Study of Attenuation Coefficient of Cow Milk Using Gamma Ray Energy

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Abstract:

The mass attenuation coefficient is very important parameter used in industry, agriculture, defense, food technology and also in forensic applications. Physico-chemical properties are influenced by the composition of milk. These properties are important in detection of adulteration in milk. Adulterated milk is very dangerous to human health. We were studied the mass attenuation coefficient of adulterated milk sample with lactose powder with different concentrations. The result shows the density of admixture milk sample with different concentrations V/s attenuation coefficients. The attenuation coefficients decreases exponentially with increasing the density. The result represented in the form of graph and other results are in progress. Exponential decay was observed. This validates the gamma absorption law.

Key words: Attenuation coefficient, gamma ray energy sources, spectrometer, 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 [8-20] 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. This is one of the best technique for detection of adulteration in milk samples which is useful to rural as well as urban. The instruments and gamma sources are available within range from Nuleonix System Hyderabad with safety facility.

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:

$$I = I_o \exp(-\mu x) \tag{1}$$

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.

The mass absorption coefficient of milk, μ_m defined as,

$$\mu_m = \mu/\rho \tag{2}$$

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.

Experimental arrangement:

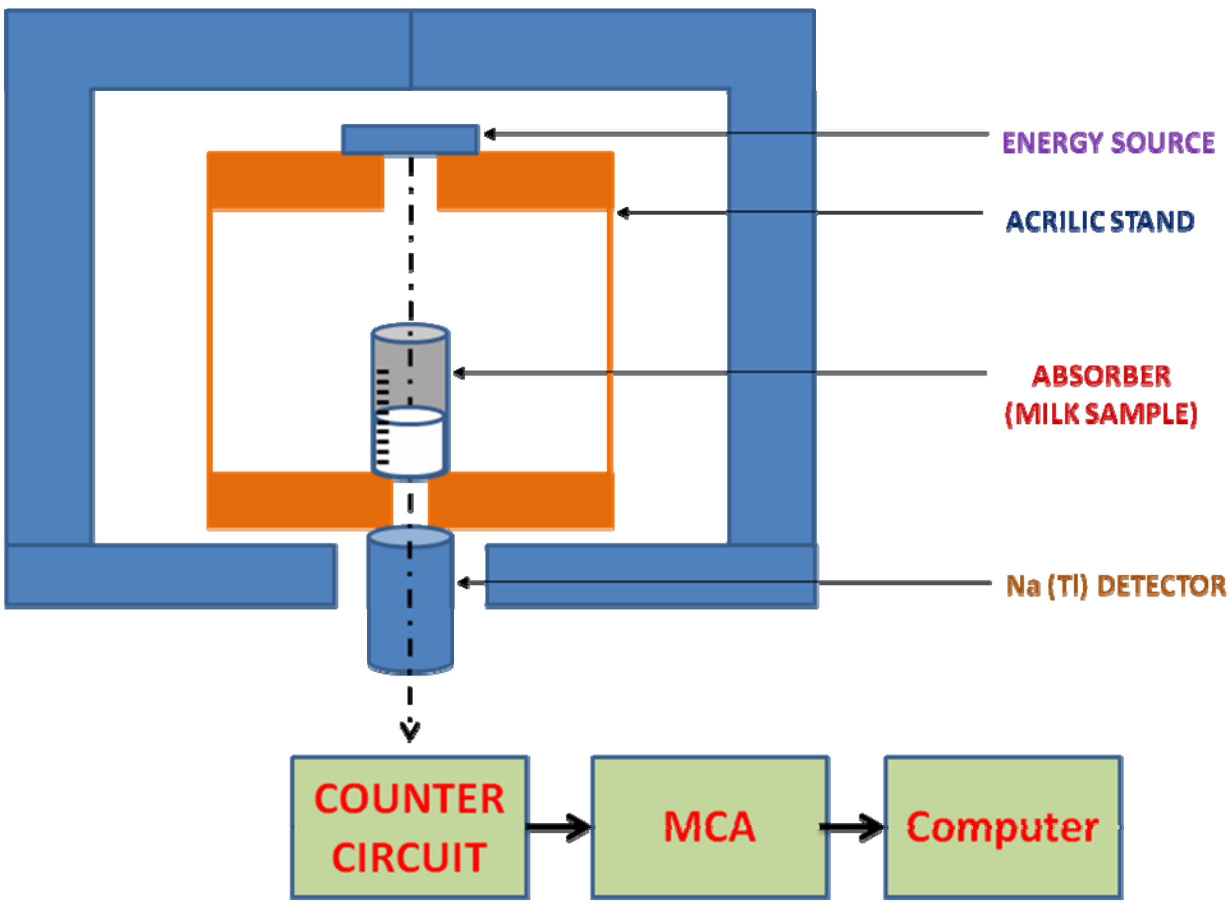

Figure - 1: The Experimental Set up

The experimental arrangement is as shown in Figure-1. 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. The 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 Na^{22} of energies 511keV and 1280 keV.

Table 1: Details of radioactive source Na^{22}:

Source	Energy keV	Normal activity µCi	Half life
Na-22	**511,1280**	**3.4**	**2.6 Years**

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 100 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 Na^{22} having the energies 511 keV and 1280 keV .

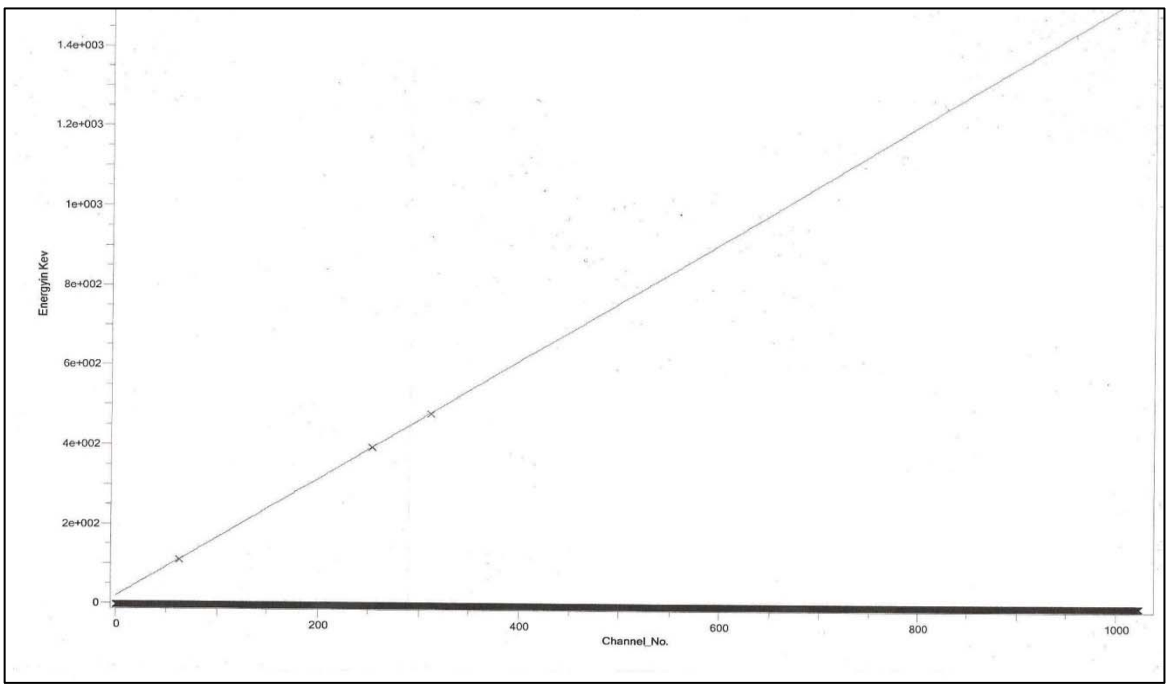

Figure 2: Calibration Spectra

Spectra of source Na^{22}:

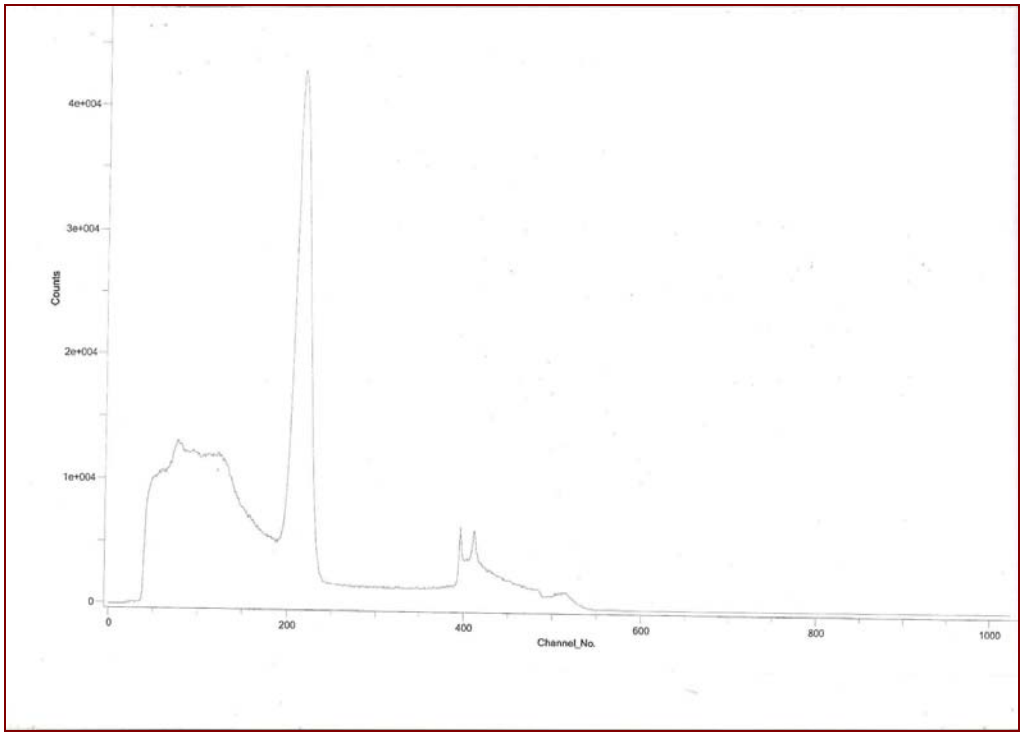

Figure - 3 Spectra of source Na^{22}

Material and Methods:

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 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 I_o. Thereafter, the path length(x) of milk sample varies by length 1 cm up to 10 cm respectively and readings taken as I. Same procedure used for each samples with concentrations by adding lactose and urea in the milk and prepared for 1%, 2%, 3%, 4% up to 10%. The Average chemical composition of cow milk[20] is given below

Constituent	Water	Fat	Total Proteins	Lactose	Ash
Percent	86.90	4.00	3.50	4.90	0.70

Result 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 for same density. The graphical results are shown in below figures.

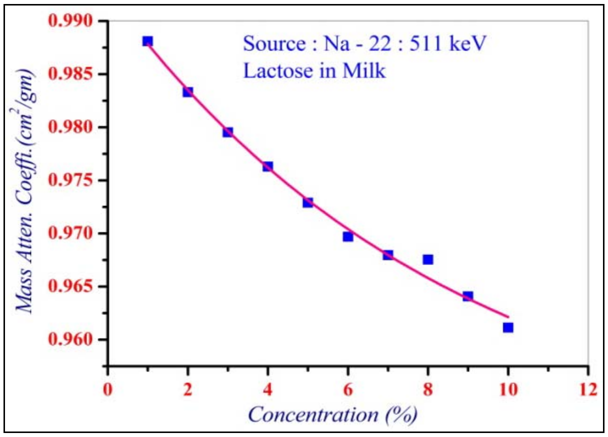

Figure - 4
Mass attenuation coefficient V/s concentration of lactose in milk at energy 511 keV

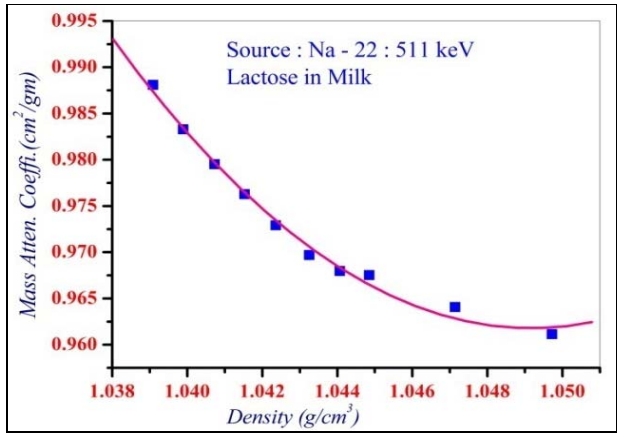

Figure – 5
Mass attenuation coefficient V/s density of lactose in milk at energy 511 keV

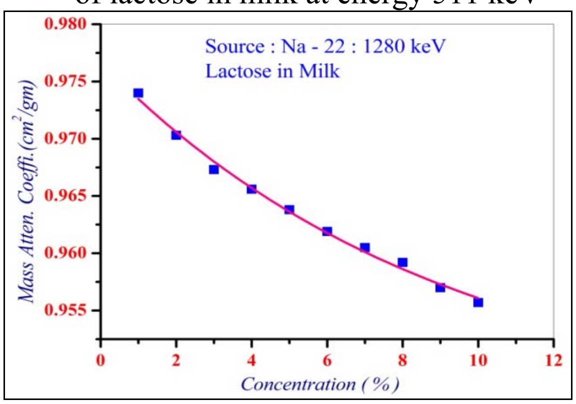

Figure -6
Mass attenuation coefficient V/s concentration of lactose in milk at an energy 1280 keV

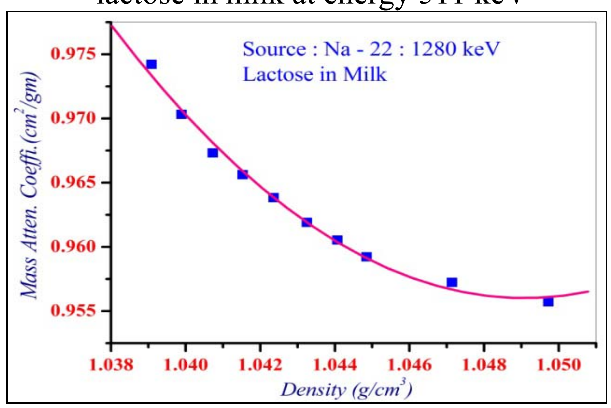

Figure - 7
Mass attenuation coefficient V/s density of lactose in milk at an energy 1280 keV

Conclusion:

We studied the linear and mass attenuation coefficient of cow milk sample with different concentrations by adding lactose in the milk at the gamma ray energy 511 keV and 1280 keV of gamma source Na^{22} 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. Gamma dissociation law is valid for the milk sample. This is one of the best methods to identification of adulteration in milk samples.

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References:

1. J. H. Hubbell, Appli. Radiat. Isot., 1982,33, 1269.
2. J.H. Hubbell and S.M. Sheltzer., NISTIR-1995, 5632.
3. D. D Bradley, C. S Chong, A Shukri, A. A. Tajuddin, A. M. Ghose, Nucl. Instrum. Meth.Phys. Res., 1989 A280, 39.
4. J.R. Cunningham, H.E. Johns. Med.Phys 1980, 7, 51
5. G.A. Carlsson, Radiation research, 1981, 5, 219-237.
6. H.A. Jahagirdar, B. Hanumaiah, B. R. Thontadarya, Appli.Radiat .Isot, 1992, 43, 1511.
7. K. Singh, H.K. Bal, I. K. Sohal,Sud S.P., Applied radiation Isotop, 1991, 42,1239.
8. L. Gerwad, Appl. Radiat. Isot. 1996,47, 19149.
9. L. Gerward , Radiat. Phys. Chem. 1996 , 48, 697
10. G. S. Bhandal, Nuclear Science and Engineering, 1994, 116, 218-222.
11. A.H. El-Kateb, Abdul Hamid, Applied radiat.Isot., 1991, 42, 303-307.
12. Demir D. Ozgul A.Un.M.,Y. Sachin, Applied Radiation and Isotopes,2008, 66, 1834-1837
13. M. T. Teli, L. M. Chaudhari, S. S. Malode, 1994,Appli. Radiat isot , 45(10), 987.
14. M. T. Teli, L. M. Chaudhari, S. S. Malode, 1994, J.of Pure & applied Physics, 32, 410.
15. M. T. Teli, L. M. Chaudhari, Appli.Radiat. Isot., 1995, 461, 369.
16. M. T. Teli, L. M. Chaudhari, Appli.Radiat. Isot., 1996,,47, 365.
17. M. T. Teli, *Appli.Radiat. Isot,* 1997, 48, 87.
18. M. T. Teli, Radiat.Phys.&Chem., 1998, 53,
19. M. T Teli., R. Nathuram, C. S. Mahajan, Radiat Meas.,2000, 32, 329.
20. S.G.Shukla, Dairy Chemistry, Aman Publication House, Merut