Investigation of the Effects of Wall Paint and Films Produced Using Aloe Vera Gel in Radiation Protection

Yusuf Alper Dirak, Sena Ozcan, ADEN COLLEGE , Tekirdag/Turkey , yusufalperdirak@gmail.com , senacanayer@hotmail.com

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Gold Medalist in IMSEF 2021 Izmir, Turkey, and participants in ISAC Olympiad 2021, Tehran, Iran
Advisor: Dr. Gülsemin Savaş Tuna
Accepted by Ariaian Young Innovative Minds Institute,AYIMI

http://www.ayimi.org , info@ayimi.org

ABSTRACT

Emission or transmission of energy in the form of electromagnetic waves or particles is called radiation. Besides natural radiation, people are also intertwined with electromagnetic waves due to the development of technology. In this study; It is aimed to investigate the effect of Aloe vera in the protection of ionizing and non-ionizing radiation by producing wall paints and films containing aloe vera gel. The plants, in the form of seedlings, were multiplied and the gel was obtained when the leaves got matured. Gel was used to produce wall paint and film.

Key words: *Aloe vera, Wall Paint, Film, Ionizing and Non-Ionizing Radiation*

1 Introduction

The emission of energy in space in the form of waves or particles is called "radiation". Radiation is classified as ionizing and non-ionizing radiation (Bor, 2015). The ionizing radiation is the radiation that forms ion pairs by removing electrons from the orbits of the atom it encounters. The ionizing radiation is divided into two; Particle-type radiation: They are very fast-moving particles with specific mass and energy. Alpha (α) and beta (β+, β-) radiations can be given as examples. Wave-type radiation: It is a type of radiation that has a certain energy but is massless. This group contains X and gamma (γ) rays. Non-ionizing radiation is radiation that does not form ions in the substance it interacts with. Radio waves, microwaves, red and ultraviolet light, and visible light are examples of this type of radiation (Ince, 2002; Togay, 2002). All living beings are exposed to ionizing radiation from natural sources and this is an indispensable feature of the natural life. There are two main so-urces of the natural radiation exposure. These are high-energy cosmic ray particles entering the atmosphere and radioactive nuclei found in the earth's crust. In addition, there is also artificial radiation exposure that is often caused by medical applications. The annual radiation doses, which humans are exposed to, are 0.39 mSv from high-energy cosmic ray partic-les, 0.46 mSv from earth and 0.23 mSv from in-body irradiation. On the other hand, the most common cause of radiation in the world is Radon gas with its annual effective dose of 1.3 mSv (Çimen et al., 2017). Since un-derstanding the presence of radiation is not possible with the sense or-gans, its detection and measurements are made with radiation-sensitive devices (e.g., radiation detector) (Dönmez, 2017). When these radiations exceed certain doses, they cause various ailments instantly or after a pe-riod of time. For example, it has been identified that there are radiation-in-duced increases in breast, thyroid, colon, stomach, ovary, esophagus, bladder, liver, and lymph cancers. Moreover, it is known that radiation ca-uses hereditary disorders, nervous and immune system disorders, cata-ract, hyperparathyroidism, microcephaly, and growth-development and mental retardation (Sugarman et al., 2009). Although radiation sources have negative effects on living beings, they are used for diagnostic and therapeutic purposes in medicine and for beneficial purposes in industry, nuclear reactors, and various research activities. For radiation protection, those, working in this area, often use folding screens, gonadal protectors, lead glasses, lead aprons, gloves, glasses, and neck protectors (Çimen et al., 2017). Studies are also carried out for protection from natural radiation, and dyes, glasses, screen protectors, and films are produced using vario-us metals and chemical materials. The most important problem today is the use of too many chemicals, their recycling, and the pollution and dis-turbances that they cause. For struggling with this problem, by using plants such as aloe vera, natural solutions should be sought and tried.

Aloe vera, which is a member of the liliacea family and also called Aloe barbadensis Miller, has over 275 species in the world (Rahman et al., 2017). Four species of these are used for commercial purposes. It is att-racted to attention that numerous studies related to the plant have been done in many different areas in the world. Studies such as polyamide nanocapsule production (Esmaeili and Ebrahimzadeh, 2015), investigation of its usability as a natural plasticizer (Pandey et al., 2016), creating tissue scaffold by using nanofibers, and producing gel and film by using biomole-cules such as polycaprolactone (PCL), chitosan, and polyvinyl alcohol (PVA) (Rahman et al., 2017) have been carried out. Furthermore, the ef-fect of aloe vera extract on the radiation-induced oxidative stress (Nada et al., 2013) and the effect of it on wounds occurred on skin due to radiation in the radiotherapy process have been investigated (Olsen et al. 2001; Haddad et al., 2013; Ahmadloo et al.,2017; Rao et al., 2017). In our co-untry, the antimicrobial effect of the plant has been studied (Çete et al., 2005) and by adding it into the structure of fishmeal, the effect of it on the growth of fish has been investigated (Yılmaz et al., 2019). By using poly (vinyl alcohol) (PVA), poly (ethylene glycol) (PEG) and PVA + PEG toget-her with Aloe vera, Uslu et al. (2010) produced a nanofiber dressing mate-rial. In this study, it was aimed to investigate the effect of Aloe vera on protecti-on from ionizing and non-ionizing radiation by producing wall paint and film containing Aloe vera gel.

2 Material and Method

2-1 Obtaining Gel from the Aloe Vera Plant

The mature leaves of the plants bought and grown as seedlings were selected and cut; then, the green parts of the leaves were peeled with a knife and the gel part was taken. The samples collected in the plas-tic container were turned into gel by thoroughly broken down with the help of blender and Mixer Producing Dye Containing Aloe Vera Gel While the dye was produced, after 275 ml of water was put into the container where the materials would be mixed, 75 g of rejuvenating liquid, 10 g foam blocker, 90 g natrosol preventing dye collapse, 35 g antibacteri-al protective material preventing dye odor, 50 g antifreeze preventing dye freezing, and 135 g powder filler (omyacarb calcite) were added as auxili-ary materials. Then, they were mixed and cooked at the appropriate tem-perature until it reaches the desired consistency. After the dye cooled, 30 g acrylic glue, 90 g foam blocker, 10 g thinner, and 200 ml water were ad-ded, and it was made ready by mixing for 1 hour. In the second phase of the study, after the dye cooled, instead of 200 ml water, 100 ml water+100 ml Aloe vera gel was added and mixed. The resulting dyes were used to paint the clay-made building bricks, which were the main elements of constructions (Fig. 1).

Fig.1: Preparation of the painted samples

Investigation of Ionizing Radiation Shielding Properties of the Produced Dye In the study, which was conducted at a university's Energy Institute, two methods (gamma and neutron analysis) were used. In the analyses, bricks painted with the produced dyes were used. After the painted bricks were placed in the device, the analysis began and the necessary measu-rements were taken. In the analysis, the neutron count was performed with the Polimaster (PM1401K) device (Fig. 2).

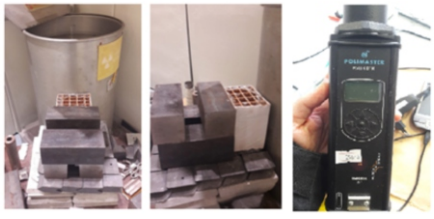

Fig. 2: Neutron analysis with the Polimaster device

Another analysis related to the ionizing radiation, on the other hand, was conducted by using the HpGe detector and performing gamma counting (Fig.3).

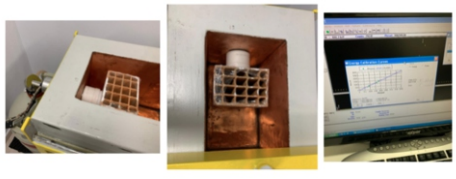

Fig. 3: Gamma counting with the HpGe detector

3 Film Production for Non-Ionizing Radiation Analysis

At this stage, 3 different films that did not contain Aloe vera gel, contained 10% gel and contained 10% gel + nano-silver were produced. First, nano-sil-ver particles were obtained. 20 ml aloe vera gel and 2ml AgNO3 were added to the glass beaker and they were mixed in a magnetic mixer; the examination was per-formed at the spec t rophotometer (380-500nm) every 30 minutes. After being washed with pure water 7 times (5000 rpm, 3 min) by using a centrifuge, it was dried, and measurement was carried out by taking photos with SEM (Fig. 4).

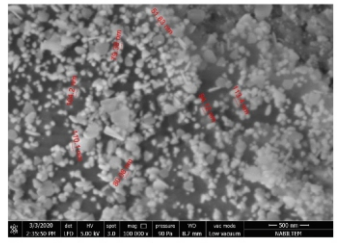

Fig. 4: Silver nanoparticles

To obtain a film that does not contain Aloe vera gel, the glass be-aker containing 190 ml distilled water, 10 ml glycerol and 2 g HEC was placed in a magnetic mixer (500-600 rpm, 2 unit temperature) and mixed for 1.5 hours until the gel consistency was obtained. In the production of the film containing 10% gel, 170 ml distilled water, 20 ml gel, 10 ml glyce-rol, and 2 g HEC were used. In the production of the third film, by setting the quantities, the same method was also followed. The prepared gels were poured into glass containers and placed in a vacuum sterile cabinet for drying After two days, it was determined that the films were dried in the desired level. Then, the films were taken out of the containers and packa-ged (Fig. 5).

Fig. 5: Sample films; A: Gel-free, B: 10% gel, C: 10% gel + silver nano-particle

4 Investigation of Non-Ionizing Radiation Protection/Shielding Proper-ties of the Produced Films

The produced films' protection or shielding effect against the non-ionizing radiation emitted from computers, mobile phones, or internet modems, which we continuously keep in touch, were examined by using the RF-An lyzer (HF 58B-R). To evaluate the result of the films, X (made of Polyester + silver) and Y (made of cotton, polyester, and stainless steel) samples produced by a company working in this field were used for comparison purposes (Fig. 6).

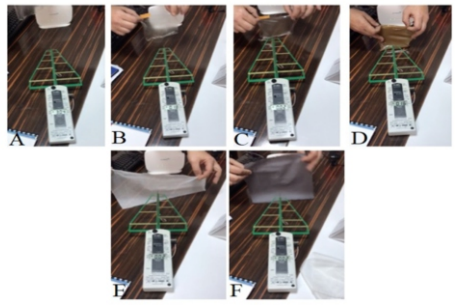

Fig. 6: A: Amount of electromagnetic radiation emitted from the modem, B: Film without Aloe vera gel, C: Film containing 10% Aloe vera gel, D: Film containing 10% Aloe vera gel+silver nanoparticle, E: sample X, F: sample Y

5 Results

The neutron count, in which the protection or shielding effect of the dye samples containing and not containing the produced Aloe vera gel is analyzed, is given in Table (1).

Table 1: Neutron count results

Measure-ment Num-ber	Dye containing Aloe vera gel (Cps)*	Dye without Aloe vera gel (Cps)*
1	250.6	275.3
2	250.3	278
3	250	275.5
4	250.7	275.2
Mean	250.4	276

*Cps: Number of neutrons per second

The results of the gamma count, which is the second analysis of the produced dyes' protection or shielding effect against the ionizing radiation, are given in Table (2). At this stage, in order to get a healthy result, the HpGe detector was first operated as empty 3 times for 10 minutes and the average was taken. Then, when it is empty, when the brick painted by the dye containing Aloe vera gel was placed in it, and when the brick painted by the dye that did not contain Aloe vera gel was placed in it, the detector was operated for 3 hours for each condition and measurements were done (3 hours is accepted as standard). The measurements were repeated 2 times.

Table 2: Gamma count results

	Detec-tor	Sample with dye that do not contain A.v. gel	Sample with dye containing A.v. gel
1st Measure-ment	14100	39667	39754
2nd Measure-ment	13600	37936	38560
Mean	13850	38801.5	39157

In Table (3), the results of the analysis in which 3 different films' non-ionizing radiation protection or radiation shielding effects were examined by using the internet modem found in almost all houses and workplaces are given through comparing them with the standard X and Y samples.

Table 3: Radio frequency analysis results of the produced film and the standard samples

Samples	RF Analyzer (mW/m²)	Shielded amount (mW/m²) and its percentage
Modem	3.04	-
Film that do not contain A.v. gel	0.18	2.86 (%94.07)
Film containing 10% A.v. gel	0.02	3.02 (%99.34)
Film containing 10% A.v. Gel + silver nanoparticle	0.16	2.88 (%94.73)
X	0.02	3.02 (%99.34)
Y	0.02	3.02 (%99.34)

* The shielded amount was calculated according to the difference between the modem and the samples.
* mW/m²: Milliwatt/square meter

6 Discussion and Conclusions

There is a view that is known and practiced in most places in our country: "If plants such as cactus and aloe vera are placed next to the computer, the person will not be affected by the radiation emitted". Is it true or not? Although we do not know a clear answer, these views arouse curiosity in people and lead to many scientific studies. In this study, it was aimed to produce wall paint and film by using Aloe vera gel and to investi-gate the effect of aloe vera in protection/shielding from ionizing and non-ionizing radiation by doing various analyses with these materials. In the investigation of the plant's usability in the protection from ion-izing radiation, two different analyses were performed. Based on the re-sults of the neutron count analysis conducted with the Polimaster device (Table 1), it was determined that while the neutron count of the brick paint-ed with dye containing Aloe vera gel was 250.4 Cps, the neutron count of the brick painted with gel-free dye was 276 Cps on average. There are natural sources of radiation in the structure of the brick too. However, it is clearly seen that there is no significant difference between the dye with aloe vera gel and the dye without gel in terms of neutron permeability; the neutron absorption property of the gel is quite low. Therefore, aloe vera gel can be used as material in studies requiring neutron permeability. When Table 2 in which gamma count results are presented was examined, it was determined that the gamma value was 13850 for HPG detector where the analysis is conducted, 38803.5 on average for the brick painted with the dye that did not contain the plant gel, and 39157 on average for the brick painted with the dye containing gel. If the analyzed samples had a protec-tive effect against the ionizing radiation, the value of the brick painted with the dye containing the gel should have been less than the sample painted with the dye that did not contain the gel. When the experts in the field were consulted, they stated that the fact that this value was found in the 35000s may be sufficient to explain that it showed a positive effect. In the results of the two analyses conducted, it should not be overlooked that the brick is rich in radiation factors such as thorium and uranium which it obtained from nature. If the dye produced by adding gel is tried only on cement or different materials used in building construction, different results can be obtained. When studies related to Aloe vera and radiation are examined, it is seen that studies are mostly done on the ailments caused by radiother-apy. While in some sources, it is stated that the plant is effective in wounds caused by ionizing radiation during the radiotherapy process (Olsen et al. 2001; Haddad et al., 2013; Rao et al., 2017), in some other sources, on the other hand, it is explained that it is not effective in prevention and heal-ing of these wounds (Ünlü et al., 2016; Ahmadloo et al., 2017). In their ex-periments conducted on rats, Nada et al (2013) reported that aloe vera ex-tract created a protective effect against the radiation-induced oxidative stress. Apart from method and techniques, the differences in the results may be due to the fact that the quality of the aloe vera gel varies depend-ing on its species type, growth conditions (e.g., climate, water, fertilization), harvest, extraction method, and ambient conditions (tempera-ture, sterilization) (Rahman et al., 2017). It is known that the techniques of protecting and shielding people from the electromagnetic radiation (non-ionizing radiation) emitted by the technological products that we use very often in our daily lives are b coming a need everywhere. In this context, curtains, fabrics, dyes, and glass films are produced and studies are keeping on. In this study, film production by using HEC natural polymer was attempted and non-ionizing radiation-related studies were analyzed using these produced films. In the previous studies, films containing aloe vera gel had been produced. How-ever, in those films, substances such as PCL, PVA, PEG, chitosan, algi-nate, and pectin gelatin were used as polymers (Pereira et al, 2013, 2014; Silva et al., 2013; Anjum et al., 2016; Rahman etal., 2016; Tummalapalli et

al, 2016) and films were tested in health or tissue engineering studies. When the results of 3 different gels produced for non-ionizing radiation tri-als were examined by comparing them with the standard samples (X and Y) (Table 3), the fact that the radiation shielding property of all samples was determined to be around 99% and the fact that with 99.34% shielding rate, the film containing 10% aloe vera gel was at the same value with the standard samples attract attention. It was observed that silver nanoparticles did not increase the gel effect, but rather inhibited somewhat. In terms of standard samples, X was produced from polyester and silver, while Y was produced from cotton, polyester, and stainless steel; both of them were products available commercially. These products are usually pro-duced in Germany, Italy, and Switzerland, and their prices per square me-ter vary between 75-175 Euros. X is produced in our country and sold for 75 euros per square meter. Taking into account the data obtained, it can be said that metals can be protected from non-ionizing radiation through producing natural products, which are cheaper and do not cause environ-mental pollution (because they are recyclable), by using plants (without using various chemicals). In the conducted literature review, studies on non-ionizing radiation were not be encountered much. In their study, Sheikh et al (2013) reported that aloe vera leaves showed a significant increase in current with a slight increase in voltage at first when they exposed to microwave, but then set themselves to their normal value. Studies support each other. As a result of the study, it was determined that the dye produced by adding aloe vera gel was not effective in protection against ionizing radiation since its ion absorption property is low. The absorption property can be increased by adding some different metals to the gel. It was determined that the shielding property of the film, produced by adding Aloe vera gel, against non-ionizing radiation was equivalent to the standards. It is thought that by developing these data, cheap, natural and recyclable glass film, tulle, and fabric can be produced.

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