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A Review Paper on Melamine in Milk and Dairy Products

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Abstract

Milk has been recognized as a food with a high proportion of the dietary components which makes it a perfect food for infant, children and adults. Unfortunately milk adulteration is a serious issue through the world. Melamine, a nitrogen-rich compound, is added into the milk to increase the protein count falsely in milk and dairy products. Melamine is described as being harmful if swallowed, inhaled or absorbed through the skin. In China, more than 50,000 infants have been hospitalized and 6 persons of them died because of high level of melamine in their food. This review aims to bring up to date the current global status of melamine contamination of milk and dairy products destined for human consumption.

Introduction

Milk is the best sources for basic nutrients including protein, fat, carbohydrate, vitamins and minerals required by both infants and adults. Unfortunately milk adulteration is a serious issue through the world. Some reasons for milk fraud may include the big gap between demand and supply, perishable nature of milk, low purchasing capability of customer and lack of suitable test method for detection of milk frauds [1].

Some examples of Adulteration of milk include addition of water, whey, vegetable oil and protein and milk from different species, which are known as economically motivated adulteration [2]. These milk frauds do not pose any severe health risk. However, some adulterants showed serious adverse effect on human health such as adding urea, formalin, detergents, alkaline and acidic compounds, hydrogen peroxide and melamine.

Melamine is added into milk to increase the protein count at less cost. Melamine or 2,4,6-triamino-1,3,5-triazine ($C_3H_6N_6$) is a nitrogen-rich compound which has been used for producing plastics, adhesives, laminates, paints, permanent-press fabrics, flame retardants, textile finishes, tarnish inhibitors, paper coatings and fertilizer mixtures [3].

Milk and infant formula adulterated with melamine has been of high concern since September 2008, when in China, six children died due to the presence of melamine in their food.

Trace levels of melamine may be detected into the food because of its presence in the environment or indirectly through animal feeds that have been treated with products containing melamine, such as fertilizers or pesticide. Moreover, melamine is added into milk, wheat gluten and other protein sources to increase the protein count falsely at less cost [4]. The protein level of milk is usually determined through measuring the nitrogen content by standard test methods such as the Kjeldahl and the Duma's [5]. The farmers and milk producer may dilute the milk with water and still meet the standard level of protein content by adding melamine as fake protein. Therefore, infants and children are affected the most because of their milk dependence for nutrition, compounded by immaturity of their organs which renders them vulnerable [6].

Melamine Toxicity

In 2007, in North America, widespread pet illness and deaths were attributed to the formation of melamine- cyanurate crystals in the kidneys of these animals [7]. In 2008, in China, more than 50,000 infants have been hospitalized and resulted in 6 deaths after eating milk powdered baby food tainted with melamine [8].

Melamine is described as being harmful if swallowed, inhaled or absorbed through the skin [9]. However, it is not carcinogenic compound and has low oral acute toxicity; but it causes renal and urinary problems and even infant death when it reacts with cyanuric acid inside the body [10]. The harmful effect of melamine is considered to increase in combination with its analogues, particularly cyanuric acid. FDA reported that when melamine and cyanuric acid are absorbed into the bloodstream,

they concentrate and form large numbers of round, yellow crystals, which in turn block and damage the renal cells [11]. The toxic dose of melamine is on a par with common table salt with an LD50 of more than 3 grams per kilogram of bodyweight [9].

Codex alimentarius has established the maximum melamine limit of 1mg/kg for powdered infant formula, 0.15mg/kg for liquid infant formula and a maximum level of 2.5mg/kg for milk and products containing milk or milk-derived ingredients [12].

Melamine transmission to milk

Some of the ways in which melamine can find its way into milk and dairy products are as follows:

A. Adulteration to Milk product to "fake" protein [13]

B. Use of the pesticide cyromazine on crops (Cyromazine is metabolized into melamine in the animal's body and, therefore, could be present as contaminant in their milk and tissue).

C. Use of nitrogenous fertilizers, if containing melamine as a source of nitrogen

D. Consumption of cyromazine or melamine contaminated crops

E. Transfer of melamine from plastics used in milk packaging materials [9].

When the cows graze melamine fertilized pasture, melamine will transfer to their milk and tissue. Melamine transfer from grass to milk is as soon as 8 hours with the efficiency of 3% for the low and 2.1% for the high melamine concentration pasture [14].

It has been reported that the amount of melamine in dairy products exhibited concentrations in the following increasing order: Milk<yoghurt<coffee mate<cheese<infant formula [15].

Occurrence of melamine in milk and dairy products

After the first report about melamine in infant formula products in China, international food regulatory authorities confirmed that other foods containing milk such as, milk and whey powder, casein, milk-based candies, instant powdered coffee products, biscuits, chocolates, milk-based drinks and cakes could be contaminated with melamine [16].

In a research conducted in China, 87 out of 111 infant formula were contaminated with melamine ranged from <0.05 to 4700mg/kg (Chinese Centre for Disease Control and Prevention, unpublished data, 2008). Fifty-one of the 87 positive samples had a concentration higher than 1000mg/kg. In contrast with these reports, in Australia, 360 samples of dairy foods had been tested for the presence of melamine. No melamine was detected in any of these samples, where the limit of reporting (LOR) varied from <0.1 to <1.0mg/kg, depending on the food matrix and the analytical method employed [16].

Japan submitted positive melamine results for various milk-based bakery and confection, snack food ranged from 0.5 to 41mg/kg. Higher levels of melamine were found in frozen dairy-based desserts [17].

In general, the following data have been published by International Food Safety Authorities Network (INFOSAN) about melamine content of milk and dairy products. Samples of biscuits, cakes and confectionery (0.6-945.86mg/kg); liquid milk and yoghurt products (0.5-648mg/kg); frozen desserts (39-60.8mg/kg); powdered milk and cereal products (0.38-1143mg/kg); processed foodstuff (0.6-41 mg/kg); food-processing ingredients (1.5-6694mg/kg); and animal feed (116.2-410mg/kg) [17].

Gather information about the occurrence of melamine in food is somewhat difficult, since some countries have submitted only positive concentrations that were above the maximum levels they have established for melamine in food, whereas other countries submitted data on any positive determinations (regardless of whether they were above maximum limits [16,18-21].

Some reports about occurrence of melamine in milk and dairy products have been summarized in Table 1.

Table 1: The world wide occurrence of melamine in milk and dairy products.

Country	Matrix	No. of Sample	No. of Positive Sample	Range (Mg/Kg)	References
China	Infant milk formula	8	100%	9.49-258	18
	Growing up milk formula	8	100%	7.75-251	
	Full Cream Milk Powder	6	100%	29.1-39.7	
India	Pasteurized milk	7	100%	0.028-0.071	19
India	Powdered milk	10	100%	0.0001-0.0006	20
Newzeland	Dairy products	180	6 (>3%)	>1 – 20	16
Canada	Dairy products	80	60 (75%)	0.0043-0.346	
America	Dairy products	44	100%	0.137-0.249	
United kingdom	Dairy products	21	-	33-259	
Iran	Yoghurt	15	100%	0.2-1.12	15
	Milk	15	100%	0.12-0.41	
	Infant formula	15	96%	0.31-4.52	
	Cheese	15	93%	0.14-3.16	
	Coffee mate	15	100%	0.05-1.52	

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Turkey	Pasteurized milk	100	0	-	21
	Powdered infant formula	50	0	-	
	Fruit yogurt	50	44%	Mean: 294±98	
	Soft cheese	50	2%	Mean: 121	
	Milk powder	50	8%	Mean: 694±146	

Conclusion

Given the adverse effect of melamine on human health especially on infants, it seems that serious controlling programs should be implemented to prevent the entry of melamine in milk and dairy products. For instant good manufacturing practice (GMP) and good quality control programs are very effective manner in controlling the level of melamine in milk. Besides that, more work is still needed to estimate the concentration of melamine in edible parts of crops and feed and the ingredients of agricultural fertilizers should be regulated to prevent the use of melamine as a fertilizer ingredient in the future.

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