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Forensic Parameter Measurements in Buffalo Milk by Attenuation Coefficient 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. Anti social elements are mixed elements like lacto powder, urea, sabudana powder etc. in milk samples. Their mixtures are very dangerous to human health. By using gamma ray the above parameter are studied for milk and urea admixture with different concentrations. The result shows the density of admixture milk sample at 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.

Keywords: Attenuation coefficient, gamma ray energy sources, gamma ray spectrometer, NaI (Tl) detector, etc.

Introduction

The study 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 Hubbell[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 Hubbell and Sheltzer[2]. Other scientists such as Bradley[3], Cunningham[4], Carlsson[5], Jahagirdar[6], Singh[7], The reports on attenuation coefficients measured by researchers reported[8-24] 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 buffalo 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 122 keV of milk sample.
The attenuation of gamma rays expressed as:

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

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,

$$\log I = \log I_o - \mu x$$
$$\text{i.e. } \mu x = \log (I_o / I)$$
$$\text{i.e. } \mu = (1/x) \log (I_o/I) \quad (2)$$

The mass absorption coefficient of milk μ_m defined as,

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

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

Material and Methods

The experimental arrangement is as shown in figure. The gamma ray sources sealed in plastic pencil having nominal activity 3.26 μCi. A NaI (Tl) crystal was used as detector in conjunction with

Methods and Observations: A cylindrical glass container for milk sample of internal diameter 2.9 cm placed in between detector and source as in figure-1. The path length of milk

sample for gamma ray transmission (x) = 10 cm with suitable narrow beam arrangement. Source, Cylinder kept in a stand.

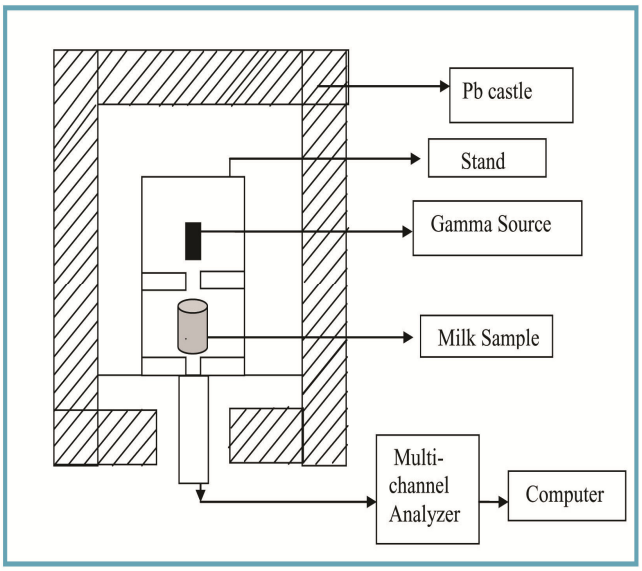


Figure-1
Experimental block diagram

Experimental Setup

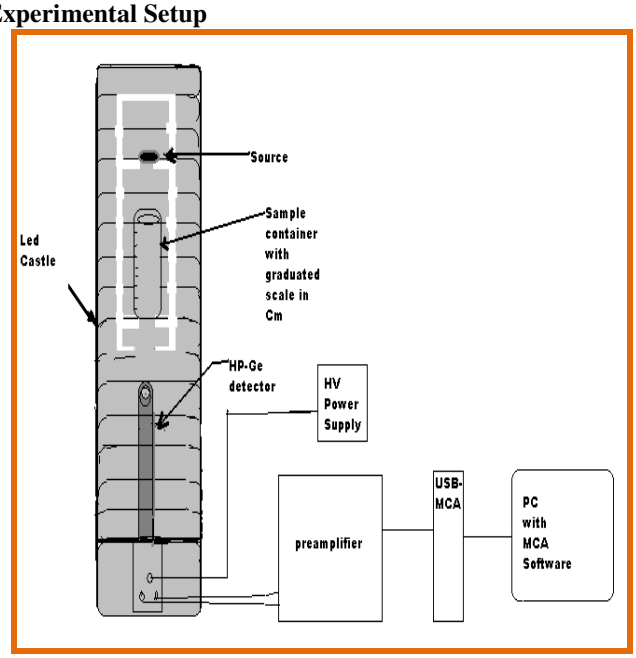


Figure-2
Experimental set-up

The assembly was placed in lead castle. The distance between detector and source was 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 time1000 sec and readings were taken for gamma rays of a particular energy and noted as I_o. Thereafter, we measured the counts I with the collimated gamma source.

Results and Discussions

Energy Source: Co-57: 122 keV

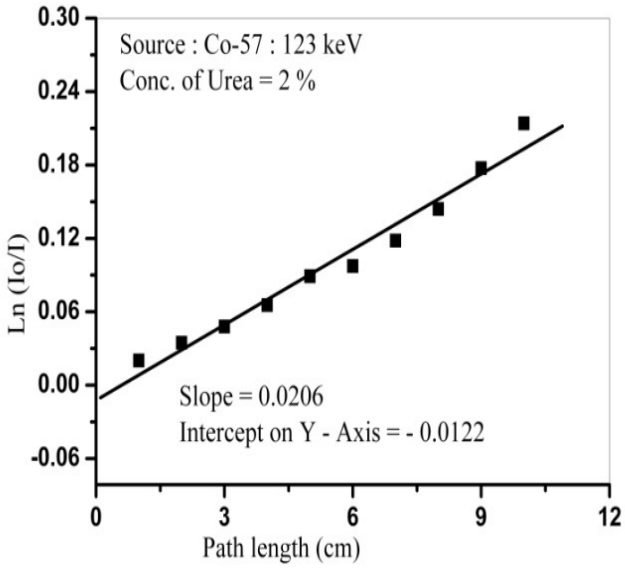
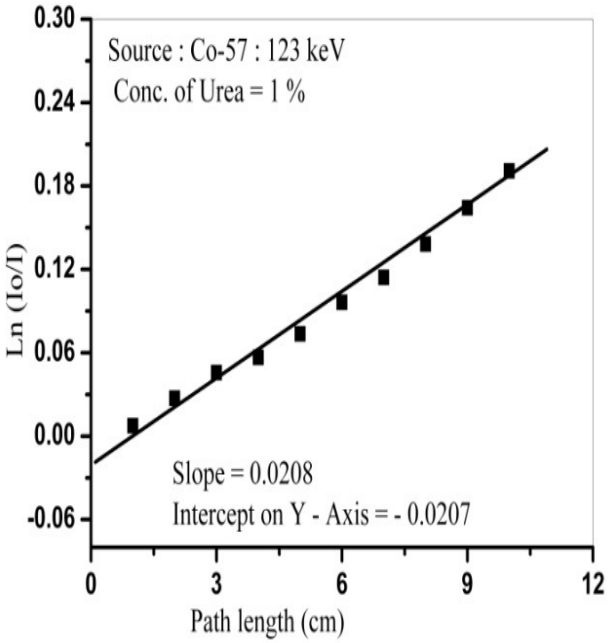


Figure-3
Concentration 1% of milk + urea



Figure–4
Concentration 2% of milk + urea

Table–1
Concentration of Urea in milk samples 1 % and 2 %

Concentration of Urea in Milk: 1 % **Initial Counts (I_o) =86025/1000 sec** **Density = 1.0317875947 gm/cc**				**Concentration of Urea in Milk: 2 %** **Initial Counts (I_o) = 85616 / 1000 sec** **Density = 1.0345749923 gm/cc**		
Path length (cm)	**No. of counts I / 1000 Sec.**	**I_o /I**	**log (I_o /I)**	**No. of counts I /1000 Sec.**	**I_o /I**	**log (I_o/I)**
1	82758	1.039477	0.016815	81743	1.04738	0.020104
2	79693	1.079455	0.033205	79052	1.083034	0.034642
3	76305	1.127384	0.052072	76671	1.116667	0.047924
4	74410	1.156095	0.062993	73643	1.162582	0.065423
5	70510	1.22004	0.086374	72016	1.188847	0.075126
6	68976	1.247173	0.095927	68424	1.251257	0.097346
7	64041	1.34328	0.128167	65225	1.312626	0.118141
8	60939	1.411658	0.149729	61450	1.393263	0.144033
9	56585	1.520279	0.181923	56912	1.504358	0.177351
10	54093	1.590317	0.201484	52310	1.636704	0.21397

Table–3
Concentration of Urea in milk samples 5 % and 6%

Concentration of Urea in Milk : 5 % **Initial Counts (I_o) =** 85362 /1000 sec Density = 1.0413041642 gm/cc				**Concentration of Milk in Milk 6 %** **Initial Counts (I_o) =** 84146 / 1000 sec Density = 1.0443449616 gm/cc		
Path length (cm)	**No. of counts I / 1000 Sec.**	**I_o /I**	**log (I_o /I)**	**No. of counts I /1000 Sec.**	**I_o /I**	**log (I_o /I)**
1	81642	1.045565	0.019351	82113	1.024759	0.010622
2	80283	1.063264	0.026641	79524	1.058121	0.024535
3	77012	1.108425	0.044706	77008	1.0927	0.0384976
4	75649	1.128396	0.052461	73644	1.142605	0.057896
5	73221	1.165813	0.066629	71028	1.184688	0.073604
6	68762	1.241412	0.093916	68015	1.237168	0.092429
7	65517	1.302898	0.114911	65113	1.292307	0.111366
8	61099	1.39711	0.14523	61998	1.357237	0.132656
9	55696	1.532641	0.185441	56128	1.49918	0.175854
10	52111	1.63808	0.214335	51028	1.649016	0.217225

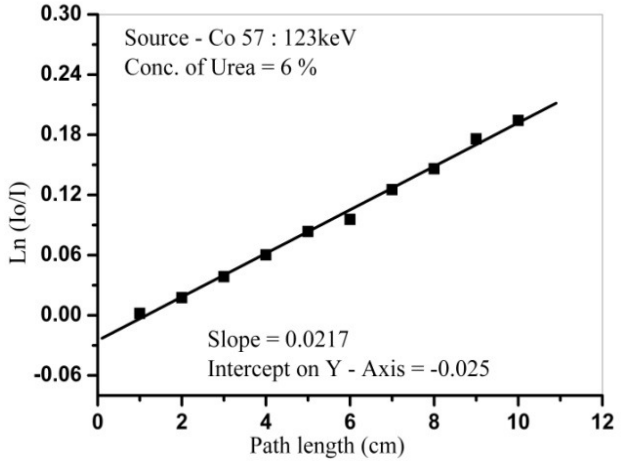
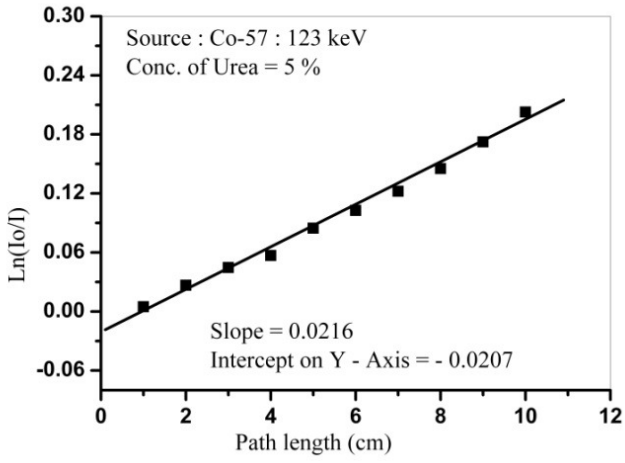


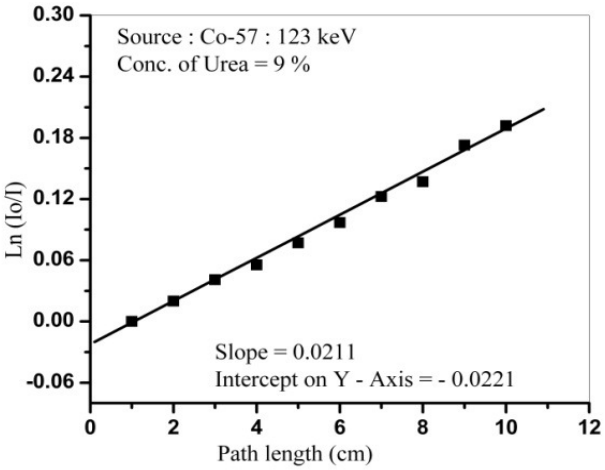
Figure-5
Concentration 5% of milk + urea



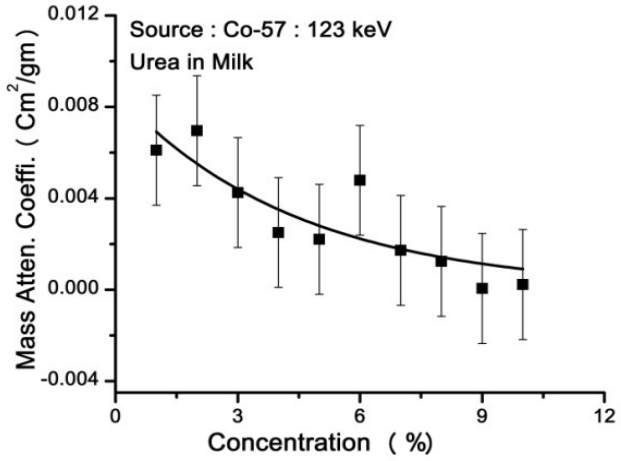
Figure–6
Concentration 6% of milk + urea

Table–5
Concentration of Urea in milk samples 9% and 10%

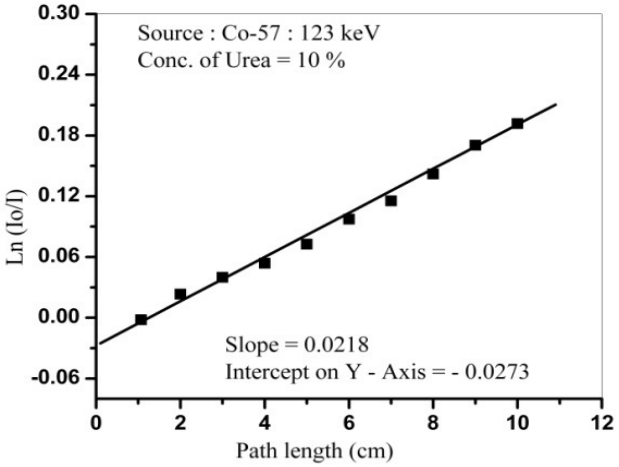
Concentration of Urea in Milk : 9 % **Initial Counts (I_o) =** 85305 /1000 sec Density = 1.0503224353gm/cc				**Concentration of Milk in Milk : 10 %** **Initial Counts (I_o) =** 84731 / 1000 sec Density = 1.0527723804gm/cc		
Path length (cm)	**No. of counts I / 1000 Sec.**	**I_o /I**	**log (I_o /I)**	**No. of counts I /1000 Sec.**	**I_o /I**	**log (I_o /I)**
1	82639	1.032261	0.013789	83695	1.012378	0.005343
2	59389	1.436377	0.157268	80296	1.055233	0.023348
3	77618	1.099036	0.041012	77295	1.096203	0.039891
4	75088	1.136067	0.055404	74864	1.131799	0.053769
5	72891	1.170309	0.068301	71675	1.182156	0.072675
6	69235	1.232108	0.090649	68483	1.237256	0.09246
7	65646	1.29947	0.113766	64947	1.304618	0.115483
8	62244	1.370494	0.136877	61112	1.386487	0.141916
9	56640	1.506091	0.177851	57247	1.480095	0.17029
10	52366	1.629015	0.211925	52052	1.627814	0.211605



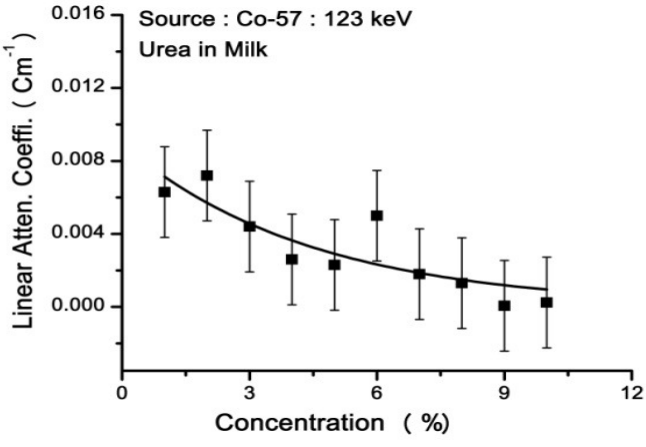
Figure–7
Concentration 9% of milk + urea



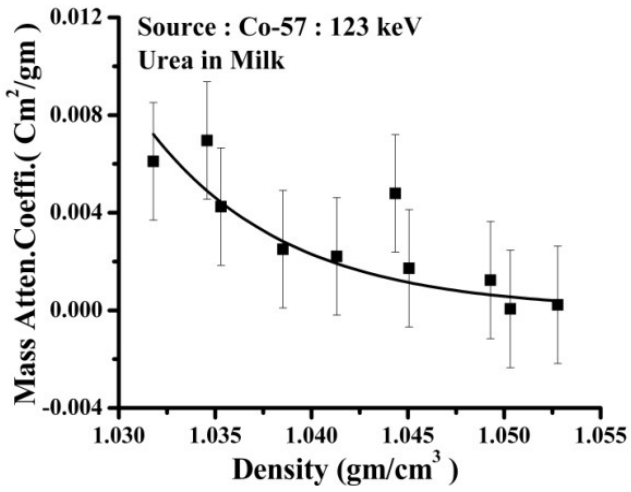
Figure–9
For energy source Co–57



Figure–8
Concentration 10% of milk + urea



Figur-10
For energy source Co – 57



Figure–11
For energy source Co – 57 of milk + urea

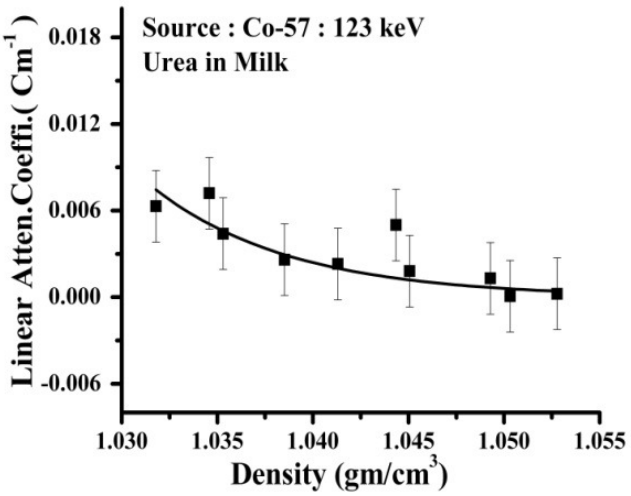


Figure-12
For energy source Co – 57 of milk + urea

Conclusion

We studied the linear and mass attenuation coefficient of buffalo admixture of milk sample (milk and urea) with different concentrations by adding water in the milk at the gamma ray energy 122 keV of gamma source C0-57 with narrowed beam. The result shows that as concentration and density of milk sample increases, linear and mass attenuation coefficient decreases. This method is very useful for detection of adulteration in the milk samples.

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