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Study of Quality Analysis of Ayurvedic Drugs (Medicines) by Mass Attenuation Coefficient of X-Ray

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Abstract- **X-Ray mass attenuation coefficient (μ/ρ), a non destructive analytical method was used for the quality analysis of Ayurvedic medicines by the help of NaI(Tl) detector. An ayurvedic medicine Muktashukti bhasma(MSB) beneficial in Hyperacidity, dyspepsia, peptic ulcer, vomiting, cough, chronic fever, calcium deficiency, rickets, arthritis. MSB manufactured by different manufacturer was selected for the study of quality analysis, using NaI(Tl) detector by determining the Mass Attenuation coefficient (μ/ρ) of X-rays at low photon energies ranging from 13.596 keV to 44.216 keV. The obtained result by this non destructive method gives good comparison for the quality analysis of medicines of different manufacturer. In other analytical methods the sample is totally destroyed. Thus the mass attenuation coefficient of X-rays by MSB which is a non destructive technique can be useful in qualitative analysis of drugs or medicines.** ***Keywords*** **: Ayurvedic medicines, Mass Attenuation Coefficient (μ/ρ), NaI(Tl) detector, Quality analysis,**

Introduction:

Knowledge of X-ray mass attenuation coefficient is required in almost all fields in which the interaction of X-ray with matter is studied. X-ray mass attenuation coefficient or cross-sections are of great importance in both applied and fundamental science. Mass attenuation coefficient (MAC) is a measure of the average number of interactions between incident photons and the matter that occur in a given mass per unit area thickness of substance. The significance of Mass attenuation coefficient found in various fields viz., industrial, biological, agricultural, radiation shielding, space research, military, security checking purpose, quantitative analysis, quality control tests etc. There have been continuous efforts in determining the mass attenuation coefficient values on various types of materials or samples such as elements [1-3], mixtures (different percentage of elements) [2], biological samples [4-5], natural minerals [6], Barite concrete used in Radiation protection as shielding [7], rare earth compounds [8], pharmaceutical drugs [9], mixture of some 3D elements (with different weight ratios) [10] and gases and Earth Atmosphere [11]. From the literature survey, the sample analysis studies were carried out at different photon energies in the range from 1 keV to 1 MeV to analyze the quality or character of the material under consideration. The mass attenuation coefficient provides a wide variety of information about fundamental properties of matter in the atomic/molecular /nuclear level. Accurate values of the photon mass attenuation coefficient are required to provide essential data in diverse field such as non-destructive techniques, nuclear diagnostics (computerized tomography) nuclear medicine etc. In the present work the quality analysis of Ayurvedic drug viz., Muktashukti bhasma from four different manufacturers were selected with non-destructive technique by the determination of X-ray Mass Attenuation Coefficient using the NaI(Tl) detector.

Theory:

When radiations are allowed to pass through any materials, its intensity progressively decreases as a result of interactions between photons with matter in the attenuating media. It is caused by both the absorption and scattering of primary photons. Hence, it explains the exponential reduction of the intensity with the thickness of material. A narrow beam of mono-energetic photons with incident intensity I_o, penetrating an absorbing material with thickness x and density ρ emerges with an intensity I after passing through the absorber is given by the exponential law

$$I/I_o = \exp[-(\mu/\rho)x]$$

The above equation can be rewritten as:

$$\mu/\rho = x^{-1} \ln(I/I_o)$$

Where I/I_o is the transmission fraction. Mass attenuation coefficient, (μ/ρ), can be obtained from measured values of I, I_o and x. The mass thickness is obtained by multiplying the thickness t by the density ρ i.e., x=ρt.

The X-Ray mass attenuation coefficient μ/ρ for any chemical compounds or a homogeneous mixture are usually estimated by Bragg's additive law or more commonly known as mixture rule. Thus mass attenuation for any chemical compound/material is given by

$$\mu/\rho = \sum \omega_i (\mu/\rho)_i$$

where $(\mu/\rho)_i$ is the mass attenuation coefficient of the i^{th} element and ω_i is the fraction by weight of the i^{th} element.

Experimental procedure:

The preferred Ayurvedic medicine, mukta shukti bhasma were purchased from Indian companies viz., Patanjali, Baidynath, Ayukalp, Vyas collected from the commercial Ayurvedic medicine shops. Muktashukti bhasma(MSB) beneficial for Hyperacidity, dyspepsia, peptic ulcer, vomiting, cough, chronic fever, calcium deficiency, rickets, arthritis. The Bhasmas were grinded to get a fine powder so as to prepare pellets of different sizes of variable thicknesses with an area of about 1.327 cm^2 using a hydraulic pellet press machine. And prepared used to study the attenuation coefficient using X-rays in the energy range 13.596-44.216 keV using the NaI(Tl) detector.

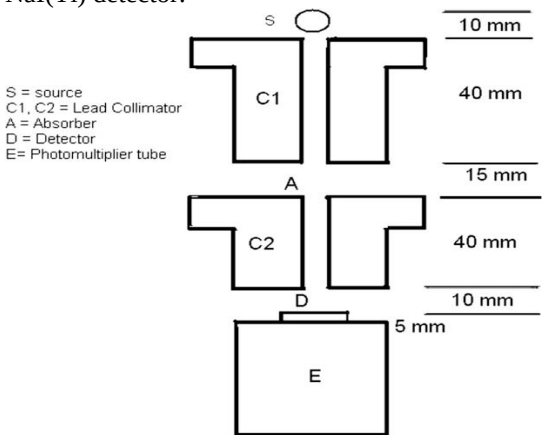

Fig 1: NaI(Tl) X-ray detector schematic diagram.

The experiment is carried out by using Variable energy X-Ray(VEX) source Am 241 (10 mCi) as the main source of excitation radiation with five different targets(Rb, Mo, Ag, Ba, Tb) for producing the fluorescent X-Rays with characteristic energies of the target. Photons from variable energy X-Ray source S passed through the Collimator C1 and fall on the sample pellet (A) under examination kept normal to incident photon beam, incident photon beam transmits through the second collimator C2 and reaches the NaI(Tl) X-ray detector D which is mounted above the photo multiplier tube(E). The transmitted photon spectrum was recorded with the help of a PC based Multi channel analyser using the OXWIN MCA software. Collimator C1 and C2 collimates the Incident and transmitted beams respectively. The Spectrum recorded by MAC consist transmitted fluorescence X-Rays and because of the poor energy resolution of detector the Characteristic X-ray fluorescence like Kα, Kβ, Kγ from target were not resolved and single transmitted photo peak was observed, and area under this peak is taken as transmitted photo peak also energy for this is taken as average weighted energy of Kα, Kβ, Kγ energies. A graph of logarithm of transmitted intensity (I) as function of sample (absorber) thickness (t) is plotted and it follows a straight line indicating exponential decay of the intensity of incident X-rays. The slope of the straight line Represents the X-ray Mass Attenuation Coefficient (μ/ρ) of the selected samples, and the obtained MAC of Muktashukti bhasma of four brands is given in table(1)

RESULT and CONCLUSION:

Table 1 gives the details of mass attenuation coefficient (MAC) obtained of four different firms for Muktashukti bhasma. Second column gives different energies of the variable energy x-ray source obtained from Am-241. The obtained mass attenuation coefficients for different energies are show in the 3rd to 6th column of the table. The percentage deviation (PD) amount the experimental values is given in 7th column. The last column shows the theoretical MAC and PD with theory and experimental values are presented. The variation in the mass attenuation coefficient among the experimental values shows minima of 7% and maxima of 14% but with the theoretical value minima of 0.2% to maximum of 8 % when compared with BMSC values. Hence, all the obtained values of mass attenuation coefficient of Muktashukti Bhasma are acceptable and compared with the theoretical values which show genuine values. Baidyanath manufactured powder sample shows less Percentage Deviation (PD) when compared with other manufactured samples. Hence Baidyanath manufactured Muktashukti Bhasma power is good quality sample compared with other manufacture firm.

Table:1 Mass Attenuation Coefficient of the Mukta Shukti bhasma of different brands at different energy

SN	Energy in KeV	X-Ray Mass Attenuation coefficient (μ/ρ) cm^2/g					
		PMSB	BMSB	AMSB	VMSB	PD (Expt)#	Theoretical values and (PD)*
1	13.596	17.54	17.12	17.04	16.32	6.9 %	17.1 **(0.1%)**
2	17.781	7.6	7.79	6.8	6.81	12.7 %	7.96 **(2.1%)**
3	22.581	3.73	4.05	3.65	3.58	11.6 %	4.04 **(0.2%)**
4	32.890	1.56	1.57	1.4	1.37	13.8 %	1.45 **(8.3%)**
5	44.216	0.642	0.669	0.613	0.641	8.2 %	0.697 **(4.0%)**

#Percent Deviation: ={[(μm)Max] – [(μm) Min]/ [(μm)Max]}×100 %.

*Percent Deviation: ={[(μm)Expt] – [(μm) Theory]/ [(μm)Theory]}×100 %.

The variation of obtained mass attenuation coefficient vs energy (keV) are shown below for four brand MSB is Show in Fig 1.

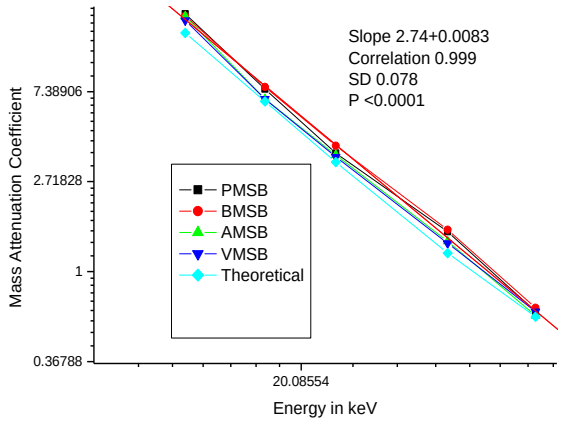

Fig.1 Mass Attenuation Coefficient Vs Energy (Logarithmic Graph)

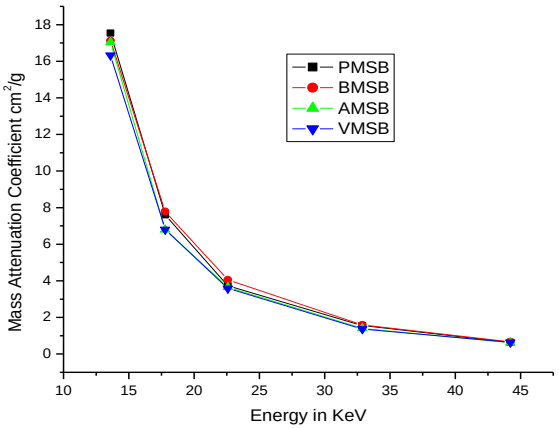

Fig.2Mass attenuation coefficient Vs Energy (Linear Graph)

From graph 1 we can see that there is no noticeable variations in MAC of sample with energy for all the four MSB, this shows that the Quality of all brands ayurvedic medicine i.e, mukta shukti bhasmas is same which indicates that there is no adulteration in Ayurvedic medicines and there may be no effect of raw material which are collected from various places by the different manufacturer thus the non destructive technique are helpful in quality analysis of any samples.

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