1990).
- Pured fruit and vegetables stored in aluminum containers found to contain after a few months of storage up to 90 mg/kg aluminum concentrations (Zurlini and Montanari, 2017).
- Containers with aluminum lids of food products that have silicon layer were found to not have good corrosion resistance during food shelf life (Zurlini and Montanari, 2017).
- During cooking of acid food, aluminum is freed from the cooking pot (Scancar et al., 2004).
- During roasting and grilling aluminum passes from aluminum foil, but in dependence on meat type and used condiments (vinegar, salt, onion, etc.) (Ranau et al., 2001; Turhan, 2006).
- Aluminum in the presence of fluoride ions formed active fluoraluminum complexes which also represents a hazard for consumers (Strunecka and Patocka, 2001).
- Aluminum was transferred to red meat wrapped in aluminum foil (Turhan, 2006).

### Conclusion

Aluminum content in food is getting and certainly will get more attention due to the discovered facts about aluminum content predisposition to be the cause of serious human disease. Consequently, the source of aluminum contamination will be the focus of the present and future research. Not negligible source of aluminum food contamination is certainly the transfer of aluminum during cooking processes, especially during the usage of aluminum foil.

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