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Analysis of adulteration in milk samples by attenuation coefficient using 840keV gamma ray energy

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ABSTRACT

Milk contains considerable amounts of constituents. For healthy nation, we need quality of food & milk. But some antisocial elements have been adding some adulterants like water, urea, lactose powder etc. in milk sample. The linear and mass attenuation coefficient plays an important role in agricultural dairy, food technology, science & technology, medicines and forensics etc. In the present work, we measured the linear and mass attenuation coefficient of adulterate milk sample with urea by using gamma source Mn^{54} *at energy 840 keV. The experimental values are in good arrangement and validate the absorption law.*

Keywords: Attenuation coefficient, gamma ray, energy source, gamma ray spectrometer NaI [TI] detector.

INTRODUCTION

The knowledge of interaction of gamma radiations with the materials of common and industrial use, as well as of biological and commercial importance has become major area of interest in the field of radiation science. For a scientific study of interaction of radiation with matter a proper characterization and assessment of penetration and diffusion of gamma rays in the external medium is necessary. The mass attenuation coefficient usually depends upon the energy of radiations and nature of the material. For characterization the penetration and diffusion of gamma radiation in any medium, the roll of attenuation coefficient is very important.

An extensive data on mass attenuation coefficients of gamma rays in compound and mixtures of dosimetric interest have been studied by [1] in the energy range of 1 kev to 20 Mev. An updated version of attenuation coefficients for elements having atomic number from 1-92 and for 48 additional substances have been compiled by [2] and other scientists [3-7]. The reports on attenuation coefficients measured by researchers reported [8-19] for different energies for various samples in solid as well as liquid.

In view of the importance of the study of gamma attenuation properties of materials and its various applications in science, technology, agriculture and human health , we have embarked on a study of the absorption properties of cow milk sample contains mixture of microelements.

The absorption coefficient of milk is dependent on its content and gamma - ray energy. This work describes a study of content dependence on measurements of attenuation of gamma - radiation at gamma-ray energy of milk sample. The absorption of gamma rays expressed as:

$$I = I_o \exp(-\mu x) \qquad (1)$$

Where I_o is the number of particles of radiation counted during a certain time duration without any absorber, I is the number counted during the same time with a thickness *x* of absorber between the source of radiation and the detector, and μ is the linear absorption coefficient. This equation may be cast into the linear form,

$\log I = \log I_o - \mu x$

i.e. $\mu x = \log (I_o / I)$

$\mu = (1/x) \log (I_o/I)$ (2)

The mass absorption coefficient of milk, μ_m defined as,

$\mu_m = \mu/\rho$ (3)

Where, μ_m is the mass absorption coefficient and ρ is the density of milk sample. The unit of μ is cm^{-1} and that of μ_m is cm^2/g.

MATERIALS AND METHODS

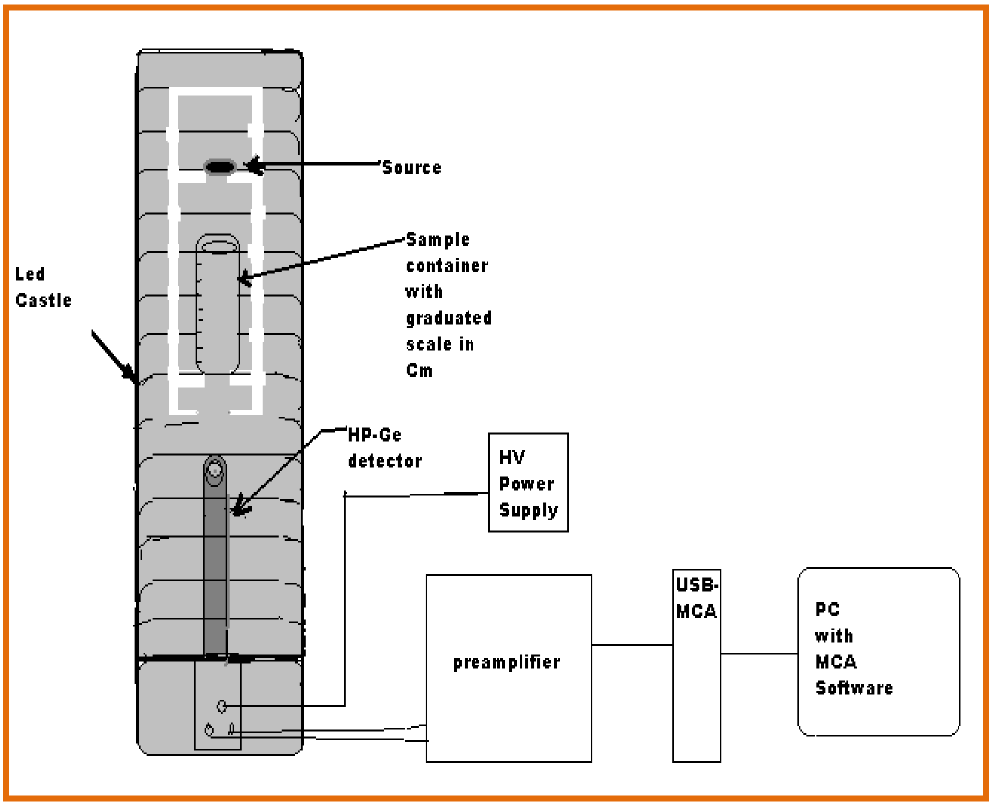

Figure - 1: The Experimental Set up

The experimental arrangement is as shown in figure. A NaI (Tl) crystal was used as detector in conjunction with counter circuits and multichannel analyzer. The stand is made up of acrylic sheet the whole system enclosed in a lead castle. Various gamma ray sources are used to study the photon attenuation coefficient of milk samples as shown in the table 1. In the present research work, we are studied the gamma attenuation coefficient for milk samples by using the gamma ray source Mn^{54} of 840 keV.

Table 1: Details of radioactive source Mn^{54}

Source	Energy keV	Normal activity μCi	Half life
Mn^{54}	840	2	314 Days

Calibration of gamma ray spectrometer:

Gamma rays is passed using Cs^{137} and Co^{60} reaching the detector and energy is calibrated. The spectrum is obtained for 1000 sec using MCA which gives graph of Channel number V/s number counts. We select the peak which is smoothened for avoiding the random nature and obtain the peak gross area which is shown in Figure -2 and Figure-3 shows spectra of source Mn^{54}having the energy 840 keV.

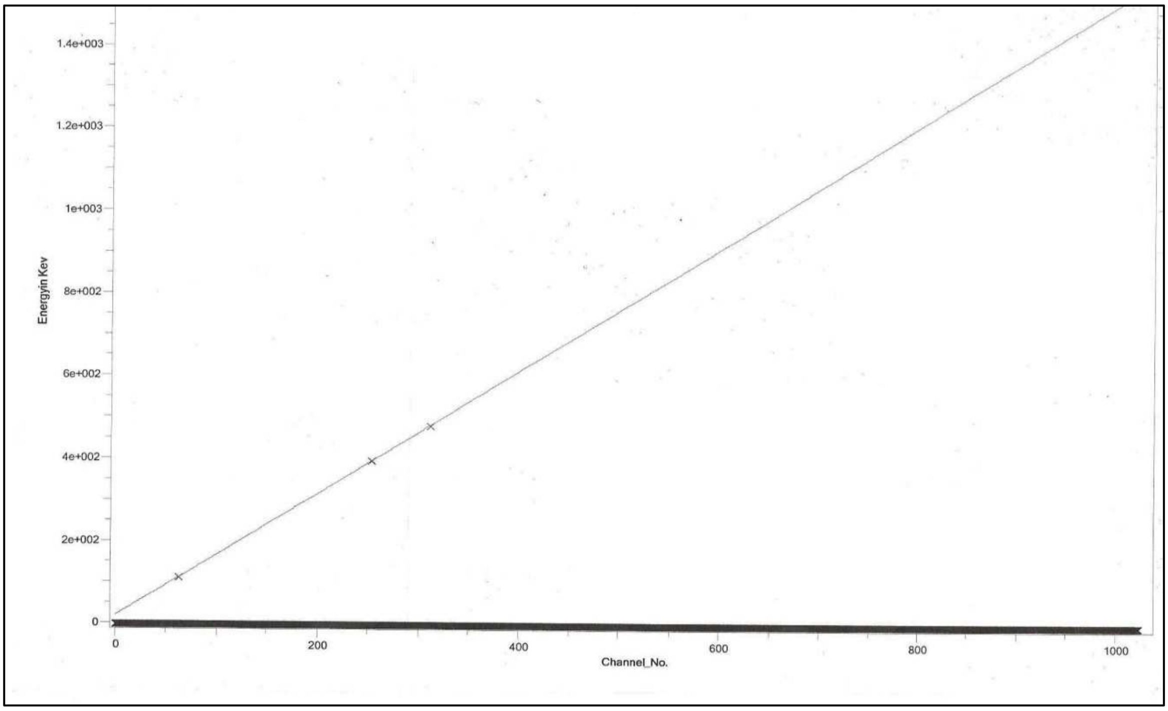

Figure 2: Calibration Spectra

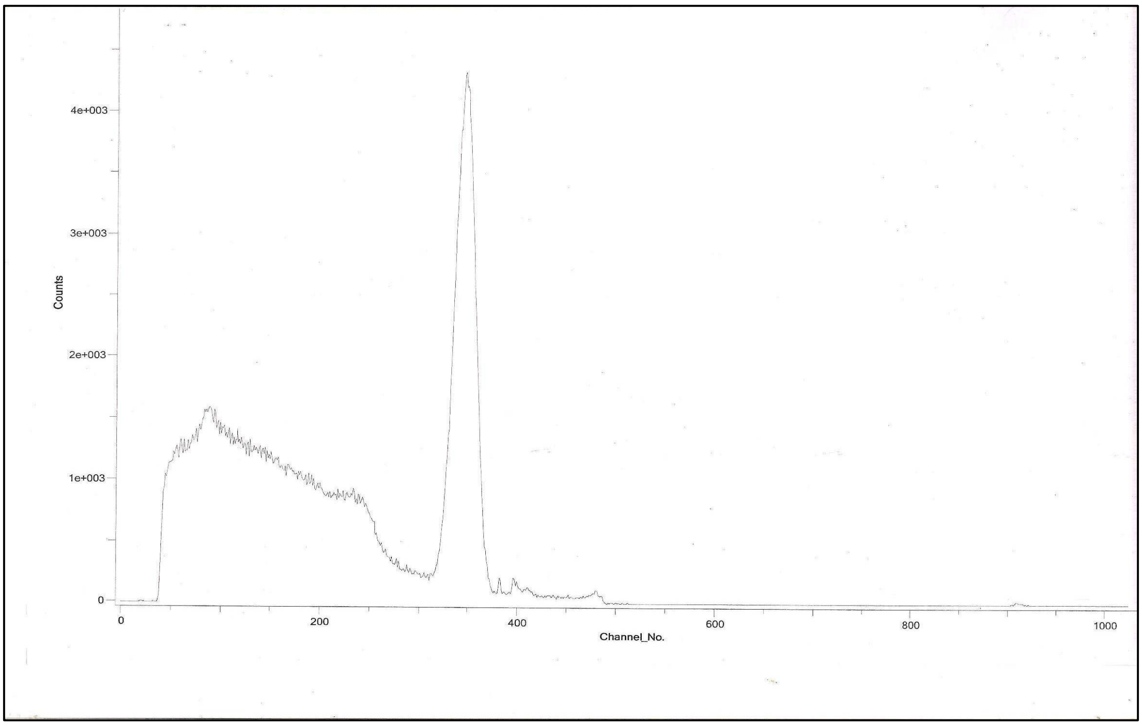

Figure 2: Gamma ray spectra for Mn^{54}

Method and observation:

A cylindrical glass container for milk sample of internal diameter 2.9 cm placed in between detector and source as shown in Figure-1. The path length of milk sample for gamma ray transmission is x = 10 cm with suitable narrow beam arrangement. The sample (cylinder) is kept in a stand between source and detector .The assembly was placed in lead castle. The distance between source $Mn^{54}$of 840 keV and detector NaI (Tl) is 18.3 cm. The transmitted and scattered gamma rays were detected using USB-MCA along with external NaI (Tl) detector. First, the cylinder was kept empty keeping acquisition time 1000 sec and readings were taken for gamma rays of a particular energy and noted as Io. Thereafter, the path length(x) of milk sample varies by length 1 cm up to 10 cm and readings taken as I.

Same procedure used for each samples with concentrations by adding urea in the milk and prepared for 1%, 2%, 3%, 4% up to 10%.

RESULTS AND DISCUSSION

Experimental values of number of particles of radiation without absorber (I_o) per number of particles of radiation counted with absorber (I) were linearly increased with increasing path length in cm. The slope of the graphs shows linear straight line. The experimental values are fitted by least square fit method. Their slope gives linear attenuation coefficients. The mass attenuation coefficient is calculated by plotting the graph of concentration versus linear attenuation coefficients same for density. The graphical results are shown in below figures.

Fig. 3 &4: Linear attenuation coefficient V/s. concentration and mass attenuation coefficient V/s. concentration at an energy 840 keV

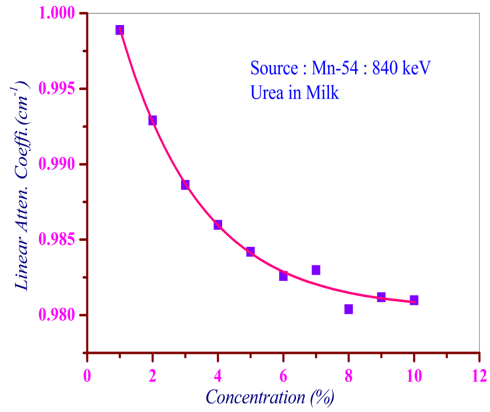

Figure - 3: Linear attenuation coefficient V/s concentration of urea in milk

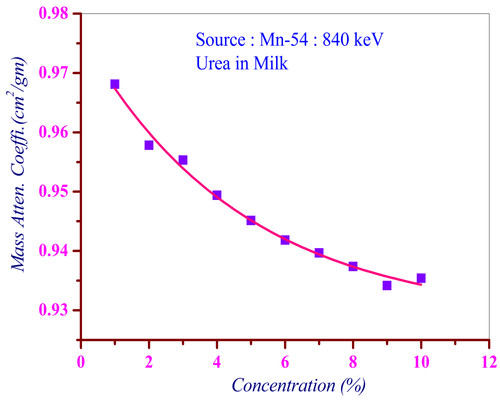

Figure - 4: Mass attenuation coefficient V/s concentration of urea in milk

Fig. 5 & 6: Linear and mass attenuation coefficient V/s. concentration and mass attenuation coefficient V/s. concentration at an energy 840 keV

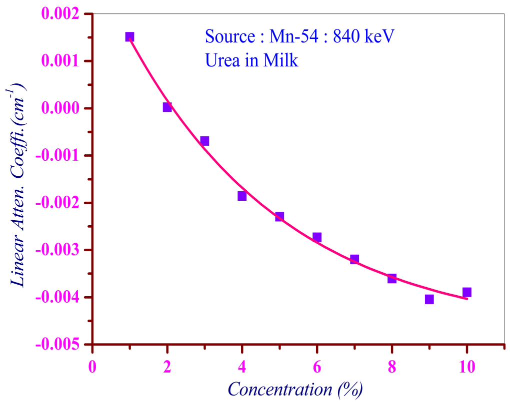

Figure - 5: Linear attenuation coefficient V/s concentration of urea in milk

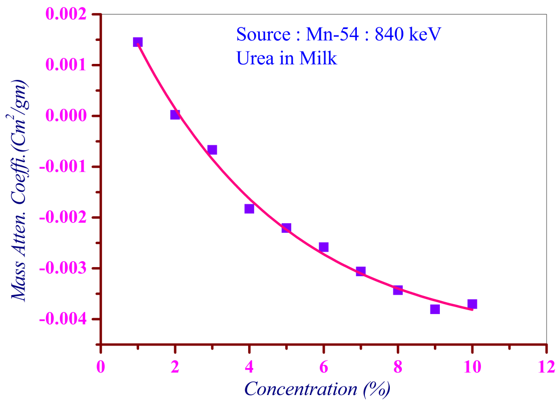

Figure - 6: Mass attenuation coefficient V/s concentration of urea in milk

Fig. 7 & 8: Linear attenuation coefficient V/s. density and mass attenuation coefficient V/s. density at an energy 840 keV using gamma source Mn^{54}

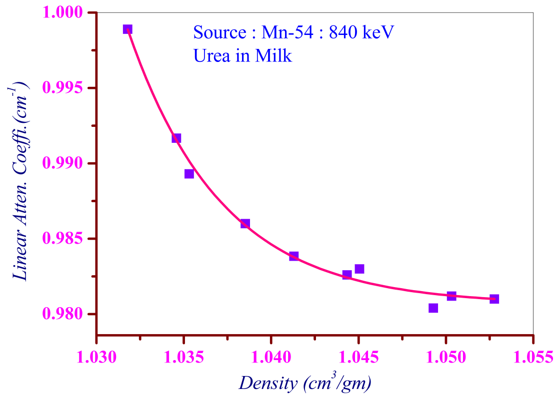

Figure - 7: Linear attenuation coefficient V/s density of urea in milk

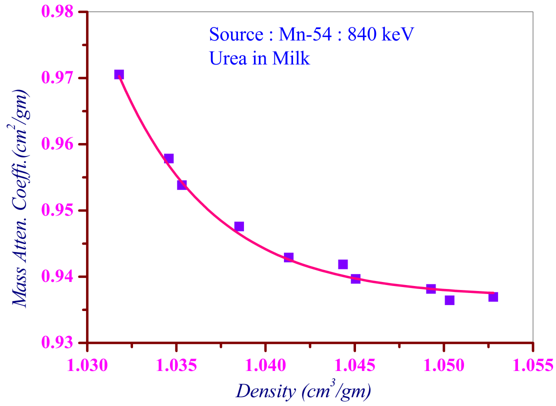

Figure - 8: Mass attenuation coefficient V/s density of urea in milk

Fig. 9 & 10: Linear attenuation coefficient V/s. density and mass attenuation coefficient V/s. density at an energy 840 keV

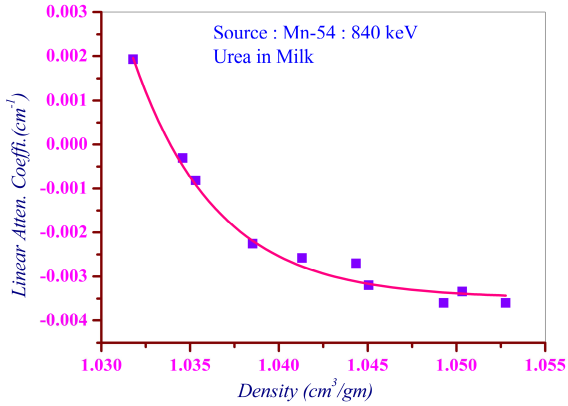

Figure - 9: Linear attenuation coefficient V/s density of urea in milk

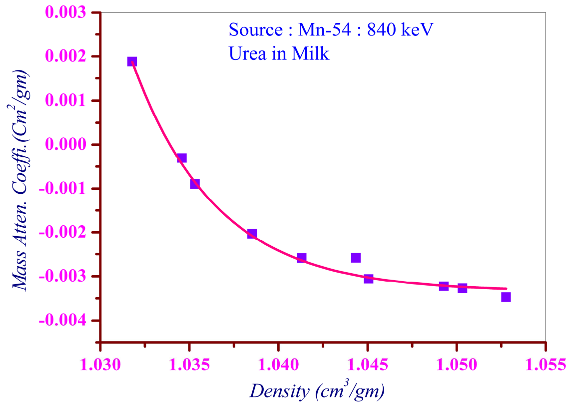

Figure – 10: Mass attenuation coefficient V/s density of urea in milk

CONCLUSION

We studied the linear and mass attenuation coefficient of buffalo milk sample with different concentrations by adding urea in the milk at the gamma ray energy 840 keV of gamma source Mn^{54} at different path length. The result shows that as concentration of milk sample increases, linear and mass attenuation coefficient decreases. Also the density of milk sample increases, linear and mass attenuation coefficient decreases. This is one of the best methods to investigation of adulteration in milk samples.

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