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The recognition of trace elements contents in medicinal plants by MAC method

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ABSTRACT

Medicinal plants have used for many years to cure a great variety of diseases. Recently, according to the World Health Organization, the use of traditional herbal medicine has spread not only in the developing counties but also in the industrialized ones, as a complementary may to treat and to prevent illnesses. Eight of the most important medicinal plants in the literature on the India traditional and popular medicine are *Ocimum sanctum L, Catharanthus roseus L, Trigonella foenum-graecum L, Azadirachta indica A.Juss and Aegle marmelos Roxb, Zingiber officinalis L, Emblica officinalis L and Anacardium occidentale* L.In this method a NaI (TI) detector, which is coupled to MCA for analysis of the spectrum is used and ^{241}Am is used to get X-ray in the energy range from 8 to 32 keV.

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KEYWORDS

Medicinal plants;
Attenuation coefficients;
Trace elements;
Microelements.

INTRODUCTION

Herbal drugs are being used remedies for various diseases across the world from ancient time[1]. In recent years, increasing interest has been focused on phytormedicines or Ayurvedic medicines as safer and more congenial to the human body. Medicinal plants come into pregrartion of various drugs single or in combinations[2] or even are used as the principal source of raw mainly responsible an important role in various physiological functions in living organisms. Thus, there is an increasing interest on the role that chemical constituents of the medicinal plants play in exhibiting biological activity. It has been reported that trace elements play a pivotal role in formation of the active constituents in medicinal plants[3]. However, most studies on such medicinal plants pertain to constituents such as essential oils, vitamins, glycosides and other organic components, while little has been reported about the elemental composition of the plants[4]. A literature survey revealed a significant modulatory role of trace elements in various diseases[5,7]. It has been documented that alteration of trace elemental homeostasis in an organism has direct correlation with different pathological conditions[8]. Thus, screening of the actual bioactive elements of plants origin and assessment of elemental composition of the widely used medicinal plants is highly essential[9]. In this perspective probing into the specific biological significance of trace elemental composition of plants is most crucial for developing new strategies of drug design based on natural resources. The present investigation is an attempt to gain an insight into the trace

elemental composition of some commonly and widely used plants of the North Karnataka region of India. For this study we employed different techniques such as Atomic Absorption Spectrophotometer, NaI (TI) detector, Proton induced X-ray emission described.

This present study relates the major and trace element contents of medicinal plants important to their content in eight plants which could potentially be either dangerous or useful humans who are consuming medicinal plants or to other feeding of these economically important plants. Study the measurement of attenuation coefficient of X-rays in herbal medicines in the energy range from 8.136keV to 32.581keV. Here the *Ocimum sanctum L, Catharanthus roseus L, Trigonella foenum-graecum L, Azadirachta indica A. Juss and Aegle marmelos* Roxb, *Zingiber officinalis L, Emblica officinalis L and Anacardium occidentale*. Samples seem to be very limited. Especially *Catharanthus roseus*, Zingiber *officinalis* and *Trigonella foenum-graecum*, has been used herbal treatments like Fever, cancer, Diabetes, Cough, Stomach, Jaundice, and Hyperacidity. It is there fore considered worthwhile to undertake a systematic study of photon interaction cross section in medicinal plants samples.

Theory

It is well known that the exponential law determines the narrow beam X-ray mass attenuation coefficient and is expressed as,

$$I = I_o \exp(-\mu_m t) \quad (1)$$

Where I_o and I are the observed intensities without and with the absorber respectively, t is the mass per unit area of the absorber and μm is the mass attenuation coefficient of target. The mass attenuation can be expressed as barns per atom through the expression.

$$\sigma \text{ (Barns/atom)} = [A/N_A] \times 10^{-24} (\mu m) \text{ (cm}^2\text{/gm)} \quad (2)$$

Where A is atomic weight of the absorber material and N_A is Avogadro's number.

Theoretical values for the mass attenuation coefficient for all element and for some compounds can be found in the tabulation e.g.by[10]. By theoretical X-ray mass attenuation coefficients, μ/ρ, for any compound/mixture/material are usually estimated from the sum of weighted contributions from the constituent elements. This is based on the assumptions that contributions of each element to the attenuation is additive and the law is known as Braggs additive law or more commonly called mixture rule is given by additivity rule:

$$\frac{\mu}{\rho} = \sum_i w_i \left(\frac{\mu}{\rho}\right)_i \text{ (cm}^2\text{)/gm} \quad (3)$$

Where w_i and $(\mu/\rho)_i$ are the weight fraction and the mass attenuation coefficient, respectively, of the i^{th} element. In a compound, the weight fraction of the i^{th} element is given by

$$w_i = \frac{a_i A_i}{\sum_j a_j A_j} \quad (4)$$

Where is α_i and A_i are, respectively, the number of formula units and the atomic weight of the i^{th} element.

MATERIALS AND METHODS

The medicinal plants are collected from different places. The leaves and seeds of these plants are washed with distilled water and air-dried in shade over a period of one month. They are finely grinded with a pestle and mortar. The grinded powered is sieved using a mesh size of 260μm. The samples of different thicknesses are prepared by weighing quantity of the finely grinded power and pressing it to a diacylindrical pellet with anhydraulic press. The aeral thickness of the pellets was calculated using an electronic weighing balance and a traveling microscope.

The schematic experimental setup in the present work is show in procedure adopted for the determination of the mass attenuation coefficient is described to the briefly, photons from a variable energy X-ray source passed through a collimator and were incident on the specimen in the form of a thin foil/pellet kept normal to the photon beam. The transmitted beam passed through another collimator and reached a NaI (Tl) X-ray detector. The transmitted photon spectrum was recorded using a PC based multichannel analyzer. The electronic setup used is a NaI (TI) detector, which is coupled to MCA for analysis of the spectrum. A primary source ^{241}Am is used to get X-rays in the energy range 8 to 32 keV from Cu, Rb, Mo, Ag and Ba targets. A bicorn makes integrated assembly of 25mm dia × 4mm thick

NaI (TI) Scintillator mounted on a photo multiplier tube (PMT) served as X-ray detector. Oxford model PCAP plus single card performed as PMT power supply, Pre-amplifier, amplifier, 1K ADC and MCA with control from software package oxford MCA.

As established earlier, for a given photon energy, accurate values of attenuation can be obtained by choosing the range of target thickness over 50-2% transmission[11]. The transmitted intensity was obtained by taking the area under the photo peak in the transmitted spectrum. The slope of the linear plot of the logarithm of transmitted intensity versus specimen thickness would yield the attenuation coefficient. Since the detector has a poor energy resolution, the energy corresponding to the measured attenuation coefficient is the weighted average of Kα, Kβ, Kγ energies. The attenuation coefficient at different energies was first determined for standard metal foils and then for the Medicinal plants.

RESULTS AND DISCUSSION

In the TABLE 1, the measured mass attenuation coefficient values along with errors for medicinal plant compounds are presented. The error involved in over all experimental values is about less than 2%. The percentage difference between theory and experimental value for all the three energies is also less than 2% can be observed than the TABLE 1. This result suggests that this method is appropriate for determining the mass attenuation coefficient for any sample (biological/medicinal/compound/mixture of elements).

The determined mass attenuation coefficients on the *Ocimum sanctum, Catharanthus roseus, Trigonella foenum-graecum, Azadirachta indica, Aegle marmelos, Zingiber officinalis, Emblica officinalis and Anacardium occidentale* show that the mixture rule is valid since the percentage mixture of content is not exactly known. This is usually the case in Herbal

TABLE 1 : Mass attenuation coefficients of x-rays in different medicinal plants Ka- Kappathagudda, Sa-Sandur and Gu-Gulbarga

Energy sample name		8.136 keV	13.596 keV	17.781 keV	22.581 keV	32.891 keV
	Ka	18.58±0.19	3.685±0.033	1.736±0.018	1.055±0.013	0.347±0.0034
Ocimum sanctum	Sa	18.09±0.22	3.539±0.034	1.514±0.013	0.982±0.014	0.356±0.0032
	Gu	18.32±0.17	3.795±0.032	1.639±0.013	1.077±0.021	0.366±0.0037
	Ka	25.23±0.25	6.778±0.081	1.736±0.018	2.297±0.032	0.978±0.0231
Catharanthus roseus	Sa	24.95±0.28	6.528±0.073	1.514±0.013	2.052±0.028	0.985±0.0197
	Gu	25.09±0.19	6.662±0.077	1.639±0.013	2.381±0.026	0.924±0.0214
	Ka	22.76±0.22	6.188±0.056	4.123±0.051	2.097±0.038	0.788±0.0162
Trigonella foenum-graecum	Sa	21.12±0.27	6.345±0.065	3.987±0.043	1.998±0.041	0.769±0.0186
	Gu	22.65±0.25	6.433±0.587	4.132±0.051	2.213±0.042	0.798±0.0195
	Ka	23.23±0.31	6.261±0.063	3.995±0.041	1.976±0.039	0.932±0.0182
Azadirachta indica	Sa	24.98±0.34	6.433±0.054	4.021±0.054	2.012±0.041	0.946±0.0132
	Gu	22.28±0.35	6.321±0.055	4.136±0.052	2.094±0.044	0.897±0.0207
	Ka	11.97±0.15	3.434±0.036	1.676±0.021	0.870±0.01	0.456±0.0057
Aegle marmelos	Sa	12.32±0.13	3.821±0.038	1.876±0.025	0.965±0.01	0.555±0.0053
	Gu	11.54±0.16	3.452±0.033	1.645±0.028	0.889±0.01	0.499±0.0058
	Ka	19.54±0.29	5.312±0.058	2.892±0.032	1.737±0.026	0.669±0.0071
Zingiber officinalis	Sa	19.09±0.28	5.021±0.051	2.243±0.035	1.255±0.027	0.594±0.0084
	Gu	18.76±0.21	5.398±0.056	2.567±0.028	1.765±0.021	0.612±0.0076
	Ka	9.34±0.16	2.702±0.027	1.231±0.019	0.596±0.0081	0.335±0.0047
Emblica officinalis	Sa	10.32±0.13	2.678±0.029	1.113±0.017	0.498±0.0015	0.340±0.0039
	Gu	9.891±0.15	2.452±0.024	1.298±0.013	0.603±0.0016	0.339±0.0041
	Ka	10.75±0.16	3.428±0.032	1.979±0.026	0.832±0.0018	0.328±0.0046
Anacardium occidentale	Sa	11.92±0.14	3.743±0.033	2.023±0.028	0.872±0.0019	0.363±0.0043
	Gu	10.52±0.16	3.448±0.032	1.987±0.025	0.834±0.0016	0.302±0.0045

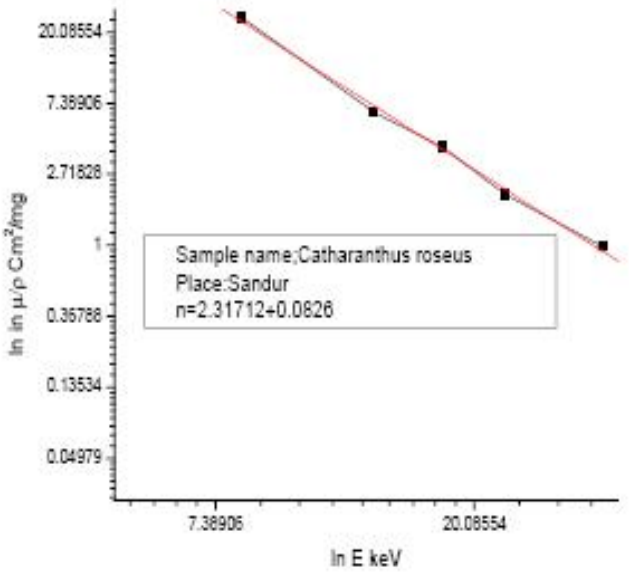
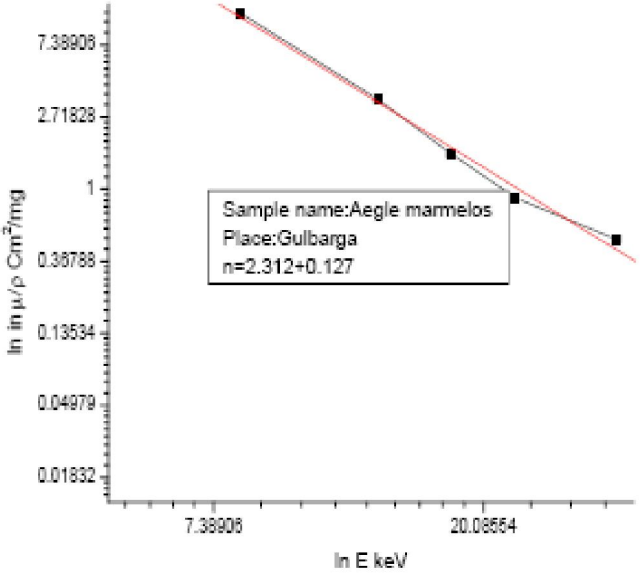


Figure 1 : From TABLE 1



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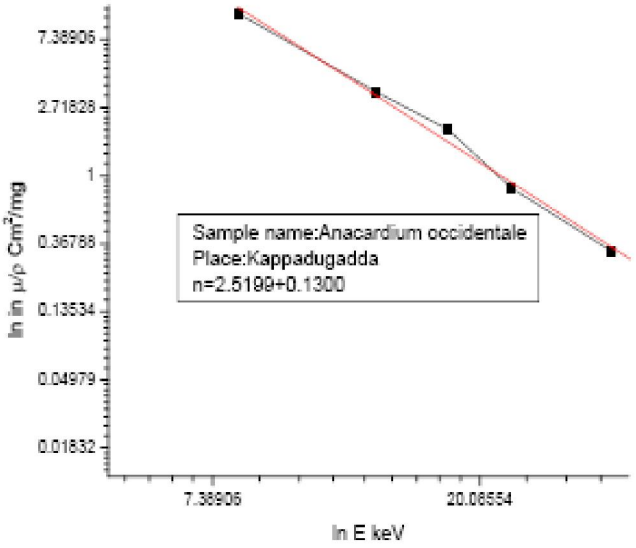

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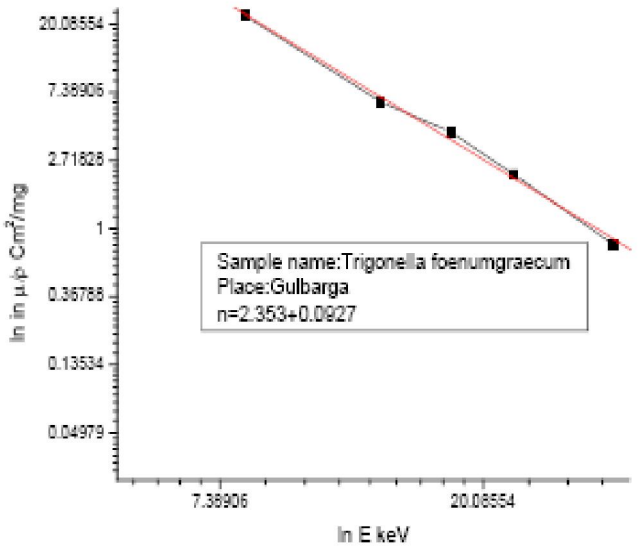

Figure 4 : From TABLE 1

medicine. It may be pointed out here that even through the photon interaction is with the individual elements the mass attenuation coefficient gives information of sample as a whole, which is very interesting from this point of view.

Another interesting point to discus from fig is that TABLE 1, graph of ln(E) against ln(μ/ρ) yields a sight line, shows that variation of the attenuation coefficient with energy. This is linear irrespective of the element provided that the sample should not contain an element whose X-ray energy is close to the incident photon energy in which case the graph would show a deviation from linearity. The value of exponent from the graph is n=2.312+0.127 in all the cases. Which is agrees with the expected value[12] which is dependent on the energy as well as atomic number. This graphical value is varying from 2.5 to 3.0 as presented the. Hence the measured value of the mass attenuation coefficient will give at least in a broad sense that the sample is uniformly prepared the μ/ρ values are the true values at these energies.

CONCLUSION

The determined mass attenuation coefficient (MAC) is linearly varying with the energies of the incident X-

rays. From this and by AAS data it is concluded that some plants shows high concentration of the elements and correspondingly the MAC also varies with the concentration of the elements present in the plants. It is known that attenuation coefficient varies four times the atomic number and inversely proportional to two thirds of the incident energy hence it verified by AAS method and also by MAC. Hence this study helps in elucidation of elements in these plants further it also helps to interpret the therapeutic actions to be undertaken in preparation of medicines. It is also observed from the MAC and AAS studies, that diversity is observed among herbal drugs originating from plants of the same family which is attributed to differences in their botanical structures, element mobility within the plants parts and other internal and external sources.

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