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MONITORING OF ALUMINUM RESIDUES IN COOKED MEAT

(With 4 Tables)

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تقدير بقايـــا الآلومنيوم فى اللحوم المطبوخة

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يهــدف هــذا البحــث إلــى دراســة تأثير نوع أوعية المطبخ المصنوعة من الآلومنيوم المســتخدمة فــى طهــى اللحوم على محتوى الألومنيوم فى اللحوم المطبوخة وذلك خلال عملــيات طــبخ مختلفة – لحوم مسلوقة ، لحوم مطبوخة بالبصل ، لحوم مطبوخة بالبصل والطمــاطم – وحفظهــا على درجة حرارة الثلاجة (٤م) لمدة ٧٢ ساعة. أوضحت النتائج احــتواء اللحوم التى تم طهيها بالاوانى الالومنيوم على نسبة عالية من عنصر الالومنيوم. كذلك وجد أن اضافة البصل والطماطم أدى إلى زيادة هجرة عنصر الآلومنيوم من الأوعية إلــى اللحوم خلال الطبخ أو الحفظ على درجة حرارة الثلاجة بينما أدى سلق اللحوم بدون اضــافات إلــى تقلــيل نسبة الألومنيوم الموجودة فى اللحوم. هجرة عنصر الألومنيوم من الأوانــى إلــى الأغذيــة تعتمد على بعض المؤثرات مثل التكوين الكيميائى للأغذية، فترة ودرجــة حــرارة الطهى والحفظ وأيضا الأضافات التى تضاف إلى الأغذية ودرجة جودة الأوانى نفسها.

SUMMARY

Effect of kitchen aluminum utensils on aluminum content of meat (cooked in different methods) during cooking and holding at 4^0 C for different periods were studied. The result indicated that the migration of aluminum from aluminum pan into meat was great. The aluminum content of meat samples were determined before and after the samples were cooked and stored in aluminum pan at 4^0 C for different periods. Highest concentrations were found in meat cooked with onion and tomato .Low concentrations were found in meat cooked by boiling without adding any ingredients. The aluminum migration seems to depend on several factors, such as the chemical constituents of food, the duration and the temperature of cooking and storage, the addition of

any other substances and complexing reactions that result in dissolution of the complexed metal.

Key words: *Aluminum residues, cooked meat, aluminum utensils.*

INTRODUCTION

Environmental pollution represents a major problem in both developed and under eveloped countries. Egypt is one country which suffers from high biosphere pollution (air, soil, and water). Many ecological changes occur in water as a result of human activities, including agricultural and municipal wastes (Atta, *et al.,* 1997).

There is an international concern about human intake of toxic trace elements, such as cadmium, lead, mercury, aluminum and others. Intake of relatively low doses of these elements over a long period of time can cause malfunction of organs and chronic toxicity.

Aluminum (AL) is the third most abundant element in the lithosphere and the aluminum resources are considerable. During the last 100 years of industrialization, the importance of aluminum has strongly increased. Because of its favorable physical characteristics, aluminum has become indispensable in many industrial areas, e.g. the packaging industry, as well as in daily life.

Aluminum compounds used as food additives are an additional source of this element in food in many countries. Such additives are not permitted. Food pollution with aluminum may, to some extent, be augmented by use of aluminum cutlery and kitchen utensils, equipment used in food industry, as well as packaging (Shaalan, 2002).

Many possible sources of aluminum intake by the human body exist, e.g. drugs, foods, drinking water and, industrial exposure. Food is the main route by which the normal daily intake of aluminum occurs. The total aluminum content arises from food containers such as cans, cookware, utensils and food wrappings. It has been established that cooking of acidic and low acidic foods in aluminum saucepans or foil causes leaching of the metal (Liukkonen- Lilja and Piepponen, 1992; Brunner, *et al.,* 1999; Rajwanshi *et al.,* 1999; Takeda *et al.,* 1998 a, b and 1999). Food, which were manufactured and stored in aluminum cans, showed an increased aluminum content (Aikoh and Nishio, 1996; Rajwanshi *et al.,* 1997; Seruga *et al.,* 1997)

High levels of aluminum in foods can be attributed to chemical corrosion by acids or alkalis during boiling for short period in aluminum vessels, electrochemical corrosion when foods are left in contact with aluminum vessels for long periods, acidic and salty food increasing concentration of complexing ions, (Mei and Yao 1994; Gramiccioni *et al*., 1996 and Shuping 1996).

Aluminum ions in the human diet are non bio available from the small intestine because the hydrated charged ions are not able to penetrate the lipid protein membranes of the duodenal mucosa. But it can be assumed that at least part of the human dietary aluminum intake is in the form of chelates with natural food components such as citric and lactic acids (Shuping, 1996) In the human body aluminum ions could inhibit different metabolism processes caused by competition reactions between aluminum and other ions such as calcium, magnesium or iron (Macdonald and Martin, 1988). Therefore, aluminum has been associated with several skeletal osteomalacia (Blumenthal and Posner, 1984; Boyce *et al.,* 1982; Bushinsky, *et al.,* 1995) and neurological disorders e.g Alzheimer's disease (Armstrong *et al.,* 1996 and Lamb, 1995).

In recent years aluminum is responsible for another neurological disorder: encephalopathy or dialysis dementia (Alfery, 1997; Meiri *et al.,* 1992) in uremic patients on dialysis.

The extent of the increase of aluminum is dependent on factors such as temperature, pH value, duration of contact or heating, presence of sugar, organic acids, salt and other ions (Ranau *et al.,* 2001)

The average daily intake of aluminum for adult men, women, 6-11 month old infants and 14-16 years old males is 8-9, 7, 0.7 and 11.5 mg/day respectively (Becker, *et al.,* 1990).

Food cooked in aluminum utensils is widely consumed in Egypt consquently the aim of the present work is to measure the aluminum content of these foods (meat cooked in aluminum utensils with different methods and stored in refrigerator for different times).

MATERIALS and METHODS

Thirty samples of meat cooked in aluminum utensils with different methods (boiling in water, boiling in water with onion, and boiling in water with onion and tomato, each 10) analyzed for aluminum content by the wet oxidation method, according to AOAC (1990) by using a Perkins Elmer 2380 Atomic Absorption Spectrophotometer at wave length 309, temp. 2900-3000°C with nitrous oxide and acetylene.

All samples were cooked until complete cooking in aluminum utensils, cooled, stored at frigidaire in aluminum pan for 72 hr. and analyzed for their aluminum. content after 0, 12, 24, 36, 48, 60 and 72 hr.

Tomato and onion used in cooking were, analyzed for aluminum content, before cooking. Each sample was minced and homogenized and subjected to aluminum determination.

RESULTS

Table 1: Levels of aluminum content (mg/kg wet weight) in raw meat, onion and tomato.

Sample	Mean ±SD	Min.	Max.
Raw meat	34.039 ± 0.98	11. 279	36.069
Raw onion	0.129 ±0.24	0.063	0.236
Raw tomato	0.147± 0.45	0.097	0.155

Table 2: levels of aluminum(mg/kg wet weight) in cooked meat in boiling water in aluminum pan.

Time for storage	Mean ±SD	Min	Max
0	11 . 34 ± 4.2	6. 79	14.11
12	13 .15 ±1.45	10.09	17.99
24	18.06± 2.50	14.76	20.12
36	24.31±15.91	15.45	27.11
48	26.22±16.22	15.65	33.32
60	29.40± 8.46	20.74	37.32
72	32.13 ± 1.69	20.98	41.64

Table 3: Levels of aluminum (mg/kg wet weight) in cooked meat with onion in aluminum pan.

Time for storage	Mean SD	Min	Max
0	48.15 ± 8.25	35.94	50.174
12	52.09±5.12	50.346	60.95
24	61.86±4.05	60.12	67.00
36	63.74±8.94	62.89	70.54
48	79.35±3.72	72.68	82.66
60	83.04± 1.94	80.09	86.33
72	92.18± 2.17	85.34	98.77

Table 4: Levels of aluminum (mg/kg wet weight) in cooked meat with onion and tomato in aluminum pan.

Time for storage	Mean SD	Min	Max
0	120.24± 25.73	100.29	129.35
12	135.19± 16.44	130.76	140.49
24	146.36± 7.51	135.81	150.12
36	169.05± 4.69	154.00	182.86
48	195.78± 0.81	190.55	198.81
60	219.31± 11.93	208.63	231.05
72	237.73± 8.65	220.75	266.17

DISCUSSION

In this investigation the aluminum content of meat cooked in aluminum pan with different cooking methods (boiled in water, cooked with onion and cooked with onion and tomato) was determined. Table (1) represents the aluminum contents of raw meat, onion and tomato. All values are given in mg Al\kg (ppm) wet weight. Additionally the proportional increase are given in Tables (2, 3 and 4).

For cooked meat with boiling in water in aluminum pan, table 2 showed the aluminum level of meat during storage where time "0" is the time of complete meat cooked while 12, 24, 36, 48, 60, 72 hr are times of storage of meat in refrigerator in aluminum pan. The mean values were 11.34, 13.15, 18.60, 24.31, 26.22, 29.40 and 32.13 mg Al/kg respectively. When compared with raw meat (34.o34 mg Al/kg), a decrease in the level of aluminum was observed, this because migration of aluminum from aluminum pan into food simulating solvents. All parameters, the type of solvent, the temperature and the time of storage affected the magnitude of aluminum dissolution. The aluminum migration into acidic solvents when heated (at temp 95°C for 30 min), was higher than that into tap water (Takeda *et al.*,1998 b).

Table (3) showed the levels of aluminum content in meat cooked with onion in aluminum pan and stored at different times in refrigerator when compared with raw meat, we found that all samples increased in its aluminum content after cooking and storage. On the basis of these data, it could be concluded that acidic and salted foods increased the migration of aluminum into foods as the result of enhancing chemical and /or electrochemical corrosion. These data are in accordance with those reported by Gramiccioni *et al.* (1996) who reported the highest release of aluminum into acidic and salted foods from cookware. Also, Mei and Yao (1994) reported that aluminum concentration increased due to chemical corrosion by acids and alkalis during boiling and storage for short periods.

Table (4) showed the levels of aluminum content in meat cooked with onion and tomato in aluminum pan and stored at different times in refrigerator when compared with raw meat, we found all samples increased in aluminum content. These data are in agreement with those reported by Gavgominy and Astier (1995) who reported that the acidity of tomatoes results in great migration of aluminum into the product. Shuping (1996) also found that increasing concentration of complexing ions (organic acids, fluoride ion, OH) significantly enhanced the release of aluminum Takeda *et al.* (1998, a) have reported aluminum migration from aluminum pan into foods and the effect of food components on the migration. The migration level in all heat (30 min at 95°C) and acidic foods (including orange and tomato juice, yoghurt and different types of pickles and vinegars) were less than that in 4% acetic acid. Dissolution of aluminum was enhanced by the addition of sodium chloride but was reduced by the presence of proteins, amino acids, sugar or cholesterol.

In conclusion it could be concluded after the three methods of cooking that meat cooked in boiling water appeared to be the best one because the amount of aluminum was lower than the raw meat itself.

Regarding the body weight, present state of knowledge and the suggested provisional tolerable daily intake of l mg Al /kg body weight per day of the World Health Organization 1989, there is no evident risk to the health of the consumer from eating 200 gm daily of cooked meat prepared in aluminum pan and care should be taken when using aluminum containers for storage of food because of the health risks associated with high aluminum intake.

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