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Biological effect of melamine and its derivative contaminated food products

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ABSTRACT

The toxicity of Melamine has been catching the attention of the people since children were infected by renal disease after consumption of Melamine trained milk products. Melamine can lead to kidney stones and other urinary tract problems. Understanding the interaction between organic ligand and bio macro molecule is always helpful for us to recognize the structure. Melamine alone do not form precipitation ie stone in the kidneys since it dissolves with uric acid but when it added with Cyanuric acid needle like micro crystallites of Melamine Cyanurate which is more toxic were formed. So it must be consider the adulteration from the economic perspective. All the protein containing products are analyzed for their Nitrogen content to determine protein concentration. In this work, the interaction of Melamine with Cyanuric acid was systematically studied by Powdered XRD and Scanning Electron Microscope. The result of this work contributes to understanding the biological effect of Melamine.

Key Words : Melamine, Cyanuric acid, Melamine Cyanurate (MCA), Powder XRD, SEM.

INTRODUCTION

Food is always trusted to be clean, healthy and to be a source of life and strength. Adulteration of protein in gradients recently in most of the pet foods and human foods. One such adulterate agent added into the food product is Melamine and its derivatives eg. Cyanuric acid, Melamine Cyanurate etc. Melamine is a nitrogen rich compound that could mimic proteins in some tests and therefore, melamine was added to protein supplements used in feeds such as wheat gluten, corn gluten and rice gluten to artificially inflate protein levels. Either Melamine or Cyanuric acid

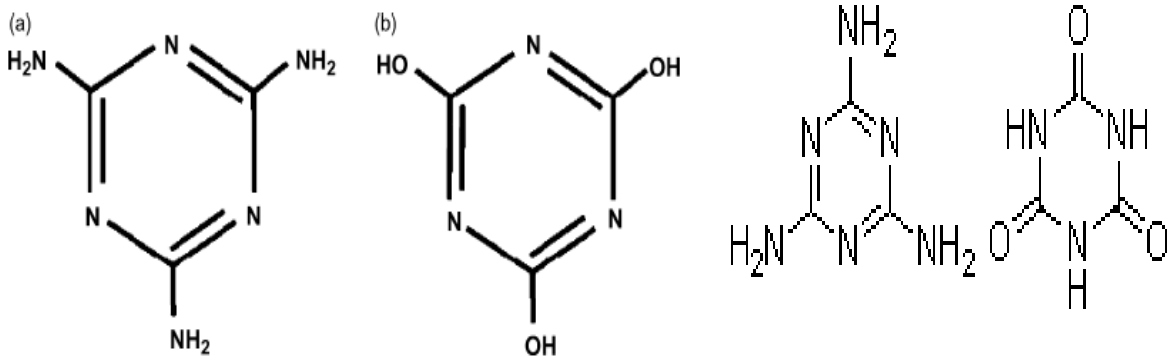
has no direct toxicity. But Melamine when react with cyanuric acid, the resultant product Melamine Cyanurate is more toxic [7].

In the recent years, the public as well as pediatrician colleagues were intensely concerned about the problem of melamine in infant formulae and dairy products and its adverse effects on the health of children. An increased incidence of kidney stones and renal failure in infants has been reported in China, believed to be associated with the ingestion of infant formula contaminated with Melamine[3]**.**

It is noteworthy that Melamine or Cyanuric acid alone did not cause any renal toxicity or precipitates in kidney tubules. The water solubility of melamine was 3240 mg/L and that of cyanuric acid 2000 mg/L.[4] However, Melamine and Cyanuric acid form a highly ordered lattice structure held together by multiple hydrogen bonds between each pair of molecules which makes the complex practically insoluble in water. Melamine Cyanurate has very low solubility and this leads to the formation of Melamine Cyanurate crystals in the kidney. We have synthesized experimentally MCA particle by slow evaporation method. Yu Qiu etal [6] synthesized MCA from urea.

Structure of Melamine(a), Cyanuric acid (b) and Melamine Cyanurate (c)

Two forms of hydrogen bonding between melamine and cyanuric acid are suggested as the driving force for them to complex with a planar structure[1]



EXPERIMENTAL SECTION

Analytical Reagent (AR) grade of Melamine and Cyanuric acid in the molar ratio 1:1 were used for synthesis of title compound. The calculated amounts of Melamine and Cyanuric acid were dissolved in double distilled water separately and stirred well by using magnetic stirrer for 6 hrs. The resulting white precipitate which is Melamine Cyanurate (MCA) centrifuged and also evaporated. After few days, the entire solvent is evaporated and the white colour MCA is obtained. Obtained complexes are insoluble in water and common organic solvents like acetone, chloroform, benzene, alcohol etc but soluble in strong acid or basic solutions. The obtained compound washed with distilled water to remove the presence of impurities and the samples were dried at a constant temperature of 80^{o}c.

RESULTS AND DISCUSSION

Powder XRD analysis:

Fig1 shows the powder XRD pattern of as-prepared MCA microparticles. The presence of sharp diffraction peaks in the XRD confirms that the products are highly crystalline [2]. The average grain size (D) of MCA is calculated by the Debye-Scherrer formula, $D = 0.9 \lambda / \beta \cos \theta$, where λ is the wavelength of CuKα line ($\lambda = 1.5418$ A ^{o}) , β is full width at half maximum height and θ is the diffraction angle. From the XRD analysis, the average particle size of the MCA was estimated as 3.067 μm which are in very good agreement with the values given in SEM.

Yi Wang etal [1] reported the crystal structure of Melamine Cyanuric acid complex (1:1) trihydrochloride . On the basis of [1] Frank H.Herbstein [2] reported the crystal structure of dipronated Melamine Cyanuric acid dichloride dihydrate . From all those results it is confirmed that the products are highly crystalline.

Fig. 1 : Powder XRD of Melamine Cyanurate

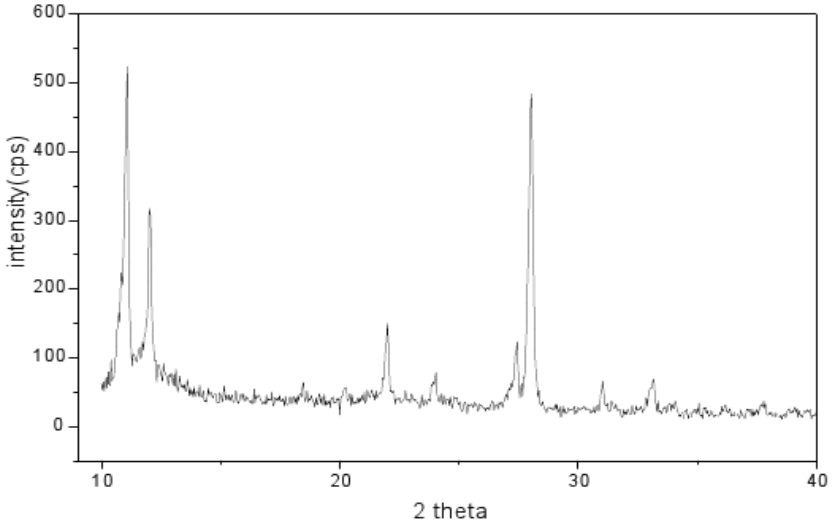


Figure 2. SEM of melamine cyanurate

Fig. 2.1

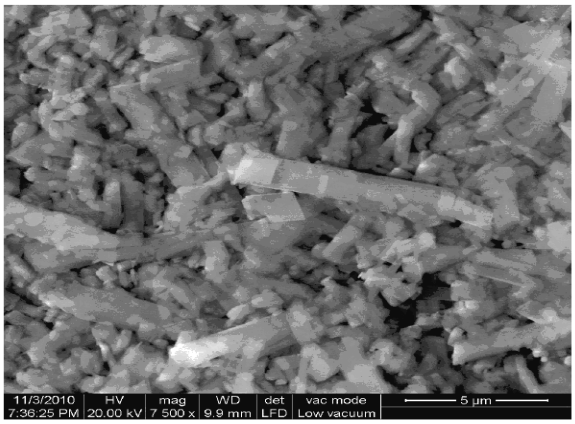


Fig.2.2

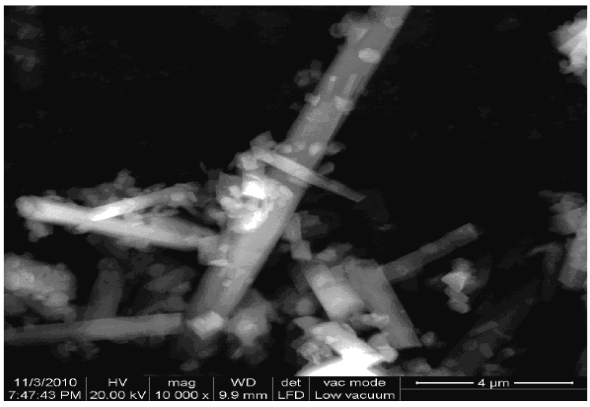


Fig. 2.3

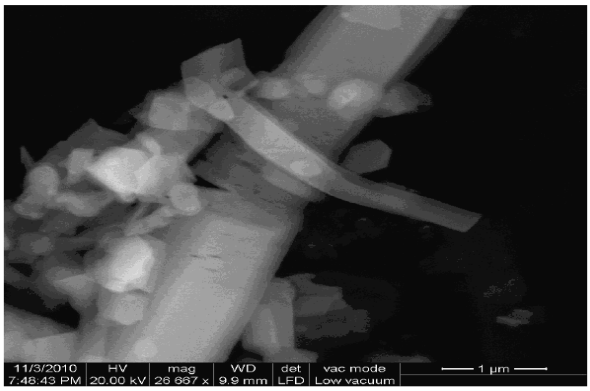
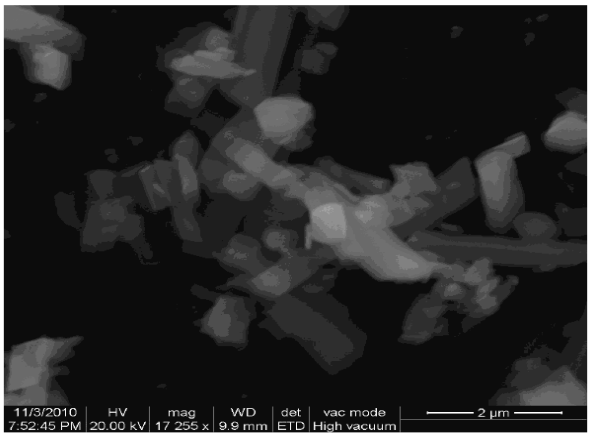


Fig. 2.4



Scanning Electron Microscope Interpretation

Fig [2.1-2.6] shows the SEM photographs of MCA micro particles [10]. SEM allows the direct imaging of particle and provides authentic information on the distribution, size and morphology of particles. On Scanning Electron Microscope examination, the needle like micro crystallites of Melamine Cyanurate was noted. By varying magnification, the size of the particles is found to be 1 μm to 5 μm. This value very well agree with the earlier report [5]

Fig. 2.5

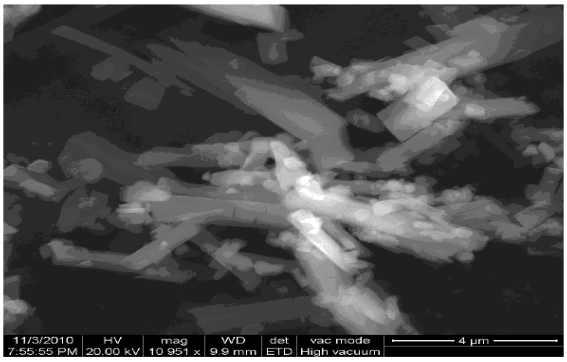
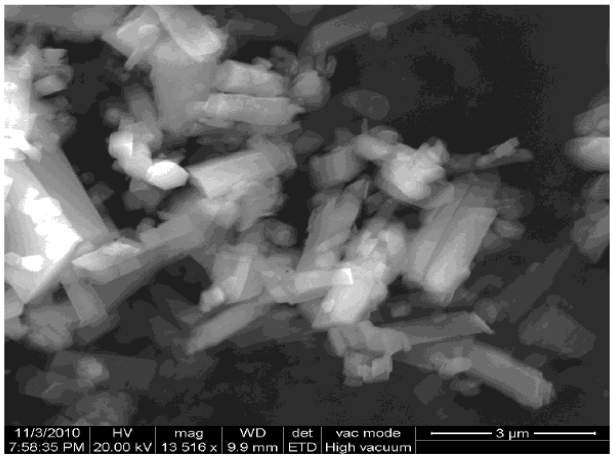


Fig. 2.6



CONCLUSION

A simple, sensitive, and specific method for the detection and quantization of Melamine and Cyanuric acid in food matrices has been demonstrated. MCA were obtained by employing slow evaporation solution growth technique. The grown crystals are of 1 µm to 5 µm size. The Powder XRD pattern of the complex ensures its crystalline nature. It can be concluded that even a small amount of Melamine is capable of doubling the apparent nitrogen content. Melamine alone never produce stone but when it combine with Cyanuric acid which is more toxic and produces kidney stones so milk formulas and other protein-containing powders are analyzed for their nitrogen content to determine protein concentration. These complexes are very promising Light Emitting materials due to their good thermal stability. Further research has to be carried out and can be extended to several industrial and research applications.

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