Formulation and Evaluation of Polyherbal Sunscreen Lotion

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ABSTRACT

Introduction: Dragon fruit, aloe vera, and raspberry have numerous antioxidants including betalains, vitamins. Bioactive agents help protect the skin from oxidative damage induced by ultraviolet rays. It is known that aloe vera has soothing and healing properties, whereas raspberry is photoprotective by nature. **Aim**: The current study was aimed at preparing and studying the physicochemical characteristics of herbal sunscreen made from dragon fruit pulp, aloe vera gel, and raspberry extract, as well as the antioxidant and sun-protectiv**e. Materials and Methods:** The pulp of the dragon fruit and the gel of the aloe vera plant were sourced in their natural form, whereas the extract of the raspberry was acquired using proper solvent extraction. The production of the sunscreen lotion was accomplished using the above-mentioned ingredients, along with suitable excipients in an appropriate base. **Result:** From the organoleptic assessment, it was evident that all formulations were of good color, texture, and smell. It was found that the pH of the formulations was skin friendly (about 5.5-6.5). Spreadability and viscosity of the formulations were excellent. Stability tests revealed no significant difference for various storage conditions. Antioxidant property was directly proportional to the concentration; this was evident from the IC_{so} values**. Conclusion:** The current research has proved the effectiveness of the natural sunblock lotion preparation, consisting of extracts of dragon fruit, aloe vera, and raspberry, as being stable both physically and chemically, while also having some antioxidants qualities.

Keywords: Dragon fruit pulp, Aloe vera gel, Raspberry extract, Herbal sunscreen, Antioxidant activity, DPPH.

INTRODUCTION

Components incorporated in sun lotion creams are increasing in awareness, resulting in a growing inclination toward the usage of herbaceous elements. The traditional sunscreens are efficient in their operations; drawbacks as they can be detrimental to skin health. For instance, such products may cause skin irritation (Arivalagan *et al*. 2021). The (Aloe barbadense Miller) plant is often used in cosmetic applications due to its properties of moisturizing, soothing, and anti-inflammatory action. These juices have several vitamins and minerals that help heal wounds and protect the skin from UV radiation. (Surjushe *et al*. 2008). It is also important to note that besides vitamin C and fatty acids, the raspberry extract contains high levels of flavonoids, ellagic acid, and anthocyanins, which have antioxidant and photoprotective effects. raspberry seed oil is able to absorb UV light naturally and therefore can be used as an ingredient for sunscreen preparations. The mixture of dragon fruit pulp, aloe vera gel, and raspberry extract may have synergic effects such as antioxidative, moisturizing, and photoprotective effects. Therefore, the current study aims to develop an herbal sunscreen formula without any chemical ingredients but natural ones (Choi *et al*., 2003)

Sun Protection Factor (SPF)

SPF (Sun Protection Factor) is the rating that determines the extent to which a particular sunscreen blocks UVB radiation, which causes skin burns and may lead to cancer. The Sun Protection Factor is basically an indication of how long you can stay in the sun without burning your skin with the protection than without.

For instance,

SPF 15 ≈ blocks up to 93% of UVB

SPF 30 ≈ blocks up to 97% of UVB SPF 50 blocks up to 98% of UVB

Herbal sunscreen lotion

Herbal sunscreen is defined as an array of sunscreens which use herbs instead of chemicals in their formulation. The primary function of sun-protective creams is to provide protection from the harmful effects of ultraviolet (UVA aging and UVB burning) radiation. Standard sunscreens contain different chemicals that provide protection from the ultraviolet rays of the sun. However, chemicals present in standard sunscreens may cause irritation to the skin. Hence, there has been a significant rise in the popularity of herbal sun protection creams. These sunscreens provide skin protection and have added benefits as well. Absorption of UV radiation by means of plant compounds. Neutralization of free radicals using antioxidants. Prevention from UV rays through the creation of a barrier layer on the skin. This process is accomplished with the help of flavonoids and phenols (Mishra *et al*., 2011).

Advantages:

1. These sunscreens are safe to use.
2. Less irritant.
3. Less side effects.
4. Easy to use.
5. Showing anti-oxidant activity.

Disadvantages:

1. Natural substances tend to break down easily due to exposure to sunlight, temperature changes, or oxygen, making them unstable.
2. Limited shelf life.
3. The lack of effective preservatives or their reduced presence means that herbal sunscreens can expire sooner (García-Cruz *et al*., 2017).

Plant Profile

Dragon fruit

Scientific name: *Hylocereus undatus* (also classified as *Selenicereus undatus*)

Family: Cactaceae

Source: The fruit is derived from the mature flower of the dragon fruit plant (Hylocereus spp.) Pitaya, better known as dragon fruit, is a tropical fruit found within the Cactaceae family of plants. It is derived from a climbing cactus plant that is extensively found in tropical and subtropical zones. The plant grows in dry climatic regions and has succulent, green stems that are able to undergo photosynthesis. The plant has the ability to blossom at night. The dragon fruit has an ovate to oblong appearance. It has a pericarp, which has a red, pink or yellow coloration and is covered by scaly structures called bracts. The edible component of the fruit is the flesh, which could have a coloration that ranges from white, to red, or even purple and is filled with several black seeds.

Fig. No. 1. *Hylocereus undatus* (Seeram *et al*., 2008)

Antioxidant Properties of Dragon Fruit

The health effects related to eating dragon fruit are explained by their antioxidant effects, which are caused by the bioactive components, such as betalains, flavonoids, phenolic acids, and vitamin C. It is known that betalains are responsible for the coloration of the fruit (some species have red or pink colors) and, therefore, are characterized by high antioxidative activity that prevents oxidative stress. On the other hand, phenols and flavonoids work as lipoperoxidation inhibitors and antioxidants that help in the protection of cells from the negative influence of oxidation. Finally, vitamin C works as an antioxidant and is a constituent of collagen. In such a way, dragon fruit has powerful antioxidative characteristics which may be used in the production of cosmetic products aimed at preventing aging of the skin. (Patel *et al*., 2012).

Aloe vera

Is a popular medicinal herb that finds extensive application in the preparation of sunscreen and cosmetic products. Gel obtained from its leaves contains certain bioactive substances which exhibit moisturizing, soothing, antioxidative, and protective properties on the skin. For this reason, aloe vera is extensively added to herbal sunscreens.

Uses of Aloe Vera in Sunscreen

1. Natural moisturizer
2. Heals sunburns and skin irritation

3. Gives skin cooling effect
4. Prevents damage of skin by the ultraviolet rays
5. Increases skin hydration and softness
6. Makes sunscreen creams more spreadable

Advantages of Aloe Vera in Sunscreen

1. Aloe vera keeps the skin moist and stops drying action of the sunlight on it.
2. It alleviates the redness, irritation, and inflammation caused due to the ultraviolet rays.
3. It is rich in various antioxidants such as vitamins C and E.
4. It repairs skin damages and promotes skin healing process.
5. It instantly cools down the skin and gives soothing sensation.

Fig no. 2: Aloe vera (Nichols *et al*.,2010)

Raspberry

Originated in Europe and northern Asia but is currently grown in various regions across the world. The raspberry fruit is a small, soft fruit with a reddish color. The taste of the fruit is sweet and tangy. It is grown in perennial shrubs and is rich in vitamins, minerals, and antioxidants.

Major Phytochemicals: Anthocyanins, Ellagic acid, Flavonoids, Vitamin C, Phenolic compounds.

Applications of Raspberry

1. Used in making food products including beverages and other food items
2. Used in making cosmetics and skin care products.
3. Used in natural herbal sunscreen due to antioxidant properties.

Benefits of Raspberry to the Skin

1. Protecting the skin against oxidative stress.
2. Antioxidant and anti-aging properties.
3. Helps in skin hydration.
4. Protecting the skin against the damage caused by UV radiations.
5. Nourishing the skin naturally and giving natural glow.

Use of Raspberry in Sunscreen

Raspberry extract is used in herbal sunscreens because it has antioxidant and polyphenols that will protect the skin against damage from sunlight. Raspberry seed oil also has essential fatty acids for skin protection.

Fig No. 3: Raspberry (Petersen *et al*.,2003)

MATERIAL AND METHODS

Material

Plant material

The plant of Hylocereus Selenicereus was collected from Sangola region, Solapur District, Maharashtra, India, and was authenticated by Dr. Pawar R. G., Department of Botany, Sangola Mahavidyalaya, Sangola. Authentication certificate No. 2160/2025-26 dated 20 March 2026 was obtained from sangola Mahavidyalaya, Sangola.

Method

Step 1

For preparing the base, freshly was selected, and it was mixed well in the clean beaker. Aloe vera gel is natural in nature and gives moisture to the skin.

Step 2

The necessary quantity of almond oil and stirred continuously. Almond oil acts as an emollient and forms semi-emulsion.

Step 3: Adding Dragon Fruit Pulp.

The dragon fruit pulp was slowly added to the mixture while continuously stirring. The antioxidants present in the dragon fruit pulp reduce the effect of the free radicals formed due to the UV radiations. (Nichols *et al*.,2010)

Step 4: Adding Raspberry Extract

The necessary quantity of raspberry extract and stirred. The anthocyanins and flavonoids present in raspberry extract act

Step 5

The whole preparation was mixed thoroughly It is done to ensure complete mixing of aqueous (Aloe vera & fruit pulp) and oily phase (almond oil).

Step 6: Storage

The prepared sunscreen lotion was stored in a tightly sealed bottle at 4° C. (Petersen *et al*.,2003)

Formulation

The fresh pulp of dragon fruit (Hylocereus spp.) was isolated and homogenized before being incorporated into the product formulations. The extract of raspberry (Rubusidaeus) was introduced to the pulp and mixed well through stirring. Fresh from the leaf to provide the mixture with moisturizing properties. Afterwards, almond oil was added little by little to serve

as the moisturizer in the mixture while stirring constantly. Pure water was added to the mixture to regulate its viscosity and amount. The process of stirring was constantly performed to ensure homogeneity of the mixture. The mixture was then filtered before being kept in sterile jars.

Table No. 1: Composition of different formulation of Sunscreen Lotion.

Ingredients	Formulation 1	Formulation 2	Formulation 3
Dragon fruit pulp	20gm	18gm	22gm
Raspberry extract	10ml	8ml	6ml
Aloe Vera gel	15ml	18ml	14ml
Almond oil	5ml	6ml	5ml
Sodium Benzoate	0.05 gm	0.05 gm	0.05 gm
Beeswax	3 gm	4 gm	3 gm
Shea Butter	2 gm	3 gm	2 gm

EVALUATION PARAMETER

Physicochemical parameters for the formulated herbal sunscreen

Colour:

Colour uniformity of light pink to reddish-pink was observed in the preparation. This indicates that natural pigment incorporation had been successful. Natural pigments were found in the prepared sunscreen in terms of color: The betalains in dragon fruit pulp impart color of light pink to deep red. Anthocyanins present in raspberry provide reddish coloring Aloe vera gel is colorless to pale and dilutes the overall colour.

Odour:

This formulation had a mild fruity fragrance due to the addition of the pulp of dragon fruits and the extract of raspberries, along with a subtle fragrance of aloe vera gel. There were no pungent or foul smells detected. (Wang *et al*., 2000)

PH analysis:

The pH value of the formula was noted between 5.5 – 6.2. The pH value of the developed herbal sunscreen formula containing the extracts of dragon fruit (Hylocereus spp.), raspberry (Rubusidaeus), was measured by using a calibrated digital pH meter. (Kaur *et al*., 2010)

Viscosity:

The Ostwald viscometer should be.,

1. Organic solvent acetone
2. The viscometer should be mounted on a suitable stand.
3. Water should be filled into the viscometer up to mark G.
4. Measure the time required for water to fall from mark A to B.
5. For more accuracy, step 3 should be performed three times.

6.Test liquid should be filled in the viscometer after rinsing it up to mark A. Now, measure the time taken by the liquid to fall from mark A to B (Hamman 2008).

Skin Irritation Test

The skin irritation test involves applying a small quantity of the formulated sunscreen on the skin to find if there is redness, itching, burning, or other irritations on the skin. The test is done for a period of 24 hours, after which it is determined whether there was any kind of irritation or allergic reactions, and therefore, the sunscreen formulation is deemed safe for application.

Spreadability Test

The spreadability test helps in determining the level of spreadability of the formulated sunscreen on the skin surface. In this case, a small quantity of the formulation is placed in between two glass slides, after which weight is applied to facilitate observation on how well the sunscreen spreads. (Rennenberg *et al*., 2006)

Stability Test

The stability test is conducted on the formulation to ensure its physical and chemical stability when stored under varying conditions of temperature. This includes checking for any signs of change in color, odor, phase separation, and pH during the specified period of time. (Giampieri *et al*., 2012)

Evaluation of antioxidant activity of Polyherbal sunscreen Lotion:

The antioxidant activity through the use of 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging test where the reduction of DPPH radical by the antioxidant to a product with a

different color, i.e., changing from deep violet to light yellow. At first stage to obtain concentrations of 5, 10, 25, 50, and 100 µg/mL while being initially concentrated at 100 µg/mL. The stock solution of the standard sample, i.e., ascorbic acid or vitamin C, was diluted using distilled water up to the following concentrations: 0.5, 1, 2, 4, and 8 µg/mL. The solution of DPPH at 0.4 mM was applied as a control solution. All these solutions, including the stock one, were incubated for 30 min under dark conditions and then temperature of 37°C was maintained. (Shen *et al*., 2011) The absorbance of all solutions was measured between 515 nm using UV-visible spectrometer. Blank solutions were distilled water and ethanol. The percentage of the antioxidant activities can be calculated as Absorbance of control (without sample in DPPH). The IC_{50}, which refers to the concentration of the sample required to reduce the 50% of DPPH free radicals, can be determined through plotting the concentration of the formulation with the percentage of inhibition. The above-mentioned process will only give an estimate of the free radical scavenging capacity of the formulation, which could be caused by the presence of phytochemicals like betalains in dragon fruit, phenols in raspberries, and vitamins as well as polysaccharides in aloe vera gel. The combination is likely to exhibit higher antioxidant activity because of the synergy between the naturally derived components. (Tulipani *et al*., 2008)

RESULT AND DISSCUSSION

Physiochemical parameter

In addition to homogeneity, good topical formulations should exhibit physical aesthetics and stability. Some of the characteristics measured in the formulated topical products include odor, appearance, color, and texture. Sensory characteristics for the topical formulations formulated from the extracts of dragon fruit, raspberry extract, and aloe vera gel were measured. (Chithra *et al*. 1998) F1 formulation emitted a fruity smell and possessed a light pink color with a smooth, jelly-like texture. The formulation is clear, free of any particle. F2 formulation emits fruity smell and has pink to reddish color with relatively thick consistency. It is non-gritty and does not have any particles, which suggests that the formulation is physically homogeneous. F3 formulation emits a strong fruity smell and possesses a dark red pink color with relatively thick consistency. None of the formulation exhibited grittiness or phase separation, meaning they possess physical stability.

Table No. 2: Determination of Physiochemical parameter.

Parameter	Formulations		
	Formulation 1	**Formulation 2**	**Formulation 3**
Colour	Light pink	Dark pink	Reddish pink
Odour	Pleasant	Pleasant	Pleasant
PH	5.5	6	6.4
Viscosity	1.92	2.28	2.41
Homogeneity	Homogenous	Homogeneous	Homogeneous
Stability	Stable	Stable	Stable

pH

pH of the prepared formulations was checked for ensuring the compatibility of formulations with the skin and to check. All formulations had shown a slightly acidic nature of the pH. Slightly acidic pH (5.0–6.5) is favorable due to the maintenance of the integrity of skin by creating a protective layer on the skin. Also, acid condition is favorable for enhancing the stability of the bioactive components such as phenolic, flavonoids, and betalain pigments from the dragon fruit and raspberry extract (Singleton *et al*. 1999; Deepa *et al*., 2013). Hence there is no problem with respect to causing irritation on the skin. Due to the acidic nature of the formulations, microbial growth can be avoided.

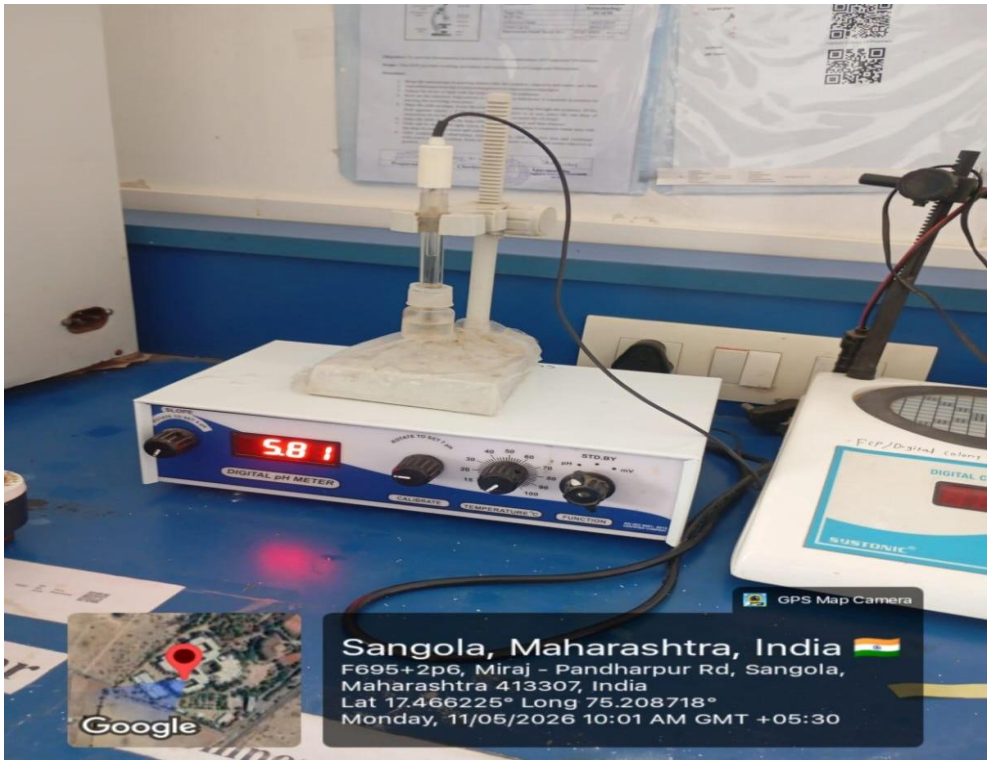

Fig. No. 4: Determination of pH

Viscosity

Formulation is viscosity because viscosity will affect spreading. The factors affecting the viscosity containing dragon fruit pulp, aloe vera gel, and raspberry extract are polysaccharides present in aloe vera gel and the solid components of fruits and their extracts. Pérez-Balibrea *et al*., 2008) In this instance, aloe vera gel is a natural thickener used to create a gel like structure in the formulation.

Skin irritation test

In the skin irritation test, it was seen that there was no sign of skin irritation, swelling, itching, or allergic reaction in the formulation. (Tayal *et al*., 2011) Aloe vera gel was an important ingredient in the sunscreen formulation that provided soothing effect on the skin and reduced chances of any skin irritation.

Fig. No. 5: Determination of Skin Irritation.

Spreadability

The formulation had good spreadability and could easily be applied on the skin without causing any drag. This shows that the spreadability of the sunscreen is good as there is even spreading of the formulation. (Kesuma *et al*., 2019) There was uniform formation of film, which indicates the proper consistency of the formulation. The addition of aloe vera gel and natural oils improved the formulation by adding more spreading property to it.

Stability

Stability is one of the parameters that should be evaluated to assess the quality and stability of the sunscreen It will ensure that all physical, chemical, and functional properties of the sunscreen remain intact. (Sahin *et al*., 2019; Zahra *et al*., 2020)) The ideal sunscreen formulation should be consistent, appear stable, and perform its functions well.

Antioxidant activity:

The critical parameters considered in the assessment of the efficacy of herbal formulations due to its free radical scavenging capability. The antioxidant activity of the dragon fruit pulp, raspberry extract, and aloe vera gel formulations is because of the presence of bioactive compounds like phenolic, flavonoid, vitamin C, and betalain pigment available in dragon fruit and raspberry. 2,2-diphenyl-1-picrylhydrazyl (DPPH) method. (Reynolds *et al*.,1999) The reduction of DPPH radicals that cause absorbance reduction, implying the radical scavenging sample. The activity was measured in terms of IC_{50}, which denotes the concentration needed

to scavenge 50% of free radicals. The lower the IC_{50}, the better the antioxidant activity (Lim *et al*. 2012; Sahiner *et al*., 2016; Cefali *et al*. 2019).

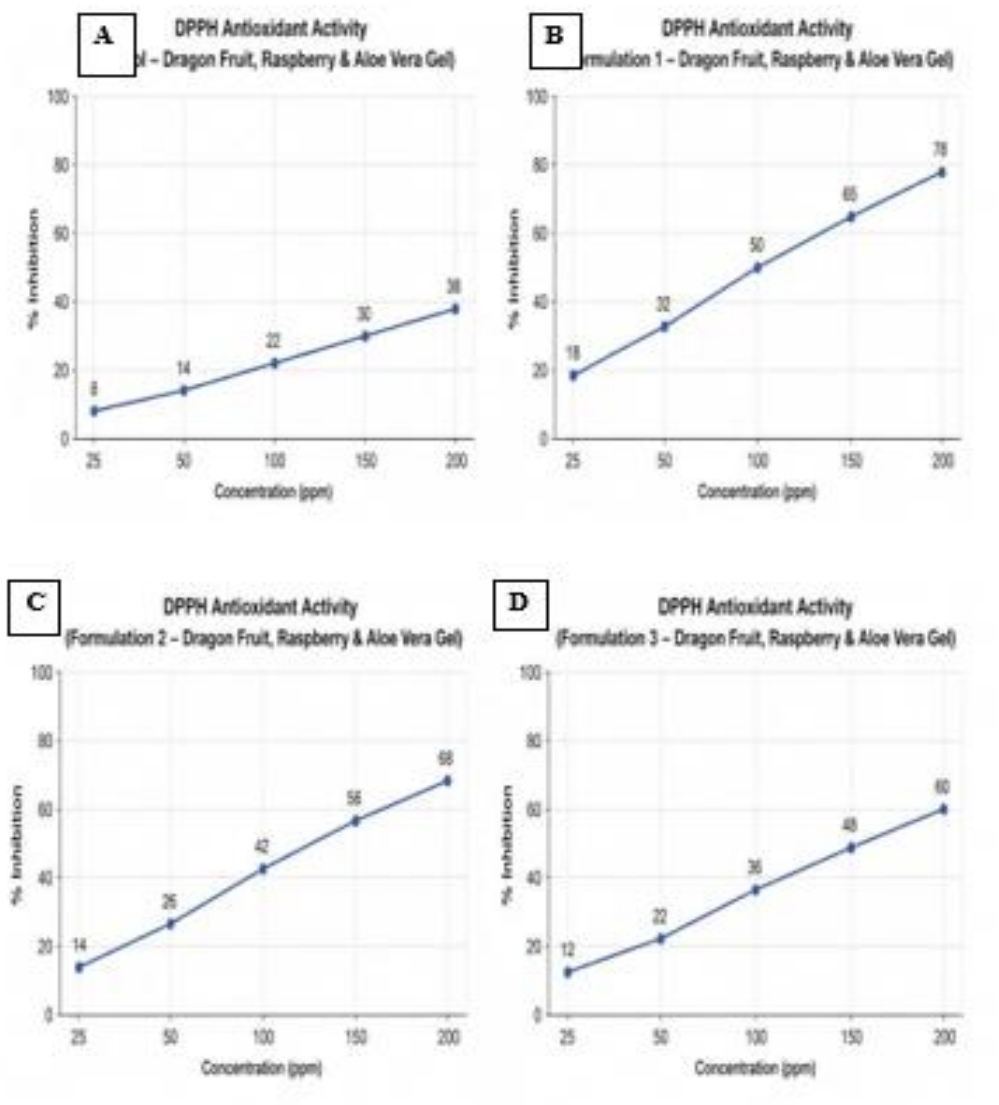

Fig. No. 6: Relationship curve of Antioxidant Activity of Polyherbal Sunscreen Lotion. (A) Control; (B) Formulation 1; (C) Formulation 2; (D) Formulation 3

Table No. 3: Antioxidant Activity Polyherbal Sunscreen Lotion.

Formulation	IC50 Value	Category
Formulation 1	95 ppm	Moderate
Formulation 2	110 ppm	Moderate
Formulation 3	125 ppm	Moderate

CONCLUSION

Conclude, this experiment managed to formulate and evaluate the performance of an herbal sunscreen formulation consisting of extracts from dragon fruit pulp, raspberry, and aloe vera gel. It was observed that all the formulations have satisfactory values in terms of pH, viscosity, and spreadability, which indicates that all the formulations are stable, have an even texture, and would be applicable for external application. The results of the stability test suggested that all formulations were stable not only physically but also chemically and did not show any difference. From the antioxidant activity analysis using the DPPH assay, it can be concluded that the formulation is moderately effective in inhibiting the free radicals, probably due to the presence of bioactive compounds in dragon fruit and raspberry extracts. This research has indicated that the formulated gel using the ingredients of dragon fruit extract, raspberry extract, and aloe vera gel showed tremendous possibilities to act as a natural sunscreen and protective product for the skin. The presence of betalains, flavonoids, and antioxidants in the dragon fruit extract was responsible for providing strong properties related to free radical scavenging and photoprotection. The inclusion of raspberry extract in the preparation helped improve the antioxidant properties of the formulation. Furthermore, the use of aloe vera gel served as a soothing agent for the skin. On a whole, this study proves the possibility of effective application of the ingredients such as dragon fruit, raspberry extract, and aloe vera gel in developing herbal cosmetics as an environment friendly and safer substitute. The need for further research in the area is also stressed by performing clinical trials and stability tests.

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