Research Journal of Physical Sciences ____ISSN 2320–4796
Vol. **1(2),** 1-8, March **(2013)** *Res. J. Physical Sci.*

Study of Attenuation Coefficients of Leaves of Asoka Plant by Using Cs and Tl Sources

Chaudhari Laxman M.
Nuclear Physics Research Laboratory, Dept. of Physics, Nowrosjee Wadia College, Pune M.S., INDIA

Available online at: www.isca.in
Received 15th January 2013, revised 20th February 2013, accepted 2nd March 2013

Abstract

The linear and mass absorption coefficients of various leaves (fresh and dry) of Asoka plant studied by using beta sources Cs and Tl. Our study explores the validity of the expected exponential absorption law for leaves. The experimental and theoretical values are well agreement with the mixture rule. The linear and mass absorption coefficient values are useful for quantitative evaluation of interaction of radiations with leaves of plants.

Keywords: Beta sources, detectors, counter, computer etc.

Introduction

Radiations have today become an inseparable part of living environment. Besides radiations from natural sources we have manmade sources such as nuclear reactors, radioisotopes, X-ray machine etc. Radiations are usefully employed in various fields such as medicine, industry, hydrology and agriculture. However the ill effects and hazards of radiation, especially the high energy gamma radiation, are well known. Hence the person using the radiation technology, the workers and the public around must be protected or shielded from these radiations.

It is on this background that 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. We can define some parameters for such a quantitative evaluation, of which the 'mass attenuation coefficient' of the material is one of the most important parameter. It is because of this that the study of mass attenuation coefficient of various materials has been an important part of research work in radiation chemistry and physics. The mass attenuation Co-efficient usually depends upon the energy of radiations and nature of the material.

Hubbell[1]has compiled an extensive data on mass attenuation coefficients of gamma rays in some compound and mixtures of dosimetric interest in the energy range of 1 keV to 20 MeV. Hubbell and Seltzer have compiled an updated version of attenuation coefficients for elements having atomic number from 1-92 and for 48 additional substances. Other scientists s Carlsson, Cunningham, Jahagirdar, Singh etc[2-23] have conducted systematic studies of attenuation coefficients from time to time.

In a pioneering work Chaudhari and Teli[9] determined gamma ray mass attenuation coefficients of salts magnesium chloride, zinc sulphate and ferrous sulphate at energies 123 keV and 662 keV in the form of solutions. The mixture rule developed by them can be applied to measure the mass attenuation coefficients of substances, with a greater accuracy, in the form of the solution. The solution method has thereafter been used for measuring mass attenuation coefficients of several salts, some amino acids, sugars, and starches.

The present work is an extension of this research field. We are studied the linear and mass attenuation coefficient of leaves of Ashoka plants at original state (before dry) and after dry for beta rays of source Cs and Tl has been studied. As leaves are plays vital role in the process of photosynthesis. With these points in consideration the experiments for measurement of mass attenuation coefficient have been taken to the unexplored frontiers of biophysical science.

The attenuation coefficient is a basic quantity used in calculations of the penetration of materials by quantum particles or other energy beams. The linear attenuation coefficient, also called the narrow beam attenuation coefficient, is a quantity which describes the extent to which the intensity of energy beam is reduced as it passes through a specific material. This might be electromagnetic radiation beam. It is represented using the symbol μ, and measured in cm^{-1}.In the case of ultrasound attenuation it is usually denoted as α and measured in dB/cm/MHz.

A small linear attenuation coefficient indicates that the material in question is relatively transparent, while larger values indicate greater degrees of opacity. The linear attenuation coefficient is dependent upon the type of material and the energy of the radiation. Generally, the higher the energy of the incident photons and the less dense the material in question, the lower the corresponding linear attenuation coefficient will be.

Experimental block diagram

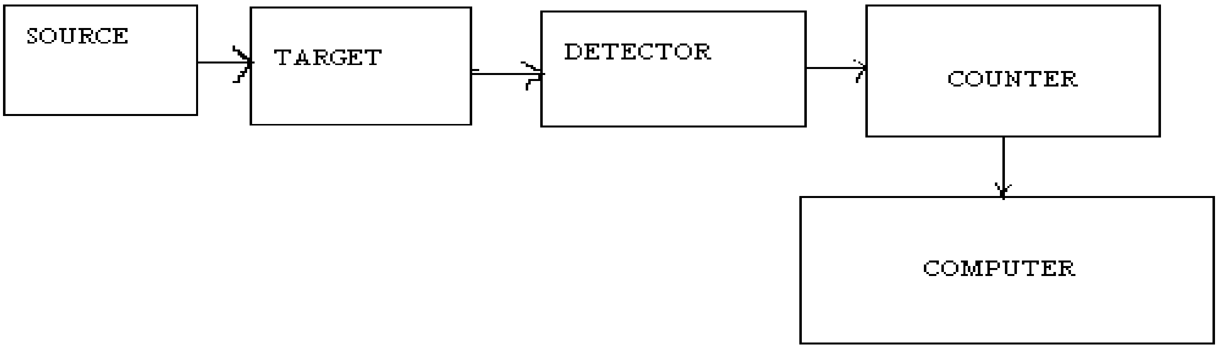

Figure-1
Experimental block diagram

The measured intensity I of transmitted through a layer of material with thickness x and density ρ is related to the incident intensity I_0 according to the inverse exponential power law that is usually referred to as Beer-Lambert law:

$$I = I_0\, e^{-\alpha x},$$

Where, x denotes the path length.

The Half Value Layer (HVL) signifies the thickness of a material required to reduce the intensity of the emergent radiation to half its incident magnitude. It is from these equations that engineers decide how much protection is needed for "safety" from potentially harmful radiation. The attenuation factor of a material is obtained by the ratio of the emergent and incident radiation intensities I / I_0. The linear attenuation coefficient and mass attenuation coefficient are related such that the mass attenuation coefficient is simply α/ρ, where ρ is the density in g/cm^3.

The linear attenuation coefficient is also inversely related to mean free path.Knowing the value of N_0 and nothing a particular reading for the same y rays as N, the absorbance was obtained as,

Abs = ln N_0/ N

Further graph of absorbance versus thickness of each leave , the slope of the graph gave value a straight line, which showed that the absorbance followed exponential law with respect to thickness . The slope of graph gave value of linear absorption coefficient for particular sample. The unit of linear absorption coefficient so obtained is cm-1.Therfore the mass attenuation coefficient was calculated by dividing linear absorption coefficient with its its measured density. The mass attenuation coefficient thus obtained has unit cm^3.g.cm^{-1} or cm^2/g.

Research Methodology

First we make standard connections and arrangement between G.M. Counting System, detector, absorber and source. Place a beta source in the source tray at about 2 cm from the end window of the GM tube. Set the GM voltage at the operating voltage(625V)of the GM tube. Place the absorber (leaves of Ashoka) between end window detector and source holder containing eight absorbers of respective thickness. We are took the reading for a present time of 60 sec. without any absorber and tabulate and repeated the experiment by recording the data stored for the same present time for different thickness in the increasing order. Repeat the same steps as explained above for next absorber sets of leaves. Plot the graph of ln(No/N) Vs thickness of absorber. The slope graphs gives as linear absorption coefficient and for mass attenuation coefficient first calculate density of absorber by taking mass and area of absorber. The ratio of linear mass coefficient to the density of absorber gives the "Mass Attenuation Coefficient" of respective absorber.

Biological /botanical detail of Polyalthia longifolia (Ashoka): Polyalthia longifolia is a lofty evergreen tree, native to India, commonly planted due to its effectiveness in alleviating noise pollution. It exhibits symmetrical pyramidal growth with willowy weeping pendulous branches and long narrow lanceolate leaves with undulate margins. The tree is known to grow over 30 ft in height. Fresh leaves are a coppery brown color and are soft and delicate to touch, as the leaves grow older the color becomes a light green and finally a dark green. The leaves are larval food plant of the Kite swallowtails.

Physical Description: Trees, shrubs, rarely woody vines, deciduous or evergreen, with aromatic bark, leaves, and flowers. Pith septate to diaphragmed. Leaves alternate, simple, without stipules, petiolate. Leaf blade pinnately veined, unlobed, margins entire. Inflorescences axillary to leaf scars on old wood or to leaves on new shoots, solitary flowers or few-flowered fascicles, pedunculate; bracts or bracteoles present or absent. Flowers bisexual, rarely unisexual; receptacle becoming enlarged, elevated or flat; perianth hypogynous, segments valvate or imbricate; sepals persistent, distinct or basally connate; petals either 6 in 2 unequal whorls of 3 with petals of outer whorl larger, petals of inner whorl fleshier than the outer, often with corrugate nectary zone, or petals, nearly equal or unequal, veins impressed on inner face; stamens 10-20 or very numerous, hypogynous, spirally arranged, forming ball or flat-topped mass; filament short, stout; anther linear to oblong-linear, extrorse, longitudinally dehiscent; connective apically elongate, connivent; pistils 1-many, superior, 1-carpellate, 1-locular, distinct or connate to various degrees with at least stigmas distinct; placentation marginal, placenta 1; ovules 1-many per pistil; style short, thick; stigma terminal. Fruits berries, distinct, per flower, or coalescent, forming syncarps, 1 per flower. Seeds 1-many per pistil, arillate; endosperm ruminate, oily. Genera ca. 128, species ca. 2300 (3 genera, 12 sp: mostly circumtropical.

The family has particular importance in the tropics because of the edible syncarps of some species of Annona ; in the eastern United States the fruit of Asimina triloba (pawpaw) was once much gathered and appreciated. Programs in breeding from selected stock of Asimina have been undertaken (G. A. Zimmerman 1941). Currently, the Pawpaw Foundation is intensively researching means to develop commercially marketable fruits. Recent studies of the chemical properties of Asimina reveal its pesticidal possibilities, and its potential as an anticancer agent (E. M. Norman, pers. comm.) The warm-climate genera Cananga, Rollinia, and Artabotrys have been used as ornamentals.

Results and Discussion

The results are shown in the following tables and figures

Table-1
Counts/sec for various thickness (gm/cm^2) of leaves Ashoka by using source Cs:

Thickness in cm	Thickness in gm/cm^2	No. of Counts in 60 sec.				Corrected counts	Counts/sec
		I	II	III	Mean		
0.16	0.00366	885	898	850	878	867	14.444
0.32	0.00731	733	700	661	698	687	11.450
0.49	0.01120	578	641	610	610	599	9.978
0.66	0.01508	443	443	436	441	430	7.161
0.83	0.01897	384	398	401	394	383	6.389
0.97	0.02216	329	321	334	328	317	5.283
1.19	0.02719	317	301	291	303	292	4.867
1.34	0.03062	326	287	285	299	288	4.806

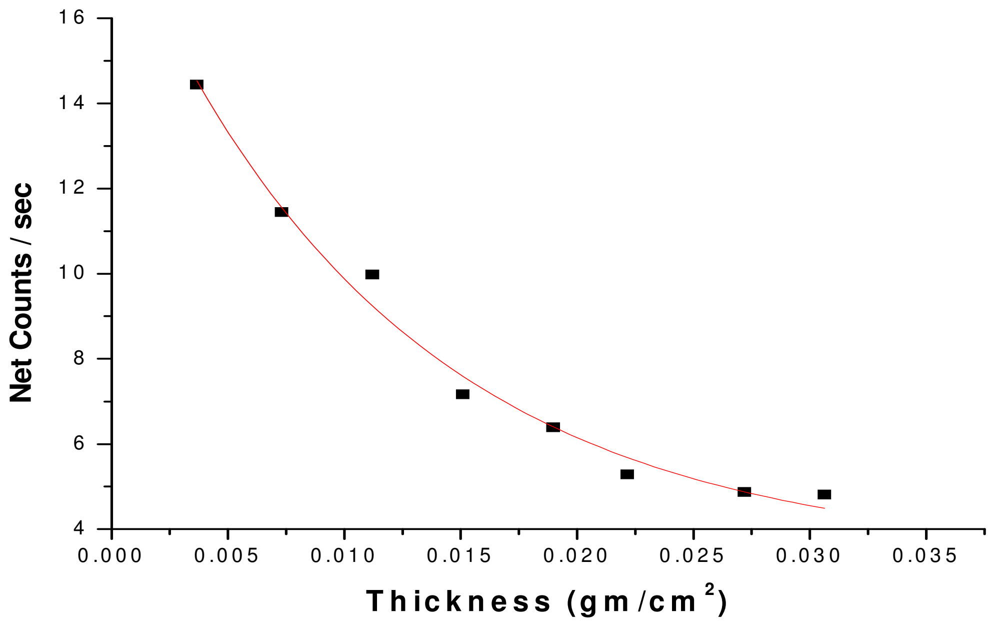

Figure-2
The net counts/sec Vs. thickness (gm/cm^2) of leaves Ashoka by using source Cs
Table-2

Counts/sec) for various thickness (gm/cm^2) of Ashkoa leaves by using source TI

Thickness in cm	Thickness in gm/cm^2	No. of Counts in 60 sec.				Corrected counts	Counts/sec
		I	II	III	Mean		
0.16	0.00366	224	231	218	224	213	3.556
0.32	0.00731	140	144	151	145	134	2.233
0.49	0.01120	98	86	77	87	76	1.267
0.66	0.01508	46	63	77	62	51	0.850
0.83	0.01897	48	43	45	45	34	0.572
0.97	0.02216	29	35	33	32	21	0.356
1.19	0.02719	31	29	32	31	20	0.328
1.34	0.03062	21	19	18	19	8	0.139

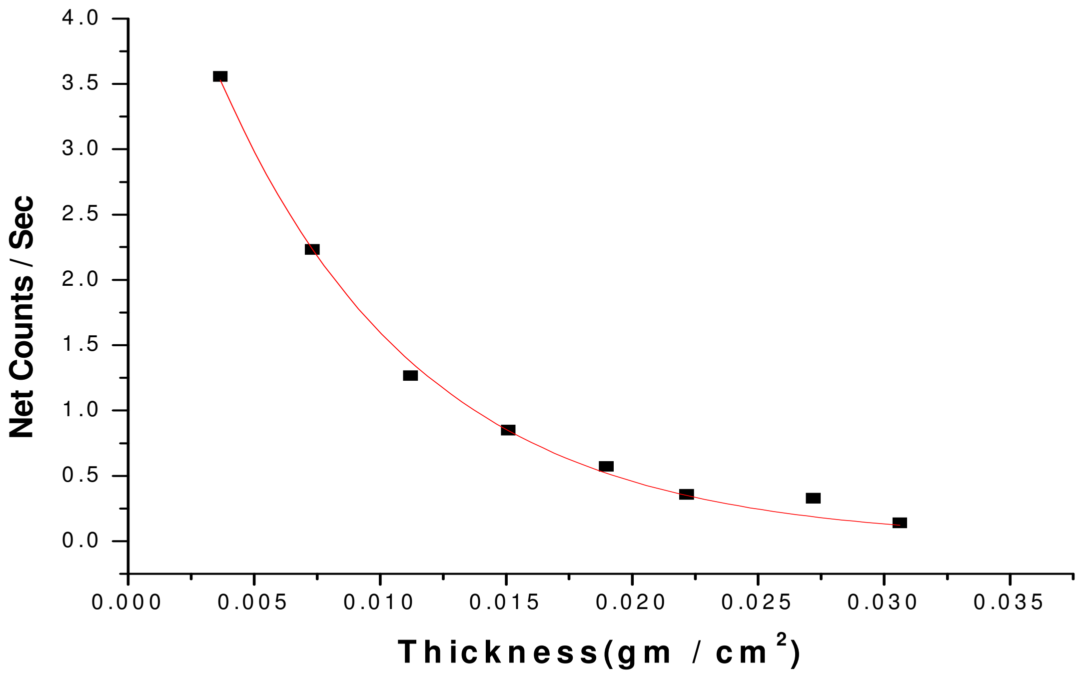

Figure-3
Counts/sec) Vs. thickness (gm/cm^2) of Askoa leaves by using source TI

Table-3
Ln(N_0 / N) for various thickness of plant Ashoka by using source Tl

No Of Leaves F	Thickness of leaves	No. of Counts in 60 sec.				Corrected counts	ln (N0/N)
		I	II	III	Mean		
1	0.16	224	231	218	224.33	213	0.550647
2	0.32	140	144	151	145.00	134	1.015663
3	0.49	98	86	77	87.00	76	1.58277
4	0.66	46	63	77	62.00	51	1.981677
5	0.83	48	43	45	45.33	34	2.377386
6	0.97	29	35	33	32.33	21	2.853232
7	1.19	31	29	32	30.67	20	2.934578
8	1.34	21	19	18	19.33	8	3.793239

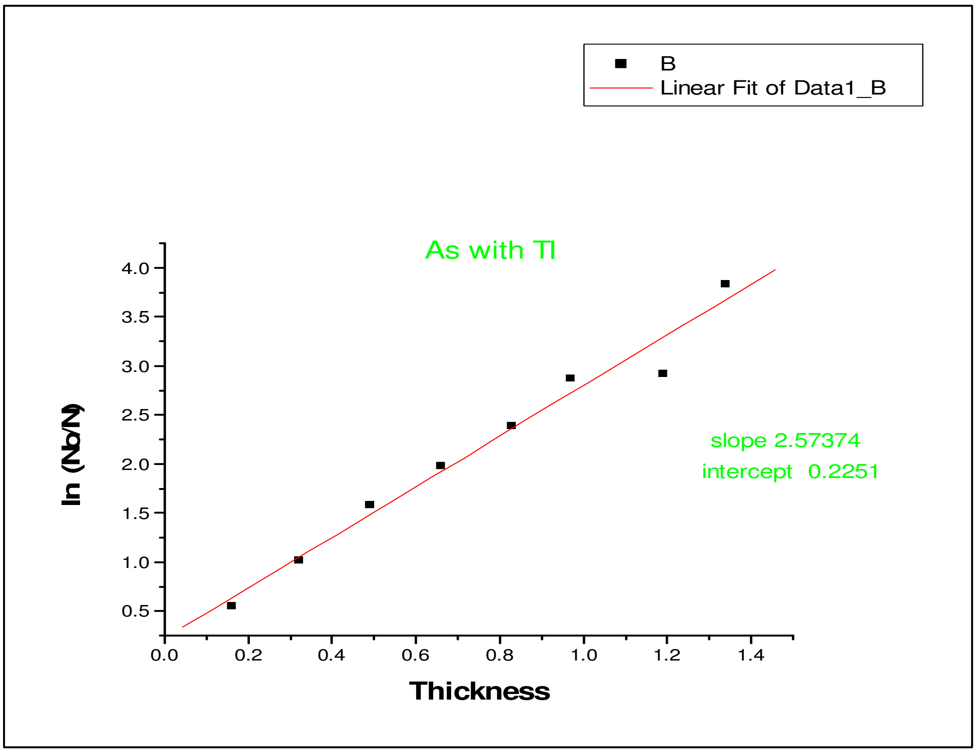

Figure-4
Ln(N_0 / N) Vs. thickness of plant Ashoka by using source Tl

Table-4
Ln(N_o/N) for various Thickness of Asoka leaves by using Cs

No Of Leaves	Thickness of leaves	No. of Counts in 60 sec.				Corrected counts	ln (N0/N)
		I	II	III	Mean		
2	0.32	733	700	661	698.00	687	0.59053
3	0.49	578	641	610	609.67	599	0.72816
4	0.66	443	443	436	440.67	430	1.05986
5	0.83	384	398	401	394.33	383	1.17396
6	0.97	329	321	334	328.00	317	1.36396
7	1.19	317	301	291	303.00	292	1.44611
8	1.34	326	287	285	299.33	288	1.45875

Table-5
Ln(N_0/N) for various thickness of leaves (dry) of Ashoka by suing source Tl :

No Of Leaves	Thickness of leaves	No. of Counts in 60 sec.				Corrected counts
		I	II	III	Mean	
1	0.16	275	274	278	275.67	264.67
2	0.3	220	245	237	234.00	223.00
3	0.45	191	194	189	191.33	180.33
4	0.59	147	142	146	145.00	134.00
5	0.74	113	132	127	124.00	113.00
6	0.88	103	96	101	100.00	89.00
7	1.1	81	85	83	83.00	72.00
8	1.13	61	58	57	58.67	47.67

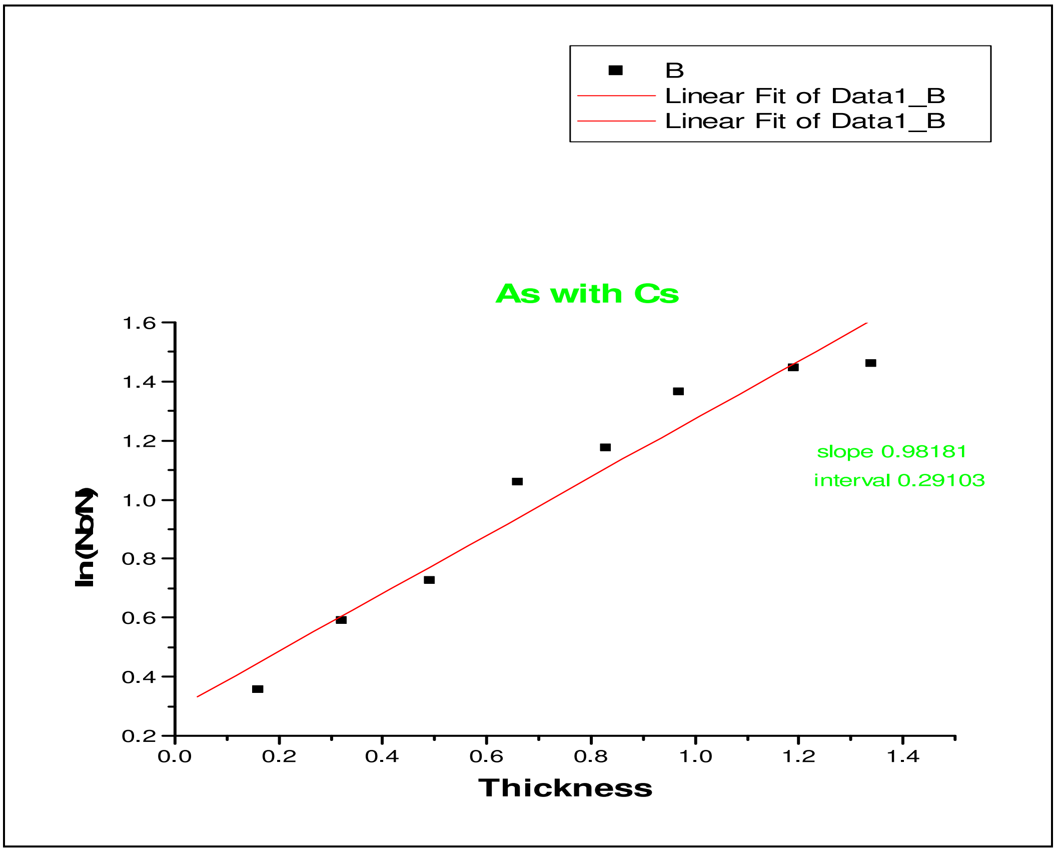

Figure-5
Ln(N_o/N) for various Thickness of Asoka leaves by using Cs

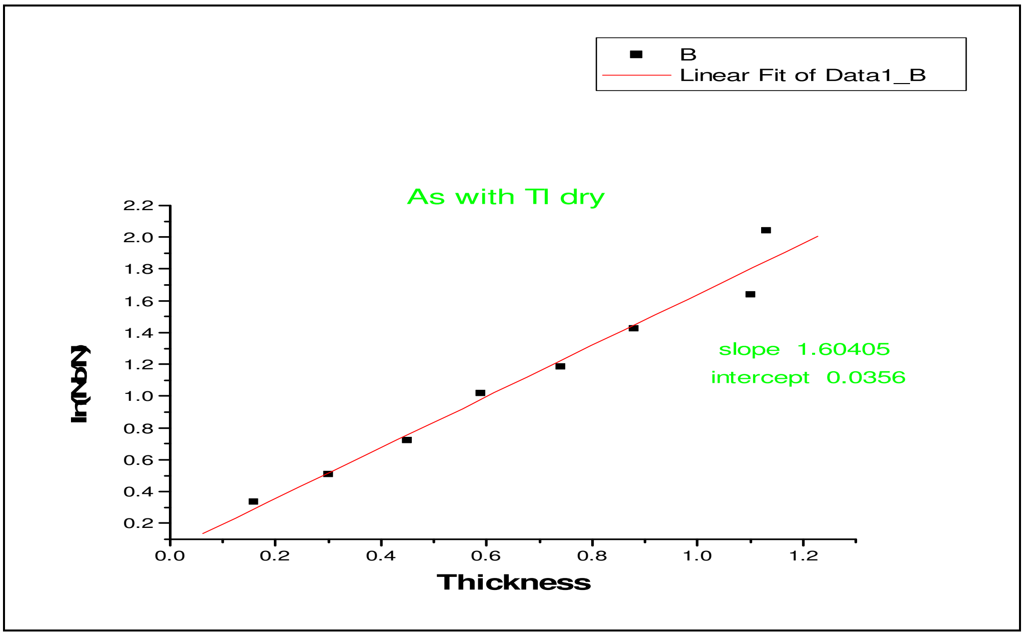

Figure-6
Ln(N_0/N) Vs. thickness of leaves (dry) of Ashoka by suing source Tl :

Table-6
Ln(N_0/N) for various thickness of leaves (dry) of Ashoka by suing source Cs

No Of Leafs	Thickness of leafs	No. of Counts in 60 sec.				Corrected counts	ln (N0/N)
		I	II	III	Mean		
1	0.16	975	980	972	975.67	964.67	0.251084
2	0.3	860	854	863	859.00	848.00	0.379986
3	0.45	804	798	801	801.00	790.00	0.450834
4	0.59	718	711	716	715.00	704.00	0.566088
5	0.74	615	575	597	595.67	584.67	0.751825
6	0.88	527	526	521	524.67	513.67	0.881292
7	1.1	451	435	443	443.00	432.00	1.054441
8	1.13	375	369	372	372.00	361.00	1.233989

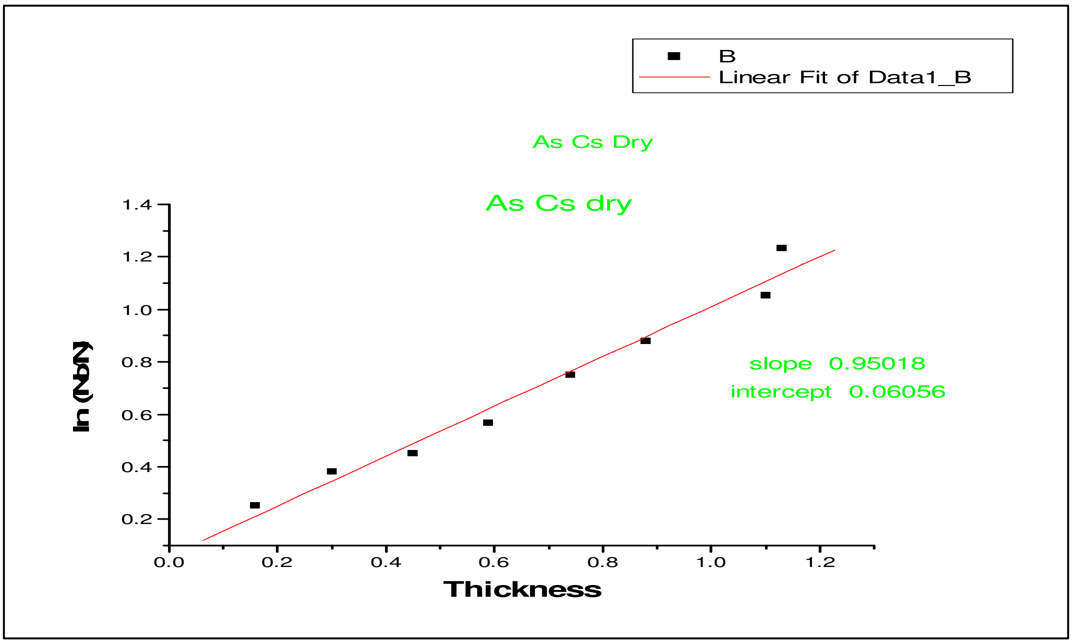

Figure-7
Ln(N_0/N) for various thickness of leaves (dry) of Ashoka by suing source Cs

Tables-7
The linear Absorption Coefficient (μ) of leaves of Ashoka as shown in the following table using source Cs as

Sr. No.	Particular	Source Cs	
		Linear attenuation coefficient (cm^{-1})	Mass attenuation coefficient (cm^{-2}/gm)
1	Fresh leaves	0.98178	47.55
2	Dry leaves	0.95018	137.37

Tables-8
The linear Absorption Coefficient (μ) of leaves of Ashoka as shown in the following table using source Tl as

Sr.No.	Particular	Source Tl	
		Linear attenuation coefficient (cm^{-1})	Mass attenuation coefficient (cm^{-2}/gm)
1	Fresh leaves	2.57374	134.22
2	Dry leaves	1.60409	233.21

Conclusion

We studied the linear and mass absorption coefficients values were measured for the leaves of Asoka plant by using Cs and Tl sources. The measured values were found to be in well good agreement with mixture rule. The linear attenuation coefficient of fresh leaves is greater than dry leaves. The difference between fresh leaves and dry leaves indicates that the contain of water in leaves. This research method is very useful for systematic study in basic sciences and also in research area . The results valid the gamma absorption law.

References

1. Hubbell J.H., Photon mass attenuation and energy absorption coefficients from 1 keV to 20 keV, *Appli. Radiat. Isot.,* **33**, 1269 **(1982)**

2. Hubbell J.H. and Sheltzer S.M., Tables of X-ray mass attenuation coefficient and mass energy absorption coefficients 1 keV to 230 MeV for elements z=1 to 92 and 48 additional substances of dosimetric interest., *NISTIR*-5632 **(1995)**

3. Bradley D.D., Chong. C.S., Shukri A., Tajuddin A.A. and Ghose A.M., A new method for the direct measurement of the energy absorbtion coefficient of gamma rays, *Nucl. Instrum. Meth.Phys. Res.,* **A280**, 39 **(1989)**

4. Cunningham J.R. and Johns H.E., Calculation of the average energy absorbed in photon interactions, *Med. Phys* **7**, 51 **(1980)**

5. Carlsson G.A. , Absorbed Dose Equations, On the Derivation of a General Absorbed Dose Equation and Equations Valid for Different Kinds of Radiation Equilibrium, *Radiation research,* **5**, 219-237 **(1981)**

6. Jahagirdar H.A.,.Hanumaiah B. and B.R. Thontadarya, Determination of narrow beam attenuation coefficients from broad beam geometrical configuration for 320KeV photons. Int., *Appli. Radiat. Isot***, 43,** 1511 **(1992)**

7. Singh K., Bal H.K., Sohal I.K. and Sud S.P., Measurement of absorption coefficients at 662 keV in soil samples, *Applied radiation Isotop,* **42**, 1239 **(1991)**

8. Gerwad L., Comments on attenuation co-efficients of 123 KeV gamma radiation by dilute solutions of sodium chloride, *Appl. Radiat. Isot.,* **47,** 19149 **(1996)**

9. Gerward L. On the attenuation of X-rays and gamma rays in dilute solutions, *Radiat. Phys. Chem.* **48,** 697 **(1996)**

10. Bhandal**.** G.S., Study of Photon attenuation coefficients of some multielement materials, *Nuclear Science and Engineering*, **116,** 218-222 **(1994)**

11. El-Kateb A.H. and Hamid. Abdul, Photon attenuation study of some materials containing Hydrogen, Carbon and Oxygen.*Applied radiat.Isot.,* **42**, 303-307 **(1991)**

12. Singh Jarnail, Singh Karamjit, Mudahar S. and Kulwant S. Gamma ray attenuation studies in Telurite glasses, *National Symposia on radiation Physics,* **15,** 36-39 **(2003)**

13. Demir D., Ozgul A., Un. M. and Sachin Y., Determination of Photon attenuation Coefficioent, Porocity and field capacity of soil by gamma ray transmission for 60,356 and 662 keV gamma rays, *Applied Radiation and Isotopes,* **66,** 1834-1837 **(2008)**

14. Appoloni C.R. and Rios E.A, Mass attenuation coefficients of Brazilian soils in the range10-1450 keV, *Applied Radiat.Isot,* **45**, 287-291 **(1994)**

15. Teli M.T., Chaudhari L.M. and Malode S.S., Attenuation coefficients of 123 keV gamma radiation by dilute solution of sodium chloride, *Appli. Radiat isot*, **45(10)**, 987 **(1994)**

16. Teli M.T., Chaudhari L.M. and Malode S.S. Study of absorption of 123 keV gamma radiation by dilute solution of zinc sulphate*, J. of Pure and applied Physics,* **32**, 410 **(1994)**

17. Teli M.T., Chaudhari L.M., Attenuation coefficient of 662 keV gamma radiation by dilute solutions of sodium chloride. *Appli.Radiat. Isot.,* **461**, 369 **(1995)**

18. M.T. Teli and L. M. Chaudhari, Linear attenuation coefficient of gamma radiation in dilute solutions of potassium chloride*, Appli.Radiat. Isot.,* **47**, 365 **(1996)**

19. Teli M.T., Answer to the comments by L. Gerward, *Appli.Radiat. Isot*, **48**, 87 **(1997)**

20. Teli M.T., On the attenuation of X-rays and gamma rays for aqueous solutions of salts, *Radiat. Phys. and Chem.*, **53** **(1998)**

21. Raje D.V. and Chaudhari L.M., Mass attenuation coefficients of soil samples in Maharashtra State (India) by using gamma energy at 0.662 MeV, *Bulg. J. Phys.,* **37**, 158-164 (**2010)**

22. Chaudhari L.M. and Nathuram R., Absorption coefficient of polymers (Polyvinyl Alcohol) by using gamma energy of 0.39 MeV, *Bulg. J. Phys.*, **38 (2010)**

23. Chaudhari Laxman M. and Raje Dayanand V., Study of photon attenuation coefficient of soil samples from Maharashtra and Karnataka states (India) from 122 keV to 1330 keV., *Research Journal of Chemical Sciences,* **2(2)** **(2012)**