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TRACESS OF ALUMINIUM IN RAW MILK AND THE EFFECT OF BOILING OF MILK AND STORAGE IN THE ALUMINIUM UTENSILS

(With 2 Tables)

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بقايا عنصر الألومنيوم باللبن الخام وتأثيره على اللبن عند حفظه بالأوانى الألومنيوم

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بعض الأبحاث ذكرت أنتقال عنصر الألومنيوم من اوانى الطهو الألومنيوم الى الطعام أثناء اعداده ولأن اللبن الخام له أهمية كبيرة للكبار والصغار وطريقة تعقيمة تتطلب غليانة لمدة من الوقت ، وفى مصر تنتشر الأوعية الألومنيوم. لذا كانت فكرة البحث التأكد من هل هناك خطورة من تناول اللبن بعد غليانة وحفظة فى الأوعية الألومنيوم. اوضحت النتائج ان نسبة الألومنيوم فى عينات الألبان المفحوصة تعتبر قليلة بالنسبة للنسب القياسية للألومنيوم فى الأغذية، كما أن هجرة عنصر الألومنيوم من أوعية الطهى الى اللبن كانت بنسبة قليلة غير جوهرية.

SUMMARY

The level of aluminium was evaluated in raw milk sold in markets and the effect of Kitchen aluminium utensils on aluminium content of milk during boiling and storing at 4^oC for different periods, the amount of aluminium was determined by atomic absorption spectrophotometry. The aluminium concentration in raw milk samples ranged from 0.1 to 1.7 with a mean of 0.84ppm, these values are below the tolerable daily intake (1mg/kg of body weight per day)which has been established by an international committee of experts under the auspices of the world Health Organization and the Food and Agricultural Organization of the united nation, the results showed that the increase in aluminium due to migration from aluminium and stainless steel utensils during boiling and storage of milk was relatively low.

Key words: *Milk, aluminum, aluminum utensils*

INTRUDUCTRION

Environmental pollution represents a major problem in both developed and underdeveloped countries. Egypt is a 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).

Aluminium is the third most abundant element in the lithosphere and the aluminium resources are considerable. During the last 100 years of industrialization, the importance of aluminium has become indispensable in many industrial areas, e.g. the packaging industry, as well as in daily life.

Aluminium 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 aluminium may, to some extent, be augmented by use of aluminium cutlery and kitchen utensils, equipments used in food industry, as well as packaging (Shaalan, 2002).

Many possible sources of aluminium 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 aluminium occurs. The total aluminium 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 aluminium 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 and 1999). Food manufactured and stored in aluminium cans, showed an increased aluminium content (Aikoh and Nishio, 1996; Rajwanshi *et al.,* 1997; Seruga *et al.,* 1997).

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

Sensetivity of infants and children to the environmental contamination is more than that of adults, because the permeability of the gastrointestinal tract of infants is great, as protective mechanisms have not yet fully developed, to allow many of the substances in human mother's milk to systemically permeate the body of the infant. Unfortunately, the same lake of protection seriously impairs an infant who consumes infant formula, especially soy formulas, and bovine milk. Research work, indicates that aluminium concentrations in most cow's milk is 20 times greater than human breast milk (5-20mcg/l) and 100 times greater in soy-based formulas (Pediatrics, 1986). In Dakahlia Governorate, Egypt, Maha Al-Ashmawy (2009) reported that, the aluminium content in examined bulk farm milk was ranged from 0.00284 to 0.00867 mg/L, while in market milk reveal higher concentration ranging from 0.02113 to 0.18350 mg/L.

Healthy adults are in zero balance for Al. The gastrointestinal tract excludes greater than 95% of diatery Al, and kidney is the dominant organ for Al excretion. However, even with normal renal function, only 30-60%of an Al load from parenteral nutrition is excreted in the urine, resulting in tissue accumulation of Al. The risk for Al toxicity is greatest in infants with chronic renal insufficiency, recipients of long term parenteral nutrition, i.e., no gut barrier to Al loading, and preterm infants with low Al binding capacity. (Koo, and Kaplan, 1988)

Aluminium ions in 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 aluminium intake is in form of chelates with natural food components such as citric and lactic acids (Shuping, 1996). In the human body aluminium ions could inhibit different metabolism processes caused by competition reactions between aluminium and other ions such as calcium, magnesium or iron (Macdonald and Martin, 1988). Therefore, aluminium 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 aluminium is responsible for another neurological disorder: encephalopathy or dialysis dementia (Alfrey, 1997; Meiri *et al.*, 1992) in uremic patients on dialysis.

The extent of the increase of aluminium 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 aluminium 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). A tolerable daily intake (TDI) for aluminium of 1 milligram per kilogram of body weight per day has been established by an international committee of experts under the auspices of the World Health Organization and the Food and Agricultural Organization of the United Nations (Bureau of Chemical Safety, 2003).

Boiling of milk in aluminium utensils is common in Egypt, for sterilization of milk which is consider as an important food for infant and children. The aim of the present work is to measure the aluminium content of the raw milk and whether the boiling process in aluminium utensils leads to increase of its amount.

MATERIALS and METHODS

The experiment samples (raw cow milk) and commercial samples (10 raw milk samples) were obtained from Cairo Governorate, send to the laboratory and analyzed for their Al. content by wet oxidation method, (AOAC, 1990) using Perkins Elmer 2380 Atomic Absorption Spectrophotometer at wave length 309 temp. 2900-3000^{o}C with nitrous oxide and acetylene.

Experiment samples were 3 samples of raw cow milk of weight 1000 gm, obtained from commercial dairy shops, each sample was divided into 3 portions, the first was examined as control, the second was boiled with stirring in aluminium pan for 10 min., cooled, and stored at 4^{o}C for 72 hr. and analyzed for their AL. content at 0,24,36,48,72 hr. The third part was boiled with stirring in stainless pan for 10 min., cooled, stored at 4^{o}C for 72 hr and analyzed for their Al content at 0, 24,36,48,72 hr.

The aluminium utensils were rubbed with aluminium scourer until the metal shining appeared, cleaned with soap sponge, then washed with water as usual in Egyptian kitchens.

RESULTS

Table 1: Levels of aluminium content (ppm) in raw milk samples

No. of samples	Mean	Min	Max
10	0.84	0.1	1.7

Table 2: level of aluminium content (ppm) in raw milk* after boiling for 10 min and holding at 4^{o}C.

Holding time	Milk in AL pan	Milk in steel pan
0 time	1.58	1.50
1st day	1.60	1.54
2nd day	1.60	1.54
3rd day	1.64	1.56

*AL. content of milk before boiling was 1.50ppm.

DISCUSSION

Table (1) showed the aluminium contents of raw milk samples in ppm wet weight. Regarding the body weight,present state of knowledge and the provisional tolerable daily intake of 1mg Al/Kg body weight per day of the World Health Organization 1989, there is no evident risk to the health of the consumer.

The results in Table (2) showed that the increase in aluminium content of raw milk because of the migration from cooking pans were relatively low.Nearly similar results were reported by Maha AL-Ashmawy (2009), this may be due to an invisible, protective outer layer of aluminium oxide forms immediately metallic aluminium is exposed to moist air. Macrae *et al.* (1997), revealed that dramatic affinity for oxygen, and the ability of the oxide so formed to bind firmly to the exposed metal, which affords aluminium its many diverse applications. Not only does this coating of oxide protect the surface of aluminium against further oxidation, but also protects the metal from reaction with many other chemicals. The oxide exhibits excellent resistance to corrosion by many inorganic and organic chemicals within a pH range of 4.5-9, but is susceptible to reaction with both acids and bases outside of this range. Gramiccioni *et al.* (1996) found that the increase in aluminium because of migration from cookware was relatively low with the highest release into acidic and salty foods.

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