STUDY ON SHAZAUNG-LET-PAT (*Aloe vera* Linn.) HYDROGEL BY RADIATION AND THEIR PHYSICAL PROPERTIES

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Abstract

The films forming composed of polyvinyl alcohol (PVA) and *Aloe vera*(AV) gel were prepared and characterized by different ratios of PVA/AV hydrogel films 1:1, 1:2 and 1:3 variations in the *Aloe vera* contentsby using the solvent casting technique. The physical parameters like the effect of the actual dose rate, measured dose rate and specific heat capacity of the *Aloe vera* leaf, natural gel and hydrogel were analyzed and compared with geometrical 0modificationby gamma radiation of a ^{137}Cs source at room temperature. The specific heat capacity of *Aloevera* composite hydrogel was found to be 4.33 kJ/kgK, which was higher than that of liquid water4.20 kJ/kgK. The standard value of the total mass absorption coefficient (μ_m) with weighing factors of constituted elements in hydrogelby using Energy Dispersive X-Ray Fluorescence (EDXRF) analysis was calculated to be 0.069 cm^2/g. From the experimental results showed that the comparative analysis with the mass absorption coefficient (μ_m)value of film 3, used as absorber was obtained to be 0.065 cm^2/gby using Sodium Iodide Scintillation Detector [NaI(Tl)] STX-x64software ST 360 counter and approximately equal to the standard value.After studying the microstructure characterizations of all the composite films were performed by Scanning Electron Microscopy (SEM) analysis.

Keywords: *Aloe vera,* PVA, EDXRF, SEM,^{137}Cs source,NaI(Tl)STX - x64software ST 360 counter.

Introduction

Skin is the largest organ of the human body, acting as a protective barrier between the internal body and the external atmosphere. Concerning skin damage, the treatment of burns is complex and painful and requires the use of several drugs administered separately or combined (J.M. Marshall, 1990).Potential vectors for the controlled release of substances for the treatment of skin damage occurring in wounds and burns are polymeric films. Thin-film offers advantages over other pharmaceutical forms, such as liquid or semisolid drug delivery products, as it provides a large surface area of application, adhesion to the damaged tissue, and absorption of exudates(Katie, I, Katime, O y Katime, D, 2oo5). The use of natural polymers is supported by their many desirable properties, such as biocompatibility, low irritancy, and lack of toxicity, as in the case of polysaccharides. To reduce pain and accelerate the healing process, many natural substances have been traditionally used and more recently have been scientifically studied, such as Aloe. *Aloe vera* has been used in a host of curative purposes including treatment of skin disorders and healing of wounds. In relation to this, the objective of the present work has been to develop and characterize a polymer film containing *Aloe vera* and polyvinyl alcohol with the aim of providing an innovative system for radiation burn wound treatment. Polyvinyl alcohol was used as a film-forming agent and has been often used in combination with other polymers for wound healing applications. The solvent casting technique is regarded as one of the simplest and most economical techniques for preparing films of reasonably good quality. The properties of composite films depend on the preparation conditions. Several therapeutic properties have been assigned to the *Aloe vera* hydrogel films and synthesis of natural gel and leaf. This work also investigates the usefulness of the heat absorption test of radiation around the gamma-ray from a

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Cs-137 source at room temperature and also determine by mass absorption coefficient, which provides a standardized coefficient.

Materials and Methods

Preparation of *Aloe vera* Extracts

An *Aloe vera* leaf was obtained by surface sterilized with ethanol. The outer, green dermis of the leaf was peeled off using a sterile blade. Fillets were extensively washed with distilled water to remove the exudes from their surfaces. The fillets were homogenized in a blender and then the homogenized mass was filtered. After that, the flesh gel was weighed and 25 g of this was added 5 ml of distilled water to it. Then the mixture was boiled for 15 minutes at 90ºC. After cooling to room temperature, it was filtered to get the collection of gel as shown in Figure 1.

Preparation of films (Solvent casting technique)

Polyvinyl Alcohol (PVA)3 ml of the 3% solution and the *Aloe vera*(AV) gel extract were incorporated to the ratio of 1:1, 1:2, and 1:3 (v/v) respectively. PVA solutions were prepared to vary the concentration for 3% (v/v), dissolving PVA in distilled water under constant stirring for 2 hr at 70ºC. To prepare films, solutions of PVA and *Aloe vera* (AV) were mixed for each concentration of PVA with magnetic stirrer during 30 minutes at 100ºC and then the mixtures were isolated at room temperature for 6 or 7 days to remove bubbleduring the process. The same procedures were repeated in triplicate for each ratio of PVA/AV used. The PVA/AV films as shown in Figure 2 and the flow chart of the preparation for PVA/AV films as shown in Figure 3.

Figure1 Collection of gel

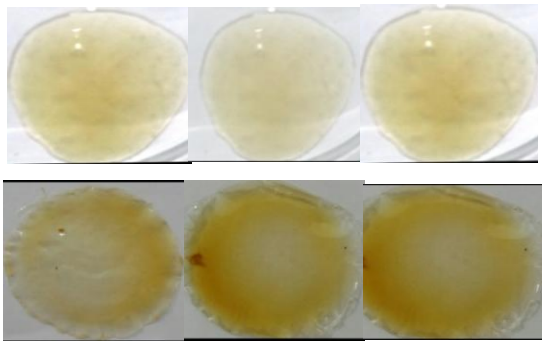

Figure 2 PVA/AV gel (1:1, 1:2 & 1:3) wet & dry films

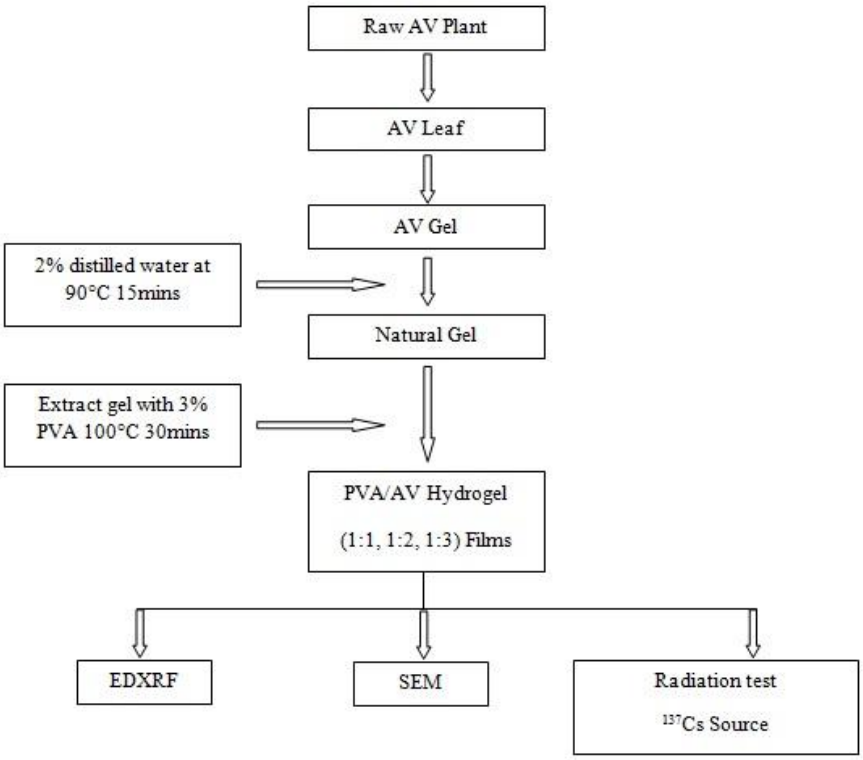

Figure 3 Flow chart of preparation for PVA/AV films

Activity and Dose rate of Caesium-137 Radioactive Source

The standard source ^{137}Cs as the radiation source for field applications because of its longer half-life and the greater penetrating of its emitted photon. Gamma rays source ^{137}Cs has one peak. It has a strength of 392.67 kBq and half-like of 30.174 years and the energy of the source is 0.662 MeV. The activity of a radioactive source is the number of disintegrations occurring within it per unit time. The rate of decay is referred to as the activity of a radioactive material expressedin the following equation (1) and (2).

$$dN/dt = A = - N\lambda \, . \quad (1)$$

$$\text{Similarly } A = A_o \, e^{-\lambda t} \quad (2)$$

Where A is the activity remaining at time t and A_o is the original activity equal to N_o(Loftus T P. 1970). Activity at installation(A_o) of the ^{137}Cs source (at Radiation Toxicology Research Division, Department of Medical Research) is 90 µCi and between the date of experiment and date of installation is (1.12.2005 to 1.10.2018). The half-life of Cs^{137} is 30 years. The actual activity is 67.014 µSv/hr. The dose rate due to source strength was calculated by the equation (3) (Tsoulfanids N. 1995).

$$H_o = \frac{ESQ}{m} \quad (3)$$

Where H_o is dose rate due to source strength, S is the activity of source and m is the mass of the sample. In a dosimeter calibration description, the dose rate around the source (core) is 7 µSv/hr and 90 µSv/hr. Therefore, the average dose rate is 23.5 µSv/hr. The geometry of the source and target for the hydrogel, natural gel, and *Aloe vera* leaf can be illustrated as shown in Figure 4(a) and (b).

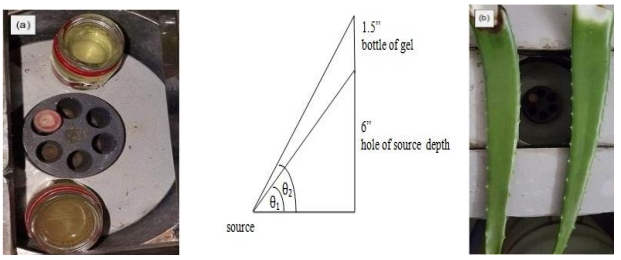

Figure 4 (a) natural gel and hydrogel

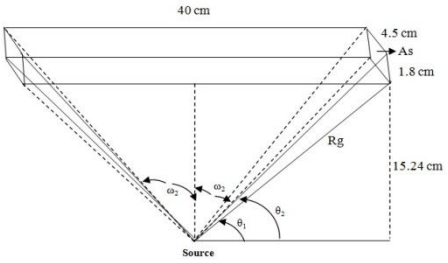

Figure 4 (b) *Aloevera*leaf

The solid angle of natural gel and hydrogel were calculated to be the geometry equation(4).

$$\Omega = \frac{1}{2}\{\sin\theta_2 - \sin\theta_1\} \quad (4)$$

The solid angle of the *Aloe vera* leaf was calculated to be the geometry equation (5).

$$\Omega = \frac{A_S}{4\pi R_S^2} \quad (5)$$

The actual dose rate of natural gel, hydrogel and *Aloe vera* leaf were calculated to be the geometry equation (6).

$$H_a = H_o F \Omega \quad (6)$$

The net rate of heat flow due to radiation and specific heat capacity of *Aloe vera* hydrogel, natural and leaf were calculated from equation (7) and (8).

$$H = e\boldsymbol{\sigma}A\,(T_f^4 - T_s^4) \quad (7)$$

$$Q = mC\Delta\theta \quad (8)$$

Where F is the correction factor = 1 ± 0.001, Ω is solid angle,T_s isuniform temperature (room temperature) = 23ºC, $\Delta\theta = T_f - T_i$and $\boldsymbol{\sigma}$ is (5.67×10^{-8}W/m^{2}K^4) (Tsoulfanids N. 1995).

The Absorption of Gamma-radiation

The basic property of the absorption of gamma-rays is the exponential decrease in the intensity of radiation as a homogeneous beam of gamma-rays passes through a thin slab of matter as following the absorption equation (10), (11) and (12).

$$I = I_o e^{-\mu d} \quad (10)$$

$$I = I_o e^{-\frac{\mu d}{\rho}\times\rho} \quad (11)$$

$$I = I_o e^{-\mu_m d_m} \quad (12)$$

Where μ is the linear absorption coefficient of the film absorbers, μ_m is the mass absorption coefficient of the film absorbers, d_m is the mass thickness of absorption material, I_o and I are origin Intensity and Intensity of gamma-ray transmitted(J.H.Hubbel, 1969).The incident beam intensity and the attenuated beam intensity were measured by calculating the mass absorption coefficient of these samples. The experimental measurement of counting rate of the

absorber PVA/AV films was detected by using STX- x64 software ST 360 counter in Nuclear Research Laboratory of the Department of Physics, University of Yangon. The experimental setup and procedures were shown as follows in Figure 5.

The Experimental Setup

Applied operating voltage = 900V

The distance between source and absorber = 3 cm

The distance between detector and absorber = 9 cm

Detector - NaI(Tl) scintillation detector

Irradiation time = 10 min

Background counting rate in the beginning, b_1 = 2297 count/min

Background counting rate in the end, b_2 = 2095 count/min

Average background counting rate, $b = \frac{b_1 - b_2}{2} = 2196$ count/min.

Figure 5 NaI (Tl) STX- x64 software ST 360 counter

Results and Discussion

EDXRF measurement

From the results of EDXRF measurement, it was found that the mostly constituted Calcium (Ca) concentration in these samples was65.79%, which can be calculated by the mass absorption coefficient is 0.051 cm^2/g. Similarly the mass absorption coefficient of other elements were calculated corresponding to potassium (K) 15.58%,Sulfur (S) 4.42%, Iron (Fe) 1.260%, Manganese (Mn) 0.94%, Copper (Cu) 0.497%,Zinc (Zn) 0.297% respectively. It was obtained that the total mass absorption coefficient of the concentration of the element is 0.069cm^2/g. The EDXRF spectrum of *Aloe vera* hydrogel was shown in figure 6.

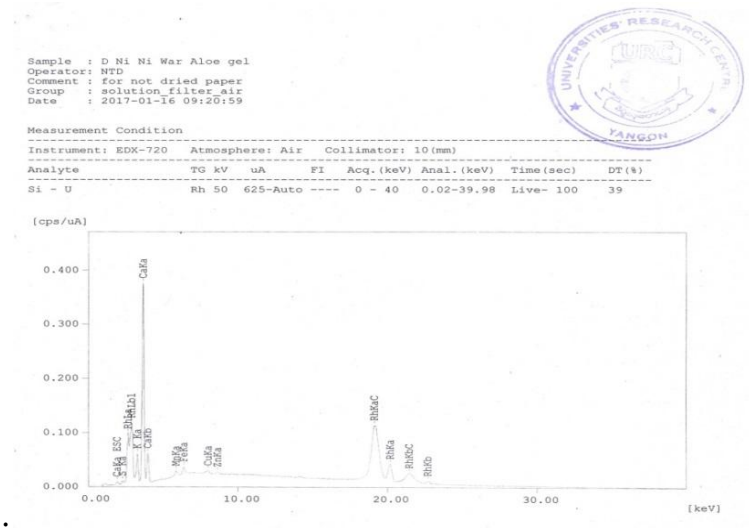

Figure 6 EDXRF Spectrum of *Aloe vera*hydrogel

Heat Absorption and Radiation Test

From geometrical results showed that the comparison of actual calculated(H_a)and measured dose rate (H_m) were shown in Table 1and Figure 7.The dose rate of *Aloe vera* leaf, natural gel and hydrogel were obtained to be 1.21 µSv/hr, 0.90 µSv/hr and 0.92 µSv/hr respectively.The specific heat capacity of the hydrogel is higher than natural gel and leaf were shown in Table 2. The measurement of the intensity count rate and mass absorption coefficient by the absorber PVA/AV films 1, film 2 and film 3 using STX- x64 software ST 360 counter as shown in Tables 3 and 4.

Table 1 Dose rate of the natural gel, hydrogel, and leaf

Sample	Mass(g)	H_0(µSv/hr)	H_a(µSv/hr)	H_m(µSv/hr)
Leaf	111.80	8.46	1.21	1.12
Natural gel	39.30	23.50	0.90	0.90
Hydrogel	39.30	24.06	0.92	0.91

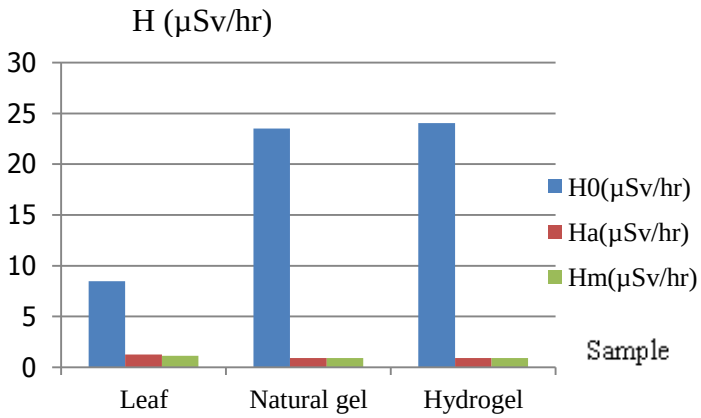

Figure 7 Actual dose rate and measure dose rate of a leaf, natural gel, and hydrogel

Table 2 The specific heat capacity of three samples

Sample	Mass (g)	T_i (°C)	T_f(°C)	C (kJ/kgK)
Leaf	111.80	26.08	28.12	3.91
Natural gel	39.30	26.99	28.80	4.02
Hydrogel	39.30	27.12	28.80	4.33

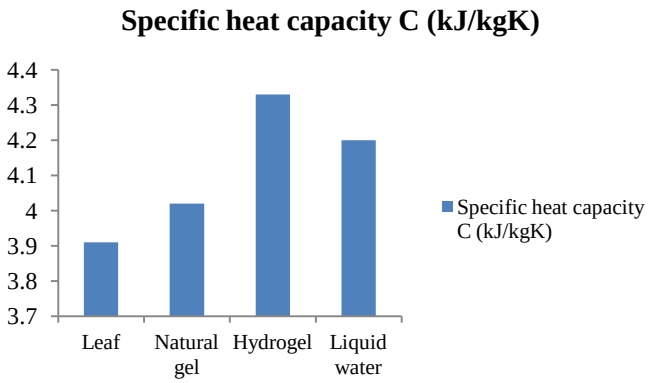

Figure 8 The specific heat capacity of three samples compare with liquid water

Table 3 Counting rate of the absorber AV films 1,2 and 3 using STX- x64 software ST 360 counter

Sr No	Source Io (count/min)	Absorber film 1 I (count/min)	Absorber film 2 I (count/min)	Absorber film 3 I (count/min)
1	98308	96870	95486	94497
2	98770	96858	95214	94069
3	97502	96265	94734	93783
Avg	98193	96664	95145	94116

Table 4 The mass absorption coefficient of absorbers film 1,film 2 and film 3.

Total mass absorption coefficient(EDXRI (cm^2/g)	The mass absorption coefficient of film 1 (cm^2/g)	The mass absorption coefficient of film 2 (cm^2/g)	The mass absorption coefficient of film 3(cm^2/g)
0.069	**0.037**	**0.053**	**0.065**

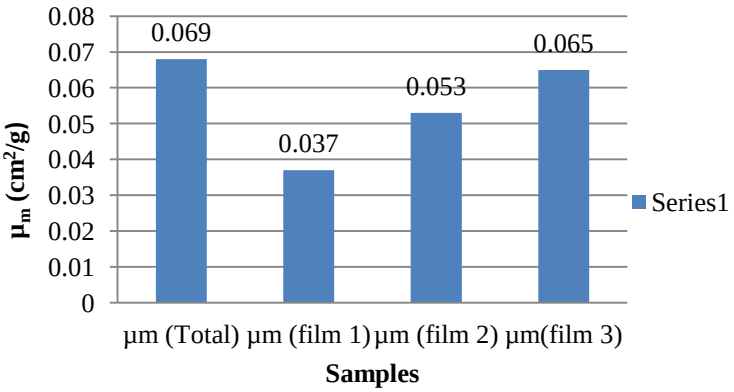

Figure 9 The mass absorption coefficient of absorbers film 1,film 2 and film 3.

Scanning Electronic Microscopy(SEM)Analyses

The SEM micrograph of the surface structure of *Aloevera* hydrogel film samples 1, 2 and 3 is shown in figure 10.The SEM analysis revealed a smooth and homogeneous surface without significant defect, which can be attributed to the excellent filming properties of polyvinyl alcohol. This image confirms that the material is forming micro-size and the surface structure of the hydrogel film images was taken at an operating voltage of 15 kV.

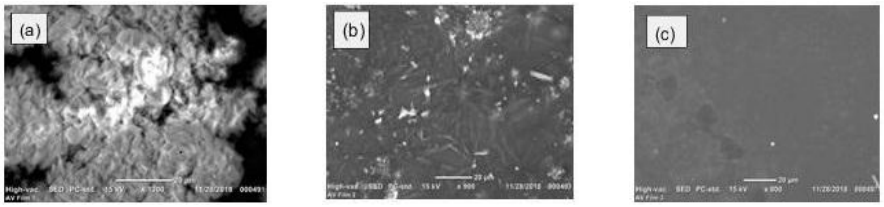

Figure 9 The SEM micrograph of the *Aloe vera* hydrogel

(a) (1:1) film, (b) (1:2) film and (c) (1:3) film

Conclusion

From the comparative study of the heat absorption test, the actual calculated and measured dose rates were found to be nearly the same values. The difference between the temperature decreased with increasing specific heat capacity. In this study, the specific heat capacity of *Aloe vera* hydrogel was calculated to be 4.33 kJ/kgK and is higher than that of liquid water 4.2 kJ/kgK. The mass absorption coefficient of *Aloe vera* hydrogel films were undertaken to be0.037cm^2/g, 0.053 cm^2/g and 0.065cm^2/g shown in Table 4 and Figure 9.It observed that the PVA/AV film 3,used as absorber nearly equal to those of standard value the total mass absorption in *Aloe vera* hydrogel is to be0.069cm^2/g by using EDXRF analysis.This study was indicated that the *Aloe vera* based hydrogel, and PVA/AV film suitable to use wound healing, treating various skin problems such as eczema, psoriasis, prevent progressive due to burns, electrical injury and reduces radiation-induced skin reaction. And so on it may be suitable for the treatment ofapplications used to protect for good absorber against radiation damage to the skin due to heat accompanying with together radiation.

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