IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Adulterant detection in cow's milk using gamma radiation

S. B. Girase
Department of Physics,
K.V.P.S.'s, S. P. D. M. College, Shirpur,
Maharashtra- 425 405 (India)

Abstract

Milk is a complete food and is being served as a natural foodstuff. It is an essential part of our daily life for human body for growth. Considering precious advantages of milk to human life there are many cases of adulteration of the milk have been recorded globally. To avoid the adulterated milk and to quantify the traces of adulterants from milk are the major challenges of today's era. Here in, we have demonstrated the method of detection of these adulterants and quantified its concentration in milk. The adulterants have been determined by using linear and mass attenuation coefficient at various gamma ray energies. In the present study, we have prepared the adulterate the milk samples by adding different concentrations of lactose powder and sabudana powder (Starch). Further, obtained results were compared with the mass attenuation coefficient of homonised pasteurised and toned milk. The percentage of lactose powder and sabudana powder (Starch) added in to the milk were extracted.

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

INTRODUCTION :

The milk is complete diet and has been recognized since Vedic times. Milk provides essential nutrients like protein, fat, carbohydrates, vitamins and minerals in moderate amounts which are in easily digestible form to humans. Cow's milk contains 86.6% of water , 4.6% of fat, 3.4% of protein and 4.9% of lactose. Milk contains more than 100 substances in the form of emulsion in water suspension or solution. Therefore, milk is a most popular foodstuff for children and old persons. Considering heavy demand and need of milk, there are many instances of adulteration of milk is observed. The adulterants like lactose powder, sabudana powder (Starch), detergent, water, formalin, urea, glucose, cane sugar are harmful to our health. As per the survey carried in a Dehradun city, the percentage of adulterants found in

milk are 80% glucose, 58% skim milk powder, 35% urea and 51% salt for samples collected from different places of city. The adulterants are decreases the nutrient values of the milk and it causes the serious problems to human health. Naturally, milk contains heavy metals like Cu and Fe which are essential to maintain the proper metabolic activity in living organisms. While some heavy metals like Pb and Cd are not essential and have not any biological role. Due to the adulteration, the concentrations of heavy metals become higher which will affect the toxicity to living organisms.

To quantify the percentage of adulterants in a milk samples, the linear and mass attenuation coefficient of milk samples were estimated. The photon attenuation coefficient is an important parameter for characterising the penetration and diffusion of X-ray and gamma rays in compound material. The researchers have been determined the linear and mass attenuation coefficients of different materials. For determination of photon absorption coefficient of multi element which are in liquid form or soluble in water researchers used mixture rule.

Current work focuses on quantifying the adulterant percentage added in milk by using photon attenuation coefficient at different gamma ray energies of 0.122 to 1.33Mev.

Experimental method

The liquid solutions of 1 % to 10 % concentration of lactose powder in a milk sample were prepared by adding 1 to 10 gm of lactose power in 100 ml of homonised, pasteurised and toned milk samples. Similarly, the adulterated milk solution of sabudana powder (Starch) having the various concentrations of 0.5 % to 5 %, by adding 0.5 g to 5 g sabudana powder (Starch) in 100 ml were prepared.. The densities of prepared milk sample solution by using specific gravity bottle were evaluated and are listed in Table -1a and Table -1b.

Here, we used Nal (Tl) detector for gamma ray radiation and measured the linear and mass attenuation coefficient of prepared adulterated milk sample. Initially, the system was calibrated by using the gamma ray energy sources Co^{57} and Co^{60}. The experimental set up is shown in Fig.1.

The well collimated gamma ray from Cs^{137} having the energy 0.662 MeV was passed through the empty cylinder for 1000s and initial counts I_o were recorded. 1% concentration of lactose powder in a milk sample was taken to pass the gamma rays through it originated from Cs^{137} source for 1000 s and number of counts I was measured.

Similarly, I_o counts and I counts were obtained for all concentrations of lactose powder and sabudana powder (Starch) contained samples by using various gamma ray sources (Co^{57}, Ba^{133}, Mn^{54}, $Na^{22}$and Co^{60}).

Result and Discussion:

Graphs of ln (Io/I) verses path length shows the linear relationship with negative slopes with exponential attenuation. Further, it is confirmed that the photon absorption coefficient was observed to be decreased linearly with increase in gamma ray energy. The slope (m), point of intersection (c) and linear absorption coefficient was estimated by using the following formula.

$$\mu_l = m\rho + c \quad (1)$$

Where, μ_l is linear attenuation coefficient, ρ is density of milk sample in g/cm^3.

The mass absorption coefficient (μ_m)is defined as,

$$\mu_m = \mu_l/\rho \quad (2)$$

The unit of μ is cm^{-1} and that of μ_s is cm^2/g.

The linear absorption coefficient of different concentrations of lactose powder in milk solution samples and linear absorption coefficient of homonised pasteurised and toned Cow's milk are shown in Table 2a & b and 4a & b. The mass absorption coefficients of different concentration of lactose powder in milk solution and homonised pasteurised and toned Cow's milk are shown in Table 3a & b and 5a & b.

The graph of linear attenuation coefficient of various concentrations of lactose powder , sabudana powder (Starch) and homonised pasteurised and toned Cow's milk with various gamma ray energies is shown in Figure 2 & 3, respectively. The graph of mass attenuation coefficient of different concentrations of lactose powder ,sabudana powder (Starch) and homonised pasteurised and toned cow's milk various gamma ray energies are shown in Figure 4 & 5, respectively. The nature of graph shows that the linear and mass attenuation coefficient of all concentrations of lactose and Sabudana powder (Starch) in milk and homonised pasteurised and toned milk decreases with increases the gamma ray energies of the sources. Comparing the linear and mass attenuation coefficient values of lactose powder solution in milk sample with the values of liner and mass attenuation coefficient of homonised, pasteurised and toned cow's milk μ_l and μ_m were estimated.

The density of cow's milk dependent on various climatic factors like season, weather, breed of animals, feeding of animal, etc. The reported range of density of cow's milk is 1.02707 to 1.03514 g/cm^3. The density of milk also affected with an addition of adulterants like water, lactose powder, sabudana powder, detergent, cane sugar, formalin etc. similarly, the absorption coefficient of milk varies with density of milk depending on the percentage of adulterant mixed.

Table-1a and b shows the density of milk solutions. The graph of linear attenuation coefficient of different concentration of lactose powder and sabudana powder (Starch) and homonised pasteurised and toned Cow's milk with various densities of milk solutions are shown in Figure 6 and Figure 7. The plot of mass attenuation coefficient of different concentration of lactose powder and sabudana powder (Starch) and homonised pasteurised and toned cow's milk various densities of milk solutions as shown in Figure 8

and Figure 9. Comparing the value of linear and mass attenuation coefficient of lactose powder solution in milk sample with the values of liner and mass attenuation coefficient of homonised, pasteurised and toned cow's milk i.e. comparing μ_l and μ_m percentage of lactose powder and sabudana powder (Starch) in milk sample were estimated. The linear and mass attenuation coefficients of milk sample solution decreases with increase inthe densities of milk samples. It obeys the gamma dissociation law for the milk sample.

Conclusion:

The study of absorption coefficient at the energy rang 0.123MeV to 1.33 MeV of adulterated milk sample for various concentration of added adulterants solution [lactose powder and sabudana powder (Starch)] and homonised, pasteurised and toned milk explores the validity of the exponential absorption law for gamma radiation. Comparing the liner and mass absorption coefficient of adulterated milk sample with the values of pure milk sample. We can determine the percentage of adulterant in milk sample. The mass absorption coefficient of adulterated milk sample solution varied with density of milk solution. Density of milk sample solution increased with decrease in the linear and mass attenuation coefficient. It validate the exponential absorption law for gamma radiation. The mass absorption coefficient of 5 % lactose powder added in milk sample solution is 0.0109 cm^2/g and the mass absorption coefficient of toned milk is 0.0135 cm^2/g for gamma energy 0.122 MeV. The simulated value of mass attenuation coefficient is 0.01191 cm^2/g. The percentage of deviation is 8.4. This variation occurs due to variation in density and other physical quantities of milk sample solution. The value of mass attenuation coefficient of unknown milk sample is nearly equal to 0.0109 cm^2/g, we say that the adulterant, lactose powder, added in milk is 5 %. In this we were determine the other adulterants added in milk sample.

Acknowledgment :

Author is thankful to Hon'ble Dr. Tushar Randhe, President, K. V. P. Sanstha, Shirpur and Hon'ble Dr. S. N. Patel, Principal, S. P. D. M. College, Shirpur for the encourages.

Table – 1a : Calculated density of various concentration of adulterants added in milk sample solution using specific gravity bottle:

Adulterant Added in milk	Density of various concentration of adulterants added in milk sample									
	1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	9 %	10 %
Lactose	1.0391	1.0399	1.0407	1.0415	1.0424	1.0433	1.0441	1.0449	1.0471	1.0497

Table – 1b : Calculated density of various concentration of adulterants added in milk sample solution using specific gravity bottle:

Adulterant Added in milk	Density of various concentration of adulterants added in milk sample									
	0.5 %	1 %	1.5 %	2 %	2.5 %	3 %	3.5 %	4 %	4.5 %	5 %
sabudana powder (Starch)	1.0322	1.0334	1.0349	1.0359	1.0372	1.0389	1.0414	1.0435	1.0454	1.0470

Table – 2a : Experimental values of linear attenuation coefficient of various concentration of lactose powder in milk sample and homonised pasteurised and toned Cow's milk:

Sr. No.	Energy MeV	Toned Cow's Milk	Concentration of Lactose in toned milk sample				
			1 %	2 %	3 %	4 %	5 %
1	0.122	0.0139	0.0134	0.0128	0.0122	0.0117	0.011
2	0.36	0.0137	0.0128	0.0122	0.0116	0.011	0.0105
3	0.511	0.0136	0.0124	0.0118	0.0113	0.0107	0.0101
4	0.662	0.0134	0.012	0.0114	0.0109	0.0104	0.0098
5	0.84	0.0133	0.0115	0.011	0.0104	0.0099	0.0094
6	1.17	0.013	0.0106	0.01	0.0095	0.0089	0.0083
7	1.28	0.0129	0.0103	0.0096	0.0092	0.0085	0.008
8	1.33	0.0128	0.0101	0.0094	0.009	0.0083	0.0078

Table – 2b : Experimental values of linear attenuation coefficient of various concentration of lactose powder in milk sample and homonised pasteurised and toned Cow's milk:

Sr. No.	Energy MeV	Toned Cow's Milk	Concentration of Lactose in toned milk sample				
			6 %	7 %	8 %	9 %	10 %
1	0.122	0.0139	0.0103	0.0098	0.0091	0.0085	0.0078
2	0.36	0.0137	0.0099	0.0093	0.0086	0.0079	0.0072
3	0.511	0.0136	0.0095	0.0089	0.0082	0.0075	0.0067
4	0.662	0.0134	0.0092	0.0085	0.0078	0.0072	0.0064
5	0.84	0.0133	0.0087	0.008	0.0074	0.0067	0.0059
6	1.17	0.013	0.0077	0.007	0.0064	0.0059	0.0052
7	1.28	0.0129	0.0072	0.0066	0.0061	0.0055	0.0049
8	1.33	0.0128	0.007	0.0065	0.006	0.0053	0.0048

Table – 3a : Experimental values of mass attenuation coefficient of various concentration of lactose powder in milk sample and homonised pasteurised and toned Cow's milk:

Sr. No.	Energy MeV	Toned Cow's Milk	Concentration of Lactose in toned milk sample				
			1 %	2 %	3 %	4 %	5 %
1	0.122	0.0135	0.0131	0.0125	0.012	0.0115	0.0109
2	0.36	0.0132	0.0124	0.0118	0.0113	0.0108	0.0103
3	0.511	0.013	0.012	0.0115	0.0109	0.0104	0.0098
4	0.662	0.0129	0.0116	0.0111	0.0106	0.0101	0.0095
5	0.84	0.0126	0.0113	0.0107	0.0101	0.0096	0.009
6	1.17	0.0122	0.0102	0.0095	0.009	0.0085	0.0079
7	1.28	0.012	0.0098	0.0092	0.0087	0.0082	0.0077
8	1.33	0.0119	0.0096	0.0089	0.0085	0.008	0.0075

Table – 3b : Experimental values of mass attenuation coefficient of various concentration of lactose powder in milk sample and homonised pasteurised and toned Cow's milk:

Sr. No.	Energy MeV	Toned Cow's Milk	Concentration of Lactose in toned milk sample				
			6 %	7 %	8 %	9 %	10 %
1	0.122	0.0135	0.0103	0.0097	0.009	0.0084	0.0078
2	0.36	0.0132	0.0097	0.0091	0.0084	0.0078	0.0072
3	0.511	0.013	0.0092	0.0086	0.0081	0.0074	0.0068
4	0.662	0.0129	0.009	0.0084	0.0077	0.007	0.0065
5	0.84	0.0126	0.0084	0.0079	0.0072	0.0067	0.006
6	1.17	0.0122	0.0074	0.0068	0.0064	0.0058	0.0052
7	1.28	0.012	0.0071	0.0066	0.0061	0.0055	0.005
8	1.33	0.0119	0.007	0.0064	0.0059	0.0053	0.0048

Table – 4a : Experimental values of linear attenuation coefficient of various concentration of sabudana powder (Starch) in milk sample and homonised pasteurised and toned Cow's milk:

Sr. No.	Energy MeV	Toned Cow's Milk	Concentration of Starch in toned milk sample				
			0.5 %	1 %	1.5 %	2 %	2.5 %
1	0.122	0.0139	0.0156	0.0141	0.0129	0.0118	0.0107
2	0.36	0.0137	0.0139	0.0124	0.0112	0.0102	0.0093
3	0.511	0.0136	0.013	0.0115	0.0105	0.0097	0.0086
4	0.662	0.0134	0.0123	0.011	0.0099	0.0092	0.0082
5	0.84	0.0133	0.0116	0.0103	0.0093	0.0085	0.0076
6	1.17	0.013	0.0106	0.0093	0.0083	0.0075	0.0066
7	1.28	0.0129	0.0102	0.009	0.008	0.0072	0.0063
8	1.33	0.0128	0.0099	0.0089	0.0079	0.007	0.0063

Table – 4b : Experimental values of linear attenuation coefficient of various concentration of sabudana powder (Starch) in milk sample and homonised pasteurised and toned Cow's milk:

Sr. No.	Energy MeV	Toned Cow's Milk	Concentration of Starch in toned milk sample				
			3 %	3.5 %	4 %	4.5 %	5 %
1	0.122	0.0139	0.0095	0.0084	0.0072	0.0061	0.0051
2	0.36	0.0137	0.0082	0.0073	0.0062	0.0051	0.0041
3	0.511	0.0136	0.0076	0.0067	0.0057	0.0046	0.0036
4	0.662	0.0134	0.0072	0.0061	0.0053	0.0042	0.0032
5	0.84	0.0133	0.0065	0.0056	0.0047	0.0036	0.0029
6	1.17	0.013	0.0056	0.0046	0.0038	0.003	0.0023
7	1.28	0.0129	0.0054	0.0044	0.0035	0.0029	2.10E-03
8	1.33	0.0128	0.0052	0.0042	0.0034	0.0028	2.10E-03

Table – 5a : Experimental values of mass attenuation coefficient of various concentration of sabudana powder (Starch) in milk sample and homonised pasteurised and toned Cow's milk:

Sr. No.	Energy MeV	Toned Cow's Milk	Concentration of Starch in toned milk sample				
			0.5 %	1 %	1.5 %	2 %	2.5 %
1	0.122	0.0135	0.0151	0.0137	0.0124	0.0113	0.0103
2	0.36	0.0132	0.0145	0.0129	0.0116	0.0104	0.0095
3	0.511	0.013	0.014	0.0124	0.011	0.0101	0.0092
4	0.662	0.0129	0.0136	0.0119	0.0107	0.0097	0.0088
5	0.84	0.0126	0.013	0.0114	0.0102	0.0093	0.0084
6	1.17	0.0122	0.012	0.0103	0.0093	0.0085	0.0076
7	1.28	0.012	0.0117	0.01	0.0089	0.0081	0.0074
8	1.33	0.0119	0.0115	0.0097	0.0087	0.0079	0.0072

Table – 5b : Experimental values of mass attenuation coefficient of various concentration of sabudana powder (Starch) in milk sample and homonised pasteurised and toned Cow's milk:

Sr. No.	Energy MeV	Toned Cow's Milk	Concentration of Starch in toned milk sample				
			3 %	3.5 %	4 %	4.5 %	5 %
1	0.122	0.0135	0.0092	0.008	0.0068	0.0057	0.0046
2	0.36	0.0132	0.0088	0.0076	0.0064	0.0052	0.0041
3	0.511	0.013	0.0083	0.0073	0.0061	0.0049	0.0038
4	0.662	0.0129	0.0079	0.0069	0.0058	0.0047	0.0035
5	0.84	0.0126	0.0076	0.0065	0.0056	0.0044	0.0033
6	1.17	0.0122	0.0068	0.0057	0.0048	0.0037	2.70E-03
7	1.28	0.012	0.0064	0.0054	0.0046	0.0036	2.60E-03
8	1.33	0.0119	0.0063	0.0053	0.0045	0.0035	2.50E-03

Fig. 1. Experimental set up:

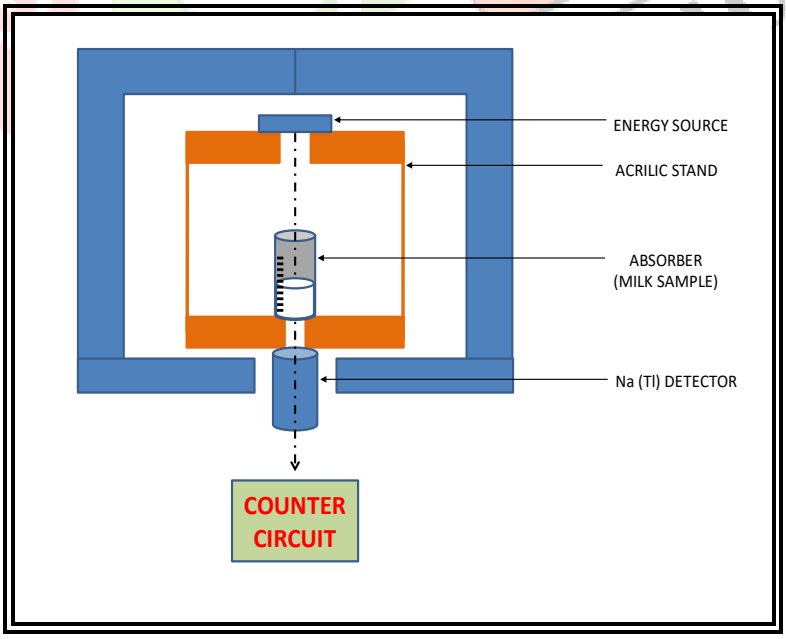

Fig. 1. The Experimental Set up

Fig.2. The linear attenuation coefficients of homonised pasteurized and toned milk compare with various concentrations of lactose powder in milk sample:

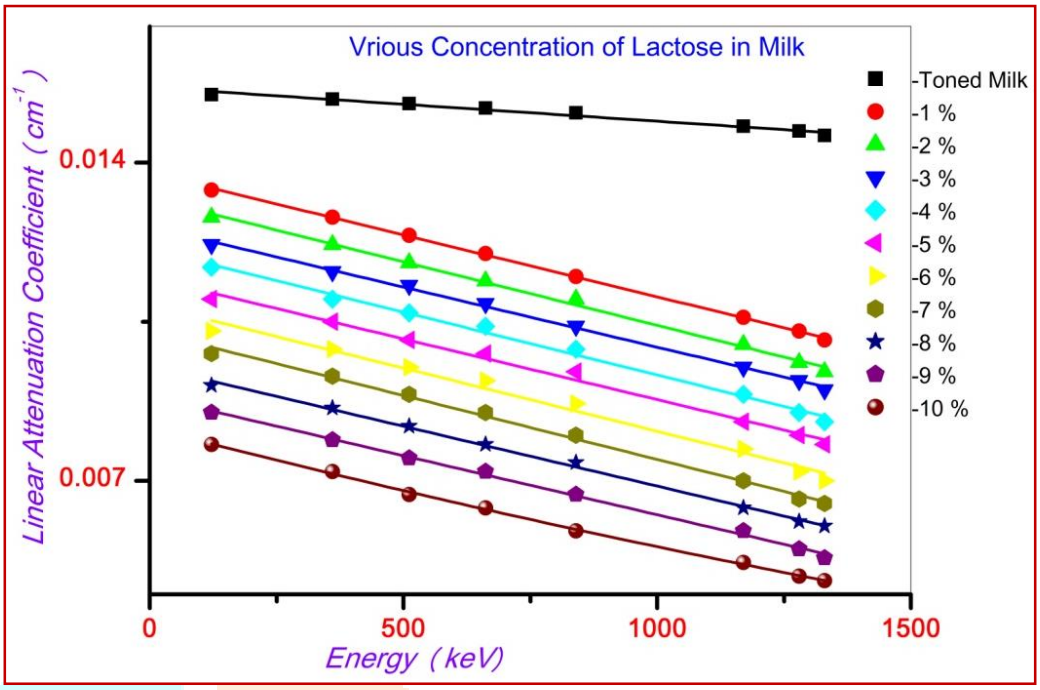

Fig.2. Linear attenuation coefficient V/s various gamma ray energy

Fig.3. The linear attenuation coefficients of homonised pasteurized and toned milk compare with various concentrations of sabudana powder (starch) in milk sample:

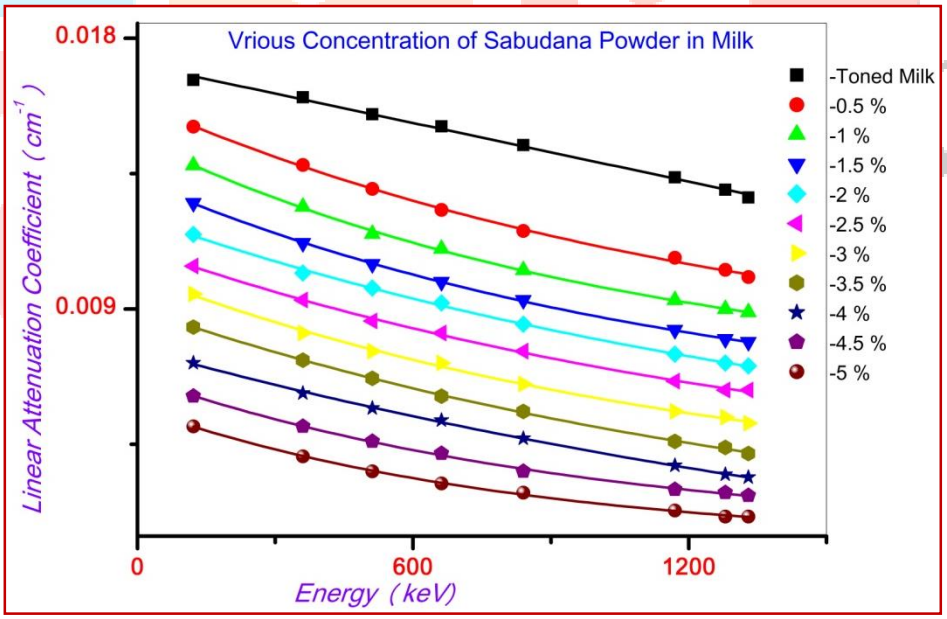

Fig.3. Linear attenuation coefficient V/s various gamma ray energy

Fig.4. The mass attenuation coefficients of homonised pasteurized and toned milk compare with various concentrations of lactose powder in milk sample:

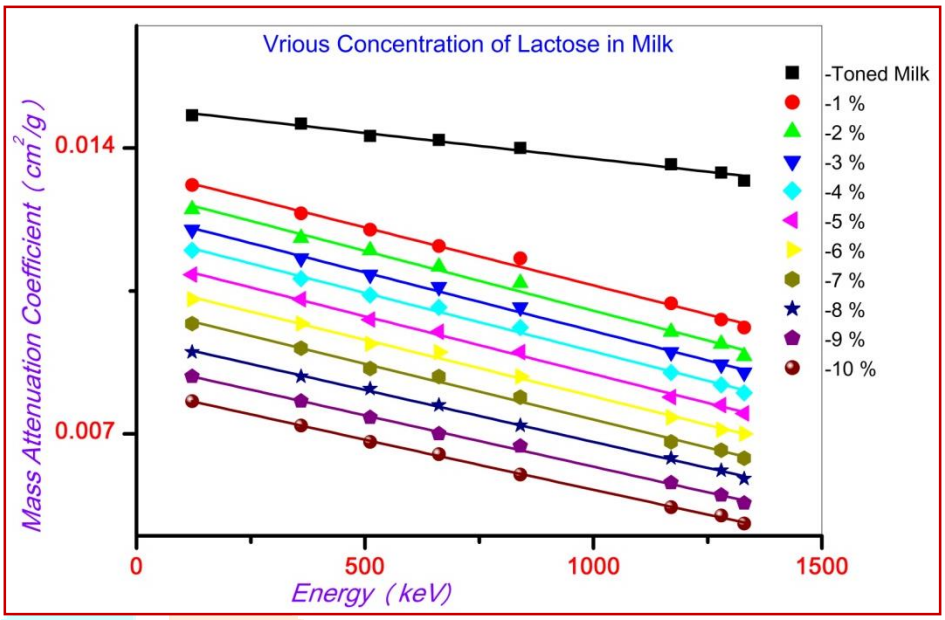

Fig.4. Mass attenuation coefficient V/s various gamma ray energy

Fig.5. The mass attenuation coefficients of homonised pasteurized and toned milk compare with various concentrations of sabudana powder (starch) in milk sample:

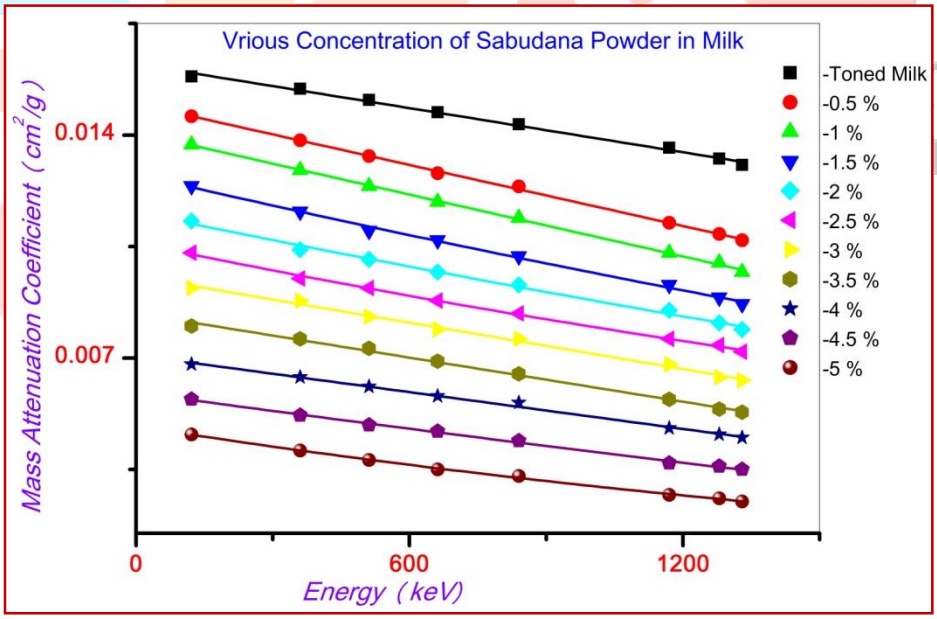

Fig.5. Mass attenuation coefficient V/s various gamma ray energy

Fig.6. The linear attenuation coefficients of homonised pasteurized and toned milk compare with various concentrations of lactose powder in milk sample:

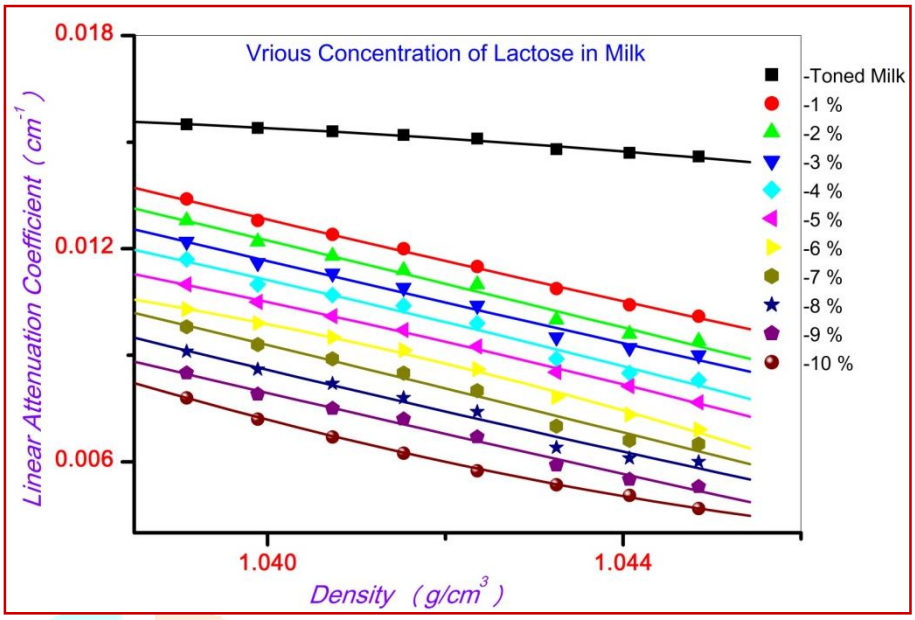

Fig.6. Linear attenuation coefficient V/s various density

Fig.7. The linear attenuation coefficients of homonised pasteurized and toned milk compare with various concentrations of sabudana powder (starch) in milk sample:

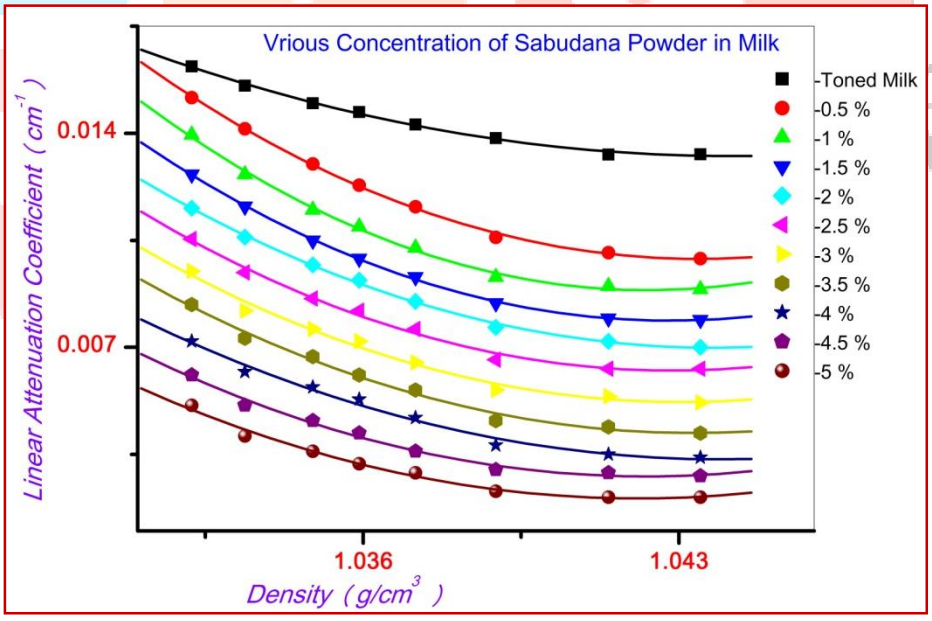

Fig.7. Linear attenuation coefficient V/s various density

Fig.8. The mass attenuation coefficients of homonised pasteurized and toned milk compare with various concentrations of lactose powder in milk sample:

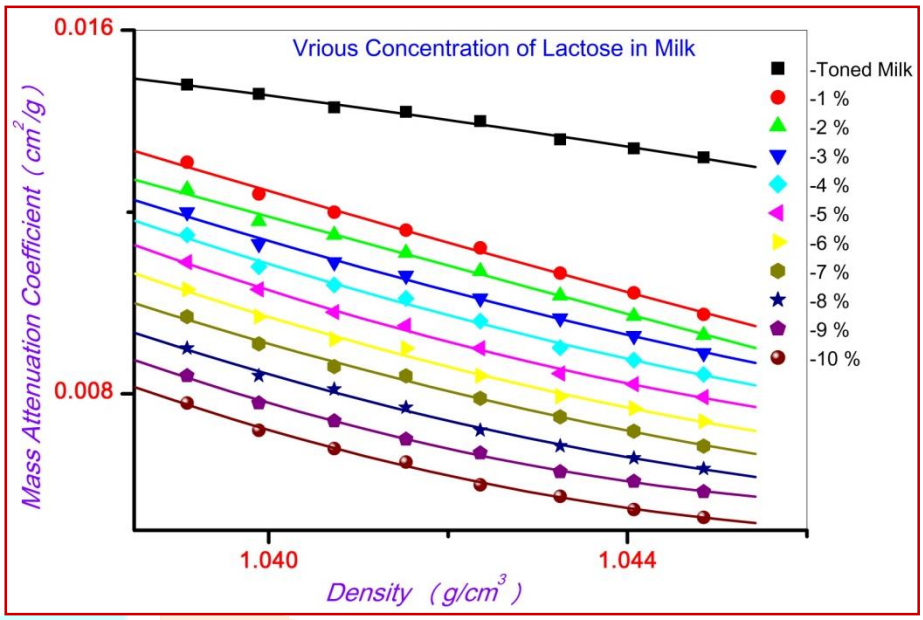

Fig.8. Mass attenuation coefficient V/s various density

Fig.9. The mass attenuation coefficients of homonised pasteurized and toned milk compare with various concentrations of sabudana powder (starch) in milk sample:

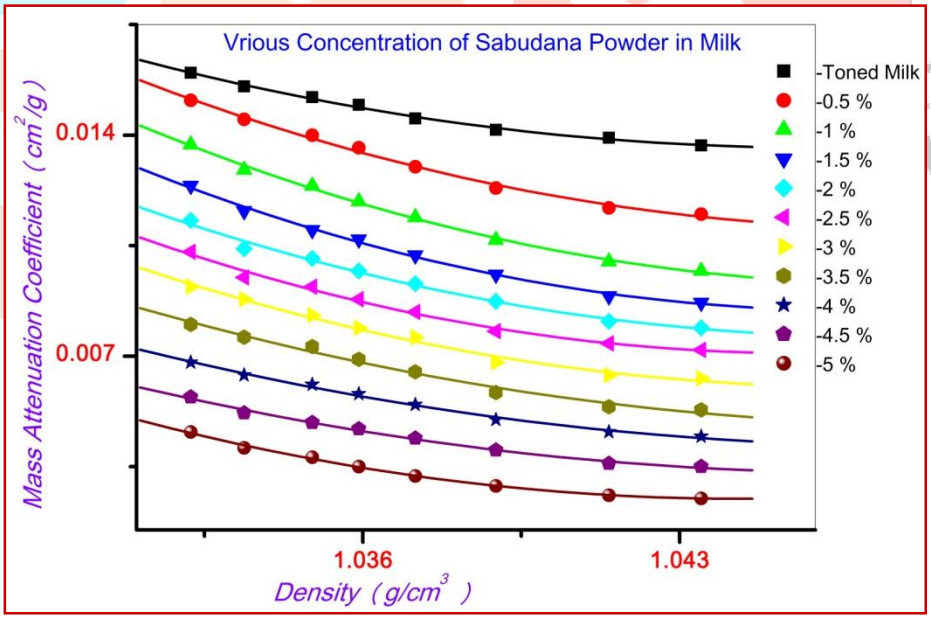

Fig.9. Mass attenuation coefficient V/s various density

References –

1. J. R. Cunningham and H. E. Johns, *Med. Phys* **1960 7**, *51*

2. J. H. Hubbell *Appli. Radiat. Isot.*, **1982,** 33, 1269

3. M. T. Teli, L. M. Chaudhari and S. S. Malode , *Appli. Radiat isot*, **1994,** 45

4. M. T. Teli, L. M. Chaudhari and S. S. Malode**,** *J. of Pure & applied Physics*, **1994**, *32*,

5. H. singuri and M.K. Sukumaran, *Journal of chromatograph separate fetching,* **2014**, 5:1

6. Ali A, mahamood A S, Hussain L, Akhtar A, *pak J Nutr*, **2011**, *12* :1195 – 1202

7. I. Altaf, A. Ashfaq, S. Saddique, By Tipu MS , Lohor *University of veterinary Animal Science*, **2007,** 7

8. S. D. Kandpal, A. K. Shrivastva, K. S. Negi**,** Indian J Community Health , **2007**, 3:188-192

9. S. Mirwal, P. Pant and M. Rai, International, Journal of *pharm Tech research*, **2013**

Vol.5, No.2, pp359-364.

10. Ayar A, sert D., and Akin N**.**, *Environmental monitoring Assessment*, **2009,** 152:

1-12.

11. E.M.R. Rodriguez, E.D. Uretra and C.D., *Zeitschrift fur lebensmi Heluntersuchnng and forschung* A, **1999**, Vol.208 No.3, pp162-168, view at google scholar. View at Scopus

12. Li Y., Mc crory D.F., Powel J.M., Saam H. and Jackson smith D., *Journal Dairy Science*, **2005,** 88:2911-2922,

13. L.Q. Qin, M.P. Wang, W. Li, X. Tong and W.J. Tong**,** *Journal Health Science* **2009**, 55(2): 300-305.