A Study on PRP's (Protein Rich Pulses) by Irradiating Co-60 Gamma Ray Photons

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ABSTRACT
The linear attenuation coefficient of some commonly available protein rich pulses (ciceraritenium, vigna radiate, phaseolus vulgaris, vigna mungo and canjanus cajan) has been measured by using direct transmission method. It has been found that the pulse: vigna radiate (VR) having more linear attenuation coefficient than others pulses.

Keywords
Protein rich pulses, linear attenuation coefficients, direct transmission method.

1. INTRODUCTION
In microscopic level, the electromagnetic radiations such as gamma and X-rays are interacting with the matter in completely different way where the concepts of the range and the specific energy loss are not applicable in the same manner like charged particles. There are three main mechanisms of interaction of gamma and X-ray with matter that play an important role in radiation detection processes and known as photoelectric absorption, Compton scattering and pair production. During these interactions, the decrease of incident photon intensity with increasing thickness of the absorber, known as photons attenuation. Photons attenuation is due to the main interaction mechanisms of photons (photoelectric effect, Compton Effect and pair productions effect), i.e. photons completely absorbing or scattering and can be measured in terms of linear/mass attenuation coefficients. Here, the linear attenuation coefficient (μ) is the probability per unit length that the photon is interacted and removed from the beam and is given by, $I = I_0 e^{-\mu t}$.

The wide range of applications of linear attenuation coefficient in various fields includes optical fiber, radiation dosimetry, radiation biophysics, nuclear medicine, nuclear diagnostic, oceanography etc. Gamma ray transmission method utilizes the application of Lambert Beer Law for the measurement of the linear attenuation coefficient of the samples. Initially, measurements of mass attenuation coefficients were studied by Barka and Sadler [1,2] and its related parameters were compiled by S. J. M Allen [3]. Further, theoretical and experimental measurement of linear/mass attenuation coefficients for elements [1-4], compounds [5,6], alloys [7,8], biological materials [9] and building materials [10] is carried out by various researchers. The theoretical values of mass attenuation coefficients and interaction cross-sections, form factor and scattering for the element/compounds of dosimetric and radiological interest, from Z=1 to 92 at various energy have been tabulated by Chantler [11] and Hubbell and Seltzer [12], which are used as reference by researchers. In the present communication, attempt has been made to find out linear attenuation coefficient of protein rich pulses (Chick Peas, Phaseolus Vulgaris, Vigna Radiate, Cicer Aritenium, Vigna Mungo and Canjanus Cajan) experimentally by using high efficiency NaI(Tl) scintillator detector.

2. EXPERIMENTAL ARRANGEMENT
Some commonly used pulses, i.e., ciceraritenium, vigna radiate, phaseolus vulgaris, vigna mungo and canjanus cajan has been chosen to prepare self supporting circular disc, regular shaped samples as the technique used by Habbani et al. [13] and Tirasoglu [14]. The list of pulses, their chemical composition and Molecular formula are also shown in Table 1. The linear attenuation coefficient has been measured by using linear transmission geometry [15] by using incident photon energy 1332keV gamma ray from Co-60. The geometrical setup for the experimental measurements using direct transmission is shown in figure 1. Ortec (2x2) inch NaI scintillation detector coupled to EG&G Ortec multichannel analyzer has been used in present measurement. Three collimators of aperture 2mm, 3mm and 3mm are used as source, sample and detector collimators respectively.

3. METHOD OF MEASUREMENT
At first from the experimental setup, I and I_o, intensity of incident gamma ray photons with and without sample has been calculated from detector in terms of area under the curve. Using I, I_o and mass per unit thickness in Beer Lambert's law, absorption coefficient of the samples has been calculated. The intensity of incident photons observed on the detector in spectrum form for sample (CP). Each run for the observed spectrum was taken for 3600 sec and repeated three times under similar conditions to overcome statistical error. The error propagation has been calculated using standard relation as,

$$\Delta(\mu) = \frac{1}{x}\sqrt{\left(\frac{\Delta I_o}{I}\right)^2 + \left(\frac{\Delta I}{I}\right)^2 + \left(\ln\frac{I_o}{I}\right)^2\left(\frac{\Delta x}{x}\right)^2}$$

Here ΔI_o, ΔI and Δx are errors linked with the intensities I_o, I and thickness of the samples respectively.

4. RESULT AND DISCUSSION
In this communication, we have measured the values of linear attenuation coefficient of some easily available protein rich pulses: Chick Peas, Phaseolus Vulgaris, Vigna Radiate, Cicer Aritenium, Vigna Mungo and Canjanus Cajan by using linear transmission geometry. Molecular formula, energy, carbohydrates and protein for all PRP's has been obtained from Wikipedia and tabulated in table 1.

Experimentally observed values have been compared with theoretically calculated values of Chantler et al. data tables and are tabulated in Table 2. From the selected pulses, it is found that, Chick Peas contains more energy but having average absorption coefficient. Besides that, Vigna Radiate having maximum absorption coefficient with average energy. A typical bar graph for experimental and theoretical variation for different pulses is also shown in figure 3. Observed variation between experimental results from theoretical values, has been 1.75%. Which show good agreement between experimental results from theoretical values. The experimental error in present measurement is of the order of 0.15%.

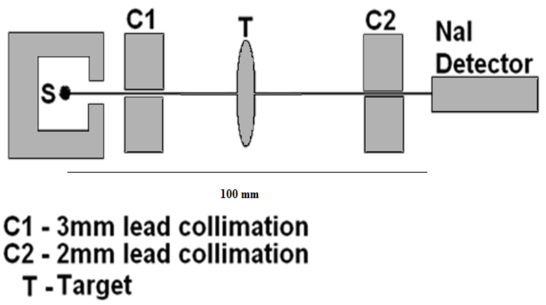

Figure 1: Geometrical setup for experimental measurements.

5. CONCLUSION

From experimentally obtained results, we conclude that the value of linear attenuation coefficients varies along with natural parameters of the sample under study, such as: Energy, amount of Proteins, Carbohydrates etc. Also vigna radiate (VR) has more attenuation coefficient than other pulses. Thus, the pulse containing more energy, carbohydrates and proteins values have more linear attenuation coefficient also.

So we can say that, there may be possibility to replace costly elemental metallic foils with such types of materials in research laboratories. In general, use of these types of pulses provides better protection from diseases in human body.

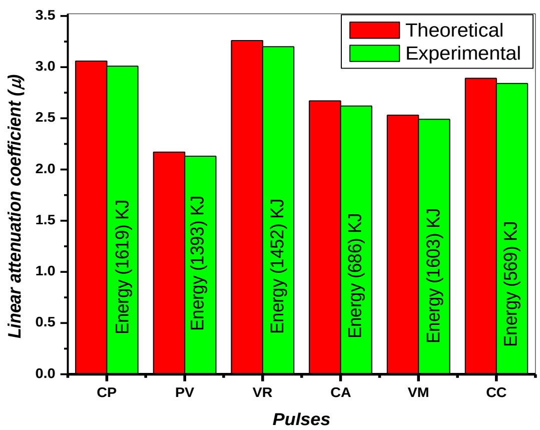

Figure 3. Variation between experimental and theoretical values.

Table1. Natural parameters of PRP's (protein rich pulses)

S. N	Protein Rich Pulses (PRP)	E*	C#	P$	Mol. formula
1	Chick Peas (CP)	1,619	57	22	$C_{17}H_{25}N_3O_5S$
2	Phaseolus Vulgaris (PV)	1,393	60	24	$C_{20}H_{18}O_4$
3	Vigna Radiate (VR)	1,452	62.6	3.86	$C_{21}H_{20}O_{10}$
4	Cicer Aritenium (CA)	686	27.4	8.86	$C_{10}H_{13}N_5O$
5	Vigna Mungo (VM)	1,603	50	24	$C_{20}H_{20}O_5$
6	Cajanus Cajan (CC)	569	23	7.2	$C_{16}H_{12}O_6$

*E-Energy (KJ), #C-Carbohydrates (g), $P-Protein (g)

Table 2. Experimentally measured results for linear attenuation coefficients

S. No.	Sample code of PRP	Linear Attenuation Coefficient (*μ*)	
		Theoretical	Experimental
1	CP	3.06	3.01
2	PV	2.17	2.13
3	VR	3.26	3.20
4	CA	2.67	2.62
5	VM	2.53	2.49
6	CC	2.89	2.84

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