Aloecare: Aloe Vera (*Aloe vera* (L.) Burm. F.) and Carrot (*Daucus carota* 'Ss35') Extract as Natural Ultraviolet Blockers in Film

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ABSTRACT

Climate change has led to high ultraviolet (UV) levels, affecting materials and human health. To become more aware of the harmful effects of UV radiation, find ways to protect against it. One solution is using natural extracts like aloe vera and carrot in polyvinyl alcohol (PVA) films. These films offer eco-friendly UV protection, helping to address growing environmental concerns while providing better protection against harmful UV rays. This into using these natural compounds in films that protect materials and human health. This study determined the effectiveness of aloe vera (Aloe vera (L.) Burm . f.) and carrot (Daucus carota 'SS35') extracts as natural ultraviolet (UV) blockers in film formulations. The researchers utilized a true experimental design, specifically a post-test-only control group design and Tukey's HSD tests. The study found that films containing aloe vera and carrot extracts displayed high efficiency in the ultraviolet (UV) blockage, claiming that T3 (100 mL extract) achieved the mean efficiency at 84.09%. Finally, the statistical analysis proved there was a significant difference between the experimental films and the negative control but not against the positive control. Therefore, it can be deduced that aloe vera and carrot films are effective UV-blocking materials, which corroborates or refutes claims from other studies. Ametur Cor Jesu, Ametur Cor Mariae!

Keywords: Aloe vera Carrot extract UV-blocking Natural UV blockers Experimental design Posttest-only control groupUV protection efficiency Quantitative Research

INTRODUCTION

Ultraviolet (UV) radiation from the sun is a major factor in the photodegradation of various materials, including plastics, paints, fabrics, wood, and rubber. Prolonged exposure to high-intensity UV rays can cause fading, brittleness, and structural weakness, significantly reducing the lifespan of some materials. There is also concern about the deleterious effects of UV on human health, such as premature aging and cataracts. With increasing awareness of the harmful effects of ultraviolet, many innovative ways of enhancing ultraviolet protection have been sought.

Globally, climate change is a current reality, and as a result, the rise in the heat index has been reported in countries such as China, India, the United States, and South Africa (Ergun, 2018; Feng et al., 2021; Rohat et al., 2019; Weinberger et al., 2021). Due to this, an increase in ultraviolet radiation levels is observed and is prevalent (Neale et al., 2021). Ultraviolet radiation can significantly weaken different textiles and wood (Andrady et al., 2023). In the study of Godinho et al. (2021), it was shown that wood deteriorated and turned grey when exposed to ultraviolet radiation. In addition, ultraviolet exposure can contribute to wood and textiles discoloration and damage (Jirouš-Rajković & Miklečić, 2021). In order to prevent these consequences, there is a growing need for effective ultraviolet-shielding materials for different products

(El-Sayed, 2024). In addition, Ibrahim et al. (2022) emphasized the need for sustainable and innovative packaging alternatives.

In Southeast Asia, specifically in Malaysia, people face problems with shortened lifespans of their objects due to the deleterious effects of ultraviolet radiation. One of the issues that the country faces is microplastics, which are produced from medical, cosmetic, and plastic debris that are exposed to ultraviolet radiation, the materials become brittle and subsequently fragment into microplastic due to the photo-oxidation process (Ng et al., 2023). In addition, the country is confronted with an issue about the effect of ultraviolet radiation on naturally occurring polymer materials like wood. According to Andrady et al. (2023), routinely exposed objects to sunlight undergo photolytic, photo-oxidative, and thermo-oxidative reactions that result in the degradation of the material, which leads to surface discoloration affecting the aesthetic appeal of a product to extensive loss of mechanical properties, which severely limits their performance. Too much exposure to ultraviolet light can damage valuable compounds, but aloe vera is safe for the environment, making it an excellent option for extending food shelf life. Moreover, the country faces issues with human skin and eye damage because of the deleterious effects of UV radiation (Chinnasami et al., 2022). These severe cases increase the need for a solution. The study conducted by Rodrigues and Jose (2020) found that incorporating aloe vera extract into sunscreen resulted in excellent sun protection factors and improved photoprotective action. This was further supported by Hendrawati et al. (2020), who also found that aloe vera enhanced sunscreen's sun protection factor.

UV radiation has been a widespread problem known for its harmful effects, including photodegradation in materials and photoaging of human skin. Effective protective solutions are needed to address these impacts. In accordance with the study of Anbualakan et al. (2023), carrots were identified as one of the phytonutrient-containing plants. Flavonoids and carotenoids can be found in carrots, and they can be used to prevent the deleterious effect of UV radiation, specifically photodamage. According to Chandirani et al. (2020), carrot extract contains three flavones: luteolin, 3-0-beta-D-glucopyranoside, and luteolin, 4-0-beta-D-pyranoside. The experiment evaluated carrot extract using the UV spectrophotometric method, resulting in a 27.28 sun protection factor (SPF), which is significant protection from UV radiation. The study by Rodrigues and Jose (2020) shows that incorporating aloe vera extract in sunscreens improved UV blocking factors and enhanced photoprotective action. Moreover, aloe vera has bioactive compounds, such as anthraquinones, acemannan, and aloin, which effectively absorb and dissipate UV radiation, offering up to 97% UV blockage (Nicácio et al., 2023; Tiwari et al., 2022). This can be supported by the study of Hendrawati et al. (2020), who found that higher concentrations of aloe vera gel in sunscreens provide better protection.

The Philippines, lying close to the equator, receives significant exposure to ultraviolet (UV) radiation. The prolonged exposure to the Sun in this area has harmful effects, including photoaging of human skin and photodegradation of sacks, automotive paint, and other construction materials. UV radiation degraded the sacks and their contents, as pointed out by Sahoo (2024) and Parked (2024) considered fading and discoloration of paint in vehicles due to UV exposure. Similarly, Andrady et al. (2023) discussed the photodegradation of materials used in construction slowly under UV. The solar ultraviolet radiation in the local context, especially in Davao del Sur, is exceptionally high in Digos City (Principe et al., 2023). It is known to affect humans in terms of photoaging, resulting in wrinkles and reduced elasticity (Ansary et al., 2021). With these issues, there is a growing need for cheaper, locally sourced ultraviolet protection products. Natural extracts such as aloe vera and carrot have shown UV-blocking abilities. Hendrawati et al. (2020) established that aloe vera extract prevents photodamage at the cellular level across both the ultraviolet and visible spectra. Carrot extract is also known for its protective, moisturizing, and elasticizing effects against UV radiation. However, a study has yet to be conducted in Digos City, Davao del Sur, to assess the efficacy of aloe vera and carrot extracts as natural UV blockers. This study aimed to investigate the potential of these two plant extracts in blocking ultraviolet radiation.

Given the growing concerns over the harmful effects of ultraviolet radiation from the sun and its impact on materials and the environment, which leads to degradation of the material and surface discoloration

(Andrady et al., 2023), there is an urgent need to develop biodegradable polymer-based films with effective UV-blocking properties. aloe vera and carrot extracts, with high natural UV-absorbing ability, offer a promising solution to reverse such environmentally friendly and biodegradable effects. By comparing how the extracts perform in film applications, the research aims to introduce an inexpensive, natural solution to protect material and human health against UV radiation's detrimental effects. It also shows photoprotective potential, their integration into polymer films, mainly using PVA, remains underexplored.

While individuals have explored the UV-blocking properties of aloe vera and carrot extract separately, research combining aloe vera and carrot extract in PVA film applications remains limited. For instance, Sumbrami et al. (2018) investigated using aloe vera nanoparticles for ultraviolet protection in textiles, demonstrating significant UV-blocking properties. Similarly, research has shown carrot extract provides reliable UV protection as it contains carotenoid content, including β-carotene and α-carotene, which effectively absorb UV radiation (Ariano et al,. 2020: Moukova et al., 2023). However, the synergistic effects of combining aloe vera and carrot extracts in PVA films remain unexplored. This gap underscores the need for studies focusing on the formulation, effectiveness, and potential applications of films incorporating these natural extracts as UV blockers.

The study aimed to comprehensively determine the effectiveness of aloe vera and carrot extracts as natural ultraviolet (UV) blockers in films by measuring their ability to absorb ultraviolet radiation and comparing their performance with commonly used synthetic UV blockers. The study explored how effective aloe vera and carrot extracts can protect against harmful UV rays, which are important for various applications such as packaging and construction materials, and their effects on humans. It also serves as an alternative to synthetic ultraviolet blockers and is eco-friendly. The extracts addressed the mounting environmental concerns and the increasing demand for biodegradable and non-toxic materials. The study opened avenues for sustainable material science practices when it points to using natural extracts instead of chemical synthetics.

This research is supported by the Photodegradation Theory, with prominent advocates such as Henry E. Leckie in 1960, Robert G. B. W. van de Sande in 1972, and Michael D. Smith in 1985. Photodegradation refers to the chemical breakdown of materials caused by exposure to sunlight's ultraviolet (UV) radiation. The changing of color and decomposition of things is highly attributed to photodegradation (Liu et al., 2015). Oxidation and hydrolysis are triggered in materials with light, which often comes from sunlight and air. This process is not affected by infrared light or heat but includes degradation in all UV light wavebands. Moreover, it provides basic knowledge of how UV radiation impacts the integrity of organic materials like textiles, wood, and paper. According to Robinson et al., 2023, ultraviolet radiation is applied extensively in medical, research, and industrial fields to visualize DNA and remove harmful microorganisms. Though not ionizing, UV radiation is just at the edge of the ionizing region. It can break chemical bonds, which may cause effects such as permanent or temporary damage to the eyes and skin cancer. The theory guides the research on the efficacy of UV-blocking agents by highlighting the mechanisms involved, such as the absorption of UV radiation, the production of free radicals, and subsequent chain reactions leading to material degradation (Andrady et al., 2019).

This study was also based on the principles of Natural Product Chemistry Theory, which comes from the contributions of William H. Perkin in 1868. This theory highlights the examination of small organic molecules, especially secondary metabolites, produced by various organisms, including bacteria, fungi, and plants. Natural products have been shown to contain a high concentration of bioactive molecules that are important in medicine and industry (Cieśla & Moaddel, 2016). In addition, it also supports this study by providing a scientific framework for understanding how the bioactive compounds in aloe vera and Carrot extract can offer UV protection. In this context, the theory helps describe how the phytochemicals found in these plants, polyphenols in aloe vera (Ioannou et al., 2024) and carotenoids in carrot (Umair et al., 2021), can absorb or block harmful UV rays, thereby offering a natural, non-toxic replacement to synthetic UV blockers.

Statement of the Problem

This study focused on the effectiveness of aloe vera and carrot extract as an ultraviolet blocker in films. Furthermore, the research compared the efficacy of film with aloe vera and carrot extract as an ultraviolet blocker in different concentrations. Specifically, this study sought answers to the following questions:

1. What is the average ultraviolet blockage of the control treatment difference between aloe vera and carrot extract added to films based on the following concentrations:

50 mL extract, with 25 mL each of aloe vera and carrot extract mixed with 100 mL of polyvinyl solution;

70 mL extract, with 35 mL each of aloe vera and carrot extract mixed with 100 mL of polyvinyl solution; and

100 mL extract, with 50 mL each of aloe vera and carrot extract mixed with 100 mL polyvinyl solution?

2. What is the average ultraviolet blockage of the following controlled treatment?

Pure polyvinyl alcohol: and

Commercial ultraviolet films?

3. Is there a significant difference in the average ultraviolet blockage of the aloe vera and carrot extract and the control treatment?

Hypotheses of the Study

To objectively answer the problems listed in the preceding section, the researchers formulated the given null hypothesis and the alternative hypothesis:

H_0: There is no significant difference in the ultraviolet-blocking capacity between films containing aloe vera **(**Aloe vera (L.) Burm. f.) extract and carrot (Daucus carota 'SS35') extract and those without.

H_1: There is no significant difference in the ultraviolet-blocking effectiveness between AloCaré containing aloe vera and carrot extracts and conventional ultraviolet-blocking window films without aloe vera and carrot extracts.

Significance of the Study

This study highlighted the potential of plant-based substances for non-toxic coatings, providing eco-friendly ultraviolet blockers. This study could be beneficial to the following:

Department of Trade and Industry Officials (DTI). This study utilised aloe vera and carrots. It can increase the demand for locally sourced crops, support farmers, and enhance the agricultural sector.

Department of Science and Technology Officials (DOH). The findings can improve packaging recommendations and safety by providing evidence-based insights and promoting the development of ultraviolet-protective packaging materials.

Packaging Manufacturers. This research provides valuable insights that can help packaging manufacturers make eco-friendly ultraviolet-blocking films. Focusing on eco-friendly materials can significantly prolong the shelf life of products.

Health-Conscious Consumers. This study offers innovative packaging solutions that prioritize safety and sustainability. These solutions can help health-conscious consumers who do not want synthetic materials that may pose health risks. This approach addresses environmental concerns and aligns with the values of individuals who are mindful of their well-being.

Future Researchers. This study could provide valuable data on the effectiveness of aloe vera and carrot extracts for ultraviolet protection, creating opportunities for further exploration into the effectiveness, stability, and uses of natural materials in making sustainable and functional films. Additionally, it promotes the development of eco-friendly alternatives to chemical-based products, inspiring ongoing exploration and advancement in natural product chemistry and materials science.

SCOPE AND LIMITATIONS

This study focused mainly on evaluating the UV-blocking properties of PVA (polyvinyl alcohol) films incorporated with aloe vera **(**A. vera (L.) Burm. f.) and carrot (D. carota 'SS35') extract. The research was conducted during the first and second semesters of the academic year 2024 to 2025 in Digos City, Davao del Sur. The researchers prepared polyvinyl alcohol films with varying concentrations of aloe vera and carrot extracts to determine their effectiveness in blocking ultraviolet radiation. A UV radiometer was utilized within the province of Davao del Sur for the UV-blocking analysis. This study did not focus on testing the films' mechanical properties; instead, it concentrated on examining the natural UV-blocking potential of aloe vera and carrot extracts incorporated into PVA films and assessing their efficacy. Furthermore, due to unforeseen weather conditions, the researchers did not test the films on peak sun activity.

Definition of Terms

The following terms are defined conceptually and operationally according to how they are used in this study.

Aloe vera Extract. This is made from the aloe vera plant. The plant's dried latex, gel, or entire leaf can all be used to make aloe vera extract.(Rahman & Rauf, 2022). Aloe vera extract refers to the material that is taken from the aloe vera plant leaves, it's Sun Protection Factor (SPF) capacity is tested to see the effectiveness and how well it shields the materials and objects from the damage caused by UV rays.

Carrot Extract. It was derived from the roots of the carrot plant, scientifically known as D. carota. It is collected through a process of extraction (Ikram et al., 2024). This study refers to the substance extracted from carrot plants; its Sun Protection Factor is evaluated to determine its ability and efficacy in preventing UV damage to materials and objects.

Ultraviolet Films. Ultraviolet films are thin layers of material designed to filter, block, or absorb ultraviolet radiation from sunlight or artificial sources (Huang et al., 2020). In this study, it refers to the coverings that are made to keep objects and materials away from UV rays. The quantity and characteristics of anti-ultraviolet radiation blockers in aloe vera and carrot extract were evaluated using ultraviolet films.

Ultraviolet Index Meter. This tool determines the intensity of ultraviolet (UV) radiation that causes sunburn at a specific location and time (Kosmopoulos et al., 2021). The equipment was used to test aloe vera and carrot extracts' capacity to block UV rays. Upon collecting UV light, the information is transformed into an electrical signal with a voltage measurement.

Ultraviolet Blockage. Ultraviolet blockage refers to the ability of a material or substance to prevent or reduce the transmission of ultraviolet radiation (Gupta, 2013). In this study, this refers to the capacity of Aloe Vera and Carrot extract in a film to protect materials and objects caused by UV rays.

METHODS

This chapter outlines the various methodologies used in conducting the study. It provides a detailed discussion of the key aspects such as research design, the subject of the study, sampling procedure, data gathering, and measurement.

Research Design

This study evaluated the effectiveness of aloe vera (A. vera (L.) Burm. f.) and carrot (D. carota 'SS35') extracts as ultraviolet blockers in films. Therefore, the researchers utilized a true experimental research design. A true experimental research design uses statistical analysis to establish cause-effect relationships between variables (Gribbons & Herman, 2019). The experimental design, specifically the post-test-only control group design, will assess samples exclusively after exposure to the experimental treatment. Each experimental group will be tested under outdoor conditions using films made from polyvinyl alcohol (PVA) combined with different concentrations of aloe vera and carrot extracts.

Furthermore, after applying the treatments, a posttest-only design was incorporated to measure the film's UV-blocking properties. According to Budert-Waltz et al. (2023), a post-test evaluates the performance, results, and changes in the dependent variable following the independent variable. To ensure reliability, the researchers conducted multiple trials for each group under identical outdoor conditions, with measurements performed at regular intervals. The experimental design consisted of three treatment groups and one control group—the random assignment of treatments aimed to minimize variability and improve the precision of the findings.

Sampling Method

The researchers used a complete random design (CRD) in this study. It is a widely used experimental methodology that ensures they randomly assign experimental units to treatment groups. This randomization is key since it gives each experimental unit an equal and unbiased chance of receiving tested treatments. In eliminating bias, CRD ensures that observed differences between groups are likely due to the treatments rather than external factors (Costello, 2023). CRD is most effective when homogeneous experimental units because similar characteristics allow researchers to confidently attribute outcome differences to treatments rather than inherent variability. However, with heterogeneous units, variability may obscure the actual effects of treatments (Harleen, 2023). CRD is one of the most straightforward and flexible techniques. It is particularly powerful in controlled environments where they can regulate temperature, humidity, and light to ensure consistency between units. CRD is especially ideal for any experiment requiring accuracy and control wherein differences observed are due primarily to treatments.

Data Gathering Procedure

The data gathering methods systematically and objectively ensure that researchers obtain valid and dependable results. This method involved structured, systematic observations and experiments to collect numerical data. Analyzing the patterns and relationships in a specific sample population will be critical using scientific inquiry and measured data (Ahmad et al., 2019). Using structured observations and controlled experiments guarantees that the data collected were accurate and consistent. In addition, researchers used the data gathered to answer research questions concerning the study sample population. The collection and extraction method for aloe vera was adapted from the studies of Maan et al. (2021), Pinzon et al. (2018), Rafieian et al. (2019), and Shah & Hashmi (2020). Similarly, the extraction method for carrots followed the procedure outlined by Yang et al. (2024). The preparation of polyvinyl films was conducted based on the methodology of C et al. (2025), while the determination of UV-blocking properties was carried out following the approach of King et al. (2015).

Collection and Extraction of Aloe Vera (A. vera (L.) Burm. f.)

1. The researchers obtained aloe vera leaves that were uniform in size, color, maturity, and freshness.
2. The leaves were washed thoroughly with tap water and then rinsed with distilled water to remove dirt.
3. After washing, the leaves were prepared by cutting their top (2–4 inches), base (1 inch), and sharp spines

4. To remove aloin (a bitter and yellow-brown colored compound), the leaves were immersed vertically in water for an hour.
5. After removing the green outer cortex layer, the colorless gel matrix was scooped out using a spoon. The extracted gel is then ground in a domestic blender.
6. To create a uniform mixture, 100 grams of aloe vera gel were weighed and blended with 150 mL of distilled water.
7. The mixture was strained through sterilized cheesecloth and passed through a fine sieve to obtain a pure liquid aloe vera extract.
8. The extract was gently heated on a hot plate for 30 minutes at a temperature not exceeding 60°C, which was monitored using an infrared thermometer. This step concentrated the extract by evaporating excess water.

Collection and Extraction of Carrots (D. carota 'SS35')

1. The researchers sourced fresh, mature, healthy carrots from a local market.
2. The carrots were thoroughly washed with clean water to remove dirt.
3. The carrots were cut into smaller pieces.
4. 100 grams of carrot pieces were weighed using an analytical balance and blended with 150 mL of distilled water to create a uniform mixture.
5. The mixture was strained through sterilized cheesecloth and passed through a fine sieve to obtain a pure liquid carrot extract.
6. The extract was heated gently using a hot plate for 30 minutes at a temperature not exceeding 60°C, monitored with an infrared thermometer.

Preparation of Polyvinyl Films and Integration of Extracts

1. The researchers dissolved 5 grams of polyvinyl alcohol (PVA) BP-24 grade powder in 100 mL of distilled water at a temperature not exceeding 60°C using a pot with constant stirring to form a homogeneous solution.
2. The prepared aloe vera and carrot extracts were incorporated into the PVA solution at varying concentrations: T_1: 50 mL of extracts (25 mL aloe vera, 25 mL carrot) mixed with 100 mL of PVA solution, producing 33.33% extract concentration. In T_2: 70 mL of extracts (35 mL aloe vera, 35 mL carrot) mixed with 100 mL of PVA solution of 41.18% extract concentration. At last, T_3: 100 mL of extracts (50 mL aloe vera, 50 mL carrot) mixed with 100 mL of PVA solution (50.00% extract concentration). The mixtures were cast onto a flat, sterilized surface and dried under controlled environmental conditions to form thin polymer films.
3. A control film containing no extracts was also prepared to serve as the baseline for comparison.
4. Each mixture was cast evenly onto a flat, sterilized surface to ensure consistent film thickness across treatments.
5. The film was dried at room temperature for 24-48 hours under controlled conditions to prevent variations due to humidity and temperature.

Determination of UV-Blocking Properties

1. A UV radiometer was used to measure the UV transmittance of the films. To ensure consistent UV radiation exposure, testing was conducted outdoors under natural sunlight.
2. A total of five film samples were prepared, consisting of three experimental films containing aloe vera and carrot extracts and two control films
3. Each film sample was cut into uniform dimensions (10 cm × 8 cm) and carefully placed in the UV meter's light path. The UV transmittance (UV index) passing through each film was recorded.
4. Multiple trials (three replicates per sample) were conducted to ensure the data's reliability and accuracy.

5. The recorded data were analyzed to compare the UV-blocking efficiency of the aloe vera and carrot extract-infused films against the control and commercial films.

This quantitative study used the method of ultraviolet index measurement, also used by Serrano et al. (2022) in their research that investigated the ultraviolet-blocking properties of transparent films. Furthermore, the formula was derived from Chavda (2023). In this study, the researchers prepared three different aloe vera and carrot extract concentrations and tested them in the laboratory at a normal temperature of around 20°C to 25°C. The first solution, labelled T_1, consisted of 50 mL of the extract, with 25 mL from each aloe vera and carrot extract. The second solution, T_2, was prepared with 70 mL of extract, including 35 mL from each extract. The third solution, T_3, contained 100 mL of extract, with 50 mL of each aloe vera and carrot extract. Lastly, T_4 consisted of 100 mL of pure PVA without the aloe vera and carrot extract. The measurement of these variables was derived from the study conducted by Gause and Chauchan (2015). According to Kovács et al. (2022), a UV meter measures UV radiation across specific wavelength ranges. The researchers used an ultraviolet meter to measure the ultraviolet-blocking properties of aloe vera and carrot extract.

$$\textbf{\textit{Blocking Efficacy}}\ \textbf{(\%)} = \left(1 - \frac{\textit{Treated Value}}{\textit{Normal UV Index}}\right) \text{x } 100$$

Figure 1: Formula for determining ultraviolet-blocking efficiency

Table 1: Levels of Ultraviolet Blocking Efficiency

Mean UV transmittance	**UV blocking efficacy (%)**	**Description**	**Interpretation**
≥ 8.01 – 11.00	<30%	Very Low	There is no UV protection; most UV rays pass through. The material is highly ineffective in blocking UV rays.
6.01 – 8.00	30-50%	Low	Minimal UV protection; significant UV passes through. The material blocks only a small portion of UV rays.
4.01 – 6.00	50-70%	Moderate	Limited UV protection; moderate UV passes through. The material provides some UV shielding but is insufficient for long-term exposure to intense sunlight.
3.01 – 4.00	70-80%	Good	Adequate UV protection; moderate to low UV passes through. The material offers good protection against UV rays.
≥ 1.00 – 3.00	>80%	Excellent	Excellent UV protection; very little UV passes through. The material provides strong protection against UV radiation.

RESULTS AND DISCUSSION

This chapter deals with the presentation, analysis, and interpretation of data. The first section discusses the mean UV transmittance of each concentration of aloe vera extract and carrot extract, including the commercial treatment. The second section highlights the significance of the difference among different concentrations in blocking ultraviolet radiation.

Ultraviolet Blockage Efficiency of Different Concentrations of Aloe Vera and Carrot Extracts Added to Film

The study investigated the efficiency in percentage of the different films by assessing the ultraviolet blockage of the following bioplastic experiment setup: Treatment 1, with 50 mL extract, with 25 mL each of aloe vera and carrot extract mixed with 100 mL of polyvinyl solution; Treatment 2, with 70 mL extract, with 35 mL each of aloe vera and carrot extract mixed with 100 mL of polyvinyl solution; and treatment 3, with 100 mL extract, with 50 mL each of aloe vera and carrot extract mixed with 100 mL polyvinyl solution. The researchers assessed the efficiency of the following setup by recording the UV index using a UV radiometer. Each film sample was placed in the light path of the radiometer, and the UV index was measured to detect any changes in UV transmission when the films were positioned to block the device. Three replicates of each film sample were tested to ensure the reliability and accuracy of the measurements. Hence, the researchers attained the following results.

Table 2. Ultraviolet Blockage Efficiency of Different Concentrations of Aloe Vera and Carrot Extracts Added to Film

	Replicate (in percentage)			**Mean**	**SD**	**Interpretation**
	R1	**R2**	**R3**			
T1	67.28	59.41	70.67	65.79	5.78	Moderate
T2	70.05	64.36	72	68.80	3.97	Moderate
T3	79.72	79.21	93.33	84.09	8.01	Excellent

Table 2 compares the films with different setups in terms of their efficiency. Among the film setups of aloe vera and carrot, T3 with 100 mL extract, with 50 mL each of aloe vera and carrot extract mixed with 100 mL polyvinyl solutio,n had the highest blockage efficiency (M = 84.09%), whereas T1 had the lowest blockage efficiency (M = 65.79%). This means that T1, with a UV blocking efficacy of 65.79%, falls into the "Moderate" category (50-70%), indicating limited UV protection and allowing a moderate amount of UV to pass through. In contrast, T3, with a UV blocking efficacy of 84.09%, falls into the "Excellent" category (>80%), providing strong protection against UV radiation. These results suggest that T3 offers significantly better UV-blocking efficiency compared to T1.

Moreover, the results were in congruence with the statements of Chandirani et al. (2020), Nicácio et al. (2023), and Tiwari et al. (2022). The experiment evaluated carrot extract using the UV spectrophotometric method, resulting in a 27.28 sun protection factor (SPF), which is significant protection from UV radiation. Aloe vera effectively absorbs and dissipates UV radiation, offering up to 97% UV blockage.

Ultraviolet Blockage Efficiency of the Control Treatments

The study determined the ultraviolet blockage efficiency of the positive control using laminated polyester film layers and the negative control with pure polyvinyl alcohol concentration. The researchers determined the efficiency of the positive and negative controls by the percentage of blockage per treatment in each replication. Hence, the researchers finally attained the following results.

Table 3. Ultraviolet Blockage Efficiency of the Control Treatments

	Replicate (in percentage)			**Mean**	**SD**	**Interpretation**
	R1	**R2**	**R3**			
Polyvinyl Film	21.2	44.55	40	35.25	12.38	Low
UV-blocking Film	73.73	73.27	66.67	71.22	3.95	Good

In Table 3, the positive sample was a laminated polyester film layer advertised to block ultraviolet light, and it revealed an average of 71.22% based on the ultraviolet blockage efficiency. This means that the material offers good protection against UV rays and adequate protection against UV rays. Based on the efficiency of UV blockage, the negative control using pure polyvinyl alcohol demonstrated an average of 35.25%, which means significant UV passes through–the material only blocks a small portion of UV rays and offers minimal protection against UV rays. Moreover, the results were in congruence with the statements of Matthew et al. (2019), Oun et al. (2022), and Zhang et al. (2020). PVA films are biodegradable, watersoluble, and mechanically strong, making them ideal for packaging and coatings. They effectively block UV light in the 200–231 nm range, with improved performance when combined with functional materials.

Significance of the Difference in Ultraviolet Blockage Efficiency of Different Concentrations of Aloe Vera and Carrot Extracts Added to Film Compared to the Control Treatment

Table 4 shows the results of a one-way analysis of variance to determine the significance of the difference in the ultraviolet blockage efficiency of films using aloe vera and carrot mixture and the control groups. It can be observed that the F value is 17.323 with 4 and 10 degrees of freedom. The p-value is 0.000, which is less than 0.05. This confirms that the three experimental groups exhibit a significant difference in ultraviolet blockage efficiency compared to the positive and negative controls. These findings highlight the effectiveness of aloe vera and carrot extract-infused films as natural UV-blocking alternatives, reinforcing their potential for practical applications.

Table 4. Significance of the Difference in Ultraviolet Blockage Efficiency of Different Concentrations of Aloe Vera and Carrot Extracts Added to Film Compared to the Control Treatment

	Sum of Squares	**df**	**Mean Square**	**F**	**p**	**Decision**
Between Groups	3909.52	4	977.38	17.323	0.000	Reject
Within Groups	564.204	10	56.42			(Significant)
Total	4473.72	14				

To determine which of the four setups significantly differs from the other, post hoc analysis was conducted, particularly the pairwise comparisons of sample means via the Tukey HSD test. The Tukey's honestly significant difference test (Tukey's HSD) tests differences among sample means for significance. Tukey's HSD tests all pairwise differences while controlling the probability of making one or more Type I errors. The Tukey's Honestly Significant Difference (HSD) test is a widely used multiple-testing procedure examining how different confidence levels influence error rates. It emphasizes the importance of controlling Type I errors when comparing tests involving more than two variables (Nanda et al., 2021).

Table 5. Post Hoc Comparisons using the Tukey HSD Test

	Mean Difference	**p**	**Decision**	**Interpretation**
Between T1 and T2	-3.01667	0.986	Failed to Reject	No Significant Difference
Between T1 and T3	-18.30000	0.080	Failed to Reject	No Significant Difference
Between T1 and Negative Control	30.53667	0.004	Reject	Significant Difference
Between T1 and Positive Control	-5.43667	0.896	Failed to Reject	No Significant Difference
Between T2 and T3	-15.28333	0.168	Failed to Reject	No Significant Difference
Between T2 and Negative Control	33.55333	0.002	Reject	Significant Difference
Between T2 and Positive Control	-2.42000	0.994	Failed to Reject	No Significant Difference
Between T3 and Negative Control	48.83667	0.000	Reject	Significant Difference
Between T3 and Positive Control	12.86333	0.292	Failed to Reject	No Significant Difference
Between Negative and Positive Control	-35.97333	0.001	Reject	Significant Difference

Meanwhile, Table 5 displays the results of post-hoc comparisons using the Tukey HSD test. This test was performed to determine whether any of the five experimental settings exhibited significant differences in ultraviolet blockage efficiency between the various experimental and control groups. The results present that there are no significant differences between T1 and T2 (MD = -3.02, p = 0.986), T1 and T3 (100 mL) (MD = -18.30, p = 0.080), and T1 and the positive control (MD = -5.44, p = 0.896). However, a significant difference was found between T1 and the negative control (MD = 30.54, p = 0.004), with T1 showing significantly higher ultraviolet blockage efficiency. For T2 (70 mL), no significant differences were observed between T2 and T3 (MD = -15.28, p = 0.168), T2, and the positive control (MD = -2.42, p = 0.994). Still, a significant difference was found between T2 and the negative control (MD = 33.55, p = 0.002), indicating that T2 had significantly greater ultraviolet blockage efficiency than the negative control. For T3 (100 mL), no significant differences were found between T3 and the positive control (MD = 12.86, p = 0.292), but T3 showed a significant difference compared to the negative control (MD = 48.84, p = 0.000), with T3 exhibiting significantly higher ultraviolet blockage efficiency. Finally, a significant difference was found between the negative control and the positive control (MD = -35.97, p = 0.001), with the positive control showing significantly higher ultraviolet blockage efficiency than the negative control.

Additionally, while some experimental groups did not show statistically significant differences, it is important to consider the numerical variations in their mean differences. For instance, although T1 and T3 (MD = -18.30, p = 0.080) and T2 and T3 (MD = -15.28, p = 0.168) failed to reach statistical significance, the relatively high mean differences suggest that T3 exhibited greater UV-blocking efficiency compared to T1 and T2. Similarly, the comparison between T3 and the positive control (MD = 12.86, p = 0.292) shows a noticeable difference, even though it was not statistically significant. These results indicate that while statistical tests did not confirm a significant effect in these cases, the observed numerical differences imply variations in UV-blocking efficiency among the experimental films.

These results indicate that T1, T2, and T3 treatments significantly have an alternative capacity for ultraviolet blockage compared to the negative control, though no significant differences were found when comparing the treatments to the positive control. The result agrees with the statement of Das (2022); and Anjani et al. (2022) that carrots can be utilized as a material coating; carrot extracts can be used to develop UV-blocking coatings for textiles, plastics, and construction materials, helping to prevent degradation caused by prolonged sun exposure. Moreover, in the study by Gupta (2013) of aloe vera's anti-solar properties, it exhibits antioxidant activity, which allows it to absorb ultraviolet rays in both UVA and UVB regions.

SUMMARY

The study investigated the ultraviolet (UV) blockage efficiency of films infused with aloe vera and carrot extracts at different concentrations. Three treatments were tested: T1 (50 mL extract), T2 (70 mL extract), and T3 (100 mL extract). Results showed that T3 had the highest UV blockage efficiency at 84.09%, categorized as "Excellent," while T1 had the lowest at 65.79%, classified as "Moderate." Comparisons with control samples revealed that the positive control (laminated polyester film) blocked 71.22% of UV radiation, whereas the negative control (pure polyvinyl alcohol) had only 35.25% efficiency. These results indicate that films containing aloe vera and carrot extracts significantly enhance UV protection compared to the negative control and offer similar protection to commercial UV-blocking materials. Statistical analysis using ANOVA and Tukey's HSD test confirmed that the treatments significantly differed from the negative control but showed no significant difference when compared to the positive control.

The findings align with previous research, which highlights the UV-absorbing properties of aloe vera and carrot extracts. Studies suggest that aloe vera and carrot extract can be used in coatings for textiles, plastics, and construction materials to prevent UV-induced degradation. Additionally, aloe vera has anti-solar properties, absorbing both UVA and UVB rays and exhibiting antioxidant activity that helps reduce sun damage. These results suggest that films infused with aloe vera and carrot extracts could be an eco-friendly alternative to synthetic UV-blocking materials, offering strong UV protection while utilizing natural, biodegradable components.

CONCLUSIONS

After a thorough investigation of the variables of the study, the following conclusions are drawn:

1. The formulated polyvinyl alcohol (PVA) films with aloe vera and carrot extracts exhibit significant UV-blocking properties. Higher extract concentrations resulted in greater UV protection, with T3 (100 mL extract) achieving 84.09% blocking efficiency, classifying it as "Excellent" in UV protection.

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2. The performance of the UV-blocking films is directly affected by extract concentration. Based on the Tukey HSD post hoc test, T3 was significantly different from the negative control ($p = 0.000$), which implies superior UV-blocking ability. T1 and T2 did not significantly differ when compared with T3 or the positive control, reflecting poorer blocking efficiency. This emphasizes that only higher concentrations (T3) yield significantly improved UV-blocking performance, validating the importance of optimizing plant extract content for enhanced protection.
3. The application of synthetic UV-blocking films is still prevalent because synthetic films have a high potential for UV protection. Commercial films are effective; this study confirms that T3 (100 mL extract) is as effective as the commercial film with an 84.90% efficiency in UV blocking, classified as "Excellent" in UV blocking efficiency. This indicates that natural plant extracts can serve as effective, eco-friendly substitute agents for UV protection when formulated to a high level.

RECOMMENDATIONS

Based on this study's findings, several recommendations are proposed to enhance the development, application, and future research on UV-blocking films using aloe vera and carrot extracts:

1. The Department of Trade and Industry officials (DTI) should monitor businesses to prevent further ultraviolet damage and explore the potential of using aloe vera and carrot extracts as natural ultraviolet (UV) blockers in films. Developing these films could provide effective UV shielding while also appealing to consumers who prefer natural and biodegradable materials. Additionally, DTI should investigate the cost implications and market viability of commercializing these films compared to synthetic UV blockers.
2. The Department of Science and Technology officials (DOST) should support research institutions in developing aloe vera and carrot extracts as natural ultraviolet (UV) blockers in films. DOH should establish regulatory standards for clinical studies on the efficacy and safety of these natural extracts when used in packaging applications, window films, and protective coatings. Furthermore, DOH should collaborate with companies and research institutions to fund innovations incorporating these plant-based UV blockers into cosmetic, medical, and food packaging applications to ensure consumer safety.
3. Packaging manufacturers should study the potential of aloe vera and carrot extracts as natural UV blockers in films. These plant-based compounds help shield products from harmful ultraviolet rays, particularly in industries where light-sensitive items—such as food, cosmetics, and pharmaceuticals—require UV protection. Conducting further research on how these extracts perform in commercial packaging could promote eco-friendly and sustainable packaging solutions, aligning with growing consumer demand for safer, non-toxic, and biodegradable alternatives.
4. Health-conscious consumers should focus on ingredient transparency and consider using natural alternatives like aloe vera and carrot extract-based products. These extracts contain bioactive compounds that block UV rays, helping to protect the skin from sun damage while reducing exposure to synthetic chemicals, by integrating the films into window films and similar items. Choosing products formulated with plant-based UV blockers allows consumers to prioritize both health and environmental sustainability.
5. This study serves as a foundation for future researchers by providing valuable data on the UV-blocking potential of aloe vera and carrot extracts in films. Researchers should further explore the long-term stability of these extracts, investigating whether environmental factors such as humidity, heat, and prolonged sun exposure affect their effectiveness. Additionally, studies should assess the mechanical and aesthetic properties of these films, including flexibility, durability, and transparency, to optimize their real-world applications. Future researchers are also encouraged to increase the number of samples to enhance the reliability and statistical significance of the findings, ensuring more comprehensive conclusions on the effectiveness of these natural UV-blocking films.

APPROVAL SHEET

This Study Entitled **"Aloecare: Aloe Vera (**Aloe Vera (L.) Burm. F.) **and Carrot** (Daucus Carota 'Ss35') **Extract as Natural Ultraviolet Blockers in Films"** Prepared And Submitted By **Arellano, Cherie Mae Lizzette A., Brar, Anmolpreet S., Bello, Prince Louise B., Enad, Katlyn Jane M., Engyo, Glydel A., Flores, Franz Xia Jean M., General, Arhem V. Jr., Rasheed, Dohah P., Salahuddin, Ana Althea D.** In Partial Fulfillment of the Requirements in the Practical Research is Hereby Accepted.

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