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Development of an anti-acne facial mask based on polyvinyl alcohol

Desenvolvimento de uma máscara facial antiacne a base de álcool polivinílico

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ABSTRACT
The objective of the present study was to develop a facial mask using polyvinyl alcohol as a film-forming agent with an anti-acne active ingredient (*Punica granatum*/pomegranate extract). Formulations with varying concentrations of polyvinyl alcohol were prepared using glycerin and sorbitol as wetting agents. Organoleptic tests, drying tests, film formation assessments, pH measurements, temperature stress, and freeze-thaw cycles were conducted. The formulation containing 10% polyvinyl alcohol and a combination of glycerin and sorbitol demonstrated the best results and was selected for the addition of the active ingredient. The formulations remained stable at room temperature for 60 days, dried on time, and formed a removable film. The pH levels of the facial masks were found to be compatible with the skin's pH. Ultimately, an ideal anti-acne facial mask formulation was developed, efficacy and safety tests being recommended prior to commercialization of the product.

Keywords: Acne vulgaris. Cosmetics. Face masks.

RESUMO
O objetivo do presente trabalho foi desenvolver uma máscara facial utilizando o álcool polivinílico como agente formador de filme com um princípio ativo antiacne (extrato de *Punica granatum*/*romã)*. Foram obtidas formulações com diferentes concentrações de álcool polivinílico utilizando glicerina e sorbitol como agentes umectantes. Foram realizados testes organolépticos, teste de secagem, formação de filme, medição de pH, estresse de temperatura e ciclos de congelamento-descongelamento. A formulação com álcool polivinílico a 10% e mistura de glicerina e sorbitol apresentou melhor resultado, sendo a escolhida para incorporar o princípio ativo. As formulações apresentaram-se estáveis em temperatura ambiente durante 60 dias, todas secaram em tempo hábil e foram capazes de formar filme removível; o pH das máscaras faciais foi compatível com o pH cutâneo. Ao final do trabalho se obteve uma formulação de máscara facial antiacne ideal sendo recomendado a realização de testes de eficácia e segurança para a posterior comercialização do cosmético.

Palavras-chave: Acne vulgar. Cosméticos. Máscaras faciais.

INTRODUCTION

Facial masks have been used since ancient times, primarily by women, to enhance their appearance. Today, the popularity of skincare culture has brought back the old reasoning behind using facial masks. More and more people, regardless of gender, are seeking to improve the health and appearance of their skin, recognizing its importance for personal health and its psychosocial effects. In recent years the use of facial masks of various formulations and functionalities has significantly increased due to their immediate effects, accessibility and ease of application and removal.[1]

Facial masks may contain bioactive ingredients that offer different benefits, such as moisturizing, reducing sebum, eliminating blackheads, and fighting acne. The facial mask industry growth is attributed to its versatility in incorporating diverse active ingredients for various purposes. These masks can be categorized based on the base used, such as waxes, gums, plastics, vinyl resins, hydrocolloids, and clays.[2]

As research continues to advance in terms of formulation technologies, there is a growing focus on finding natural bioactive ingredients that are safe for both humans and the environment. *Punica granatum*, commonly known as pomegranate, exemplifies this renewed interest. Traditionally used in medicine for treating various conditions, scientific studies have confirmed its efficacy as a rich source of bioactive compounds. Its ability to combat acne is particularly noteworthy, as acne can significantly impact an individual's quality of life.[3,4,5,6,7]

Acne vulgaris is a chronic, multifactorial skin condition characterized by inflammation and blockage of hair follicles and sebaceous glands. It affects about 9% of the global population and typically appears in areas with a high concentration of sebaceous glands, like the face. Symptoms include open and closed comedones, papules, pustules, nodules, and cysts. Acne can be triggered by genetic predisposition, stress, diet, smoking, and hormonal imbalances, making it more common in adolescents and adults over 25, especially women.[4,8]

Understanding the increased sensitivity of sebaceous glands to androgen hormones and the overexpression of TLR 2 and 4 receptors, which trigger an inflammatory response to acne-causing microorganisms, is crucial in managing acne. In addition to physical lesions, acne can cause redness, hyperpigmentation, and scarring.[9,10]

The pathogenesis of acne is not yet completely understood; however, it involves four main factors: increased sebum production by the sebaceous glands, mainly due to hormonal influence; excess keratinization of pilosebaceous follicles; changes in normal bacterial colonization, with the growth of opportunistic pathogens such as *Staphylococcus aureus*, *Staphylococcus epidermidis*, and especially *Cutibacterium acnes*, which are often associated with superficial infection of the sebaceous glands; and skin inflammation.[6,7]

Acne vulgaris does not pose a serious threat to physical health. However, in addition to the clinical symptoms that cause discomfort to patients, the most worrying aspect, as mentioned in studies, is the psychosocial impact. It is widely documented that acne has an adverse effect on the social life and self-image of affected individuals. This occurs due to the physical consequences of acne, such as pigmentation and scars, which can generate feelings of frustration, embarrassment, and anguish. As a result, mental health can be affected, leading to psychological disorders such as insecurity, anxiety, and depression.[9,11]

In recent years, the importance of psychosomatic disorders and their management in patients with dermatoses has gained increasing prominence. This is demonstrated by the increase in the number of studies and scientific articles dedicated to this issue. Acne rashes on visible areas of the body can adversely affect a person's psychological health. According to psychological

research, 80% of teenagers consider acne to be the least attractive feature in a person. Additionally, young women are particularly likely to experience psychological disorders, including depression, due to acne. The presence of acne on visible areas of the skin can trigger dysmorphophobia, a condition in which a person has a distorted perception of his/her physical appearance, imagining non-existent external deformities.[42]

The commonly adopted therapeutic approach to treat acne involves the topical use of comedolytics, which help open or break up skin lesions and also regulate oil production. Additionally, antibiotics are often prescribed. However, both treatments can cause harmful side effects, such as skin irritation and peeling. Furthermore, the overuse of antibiotics is a concerning issue in modern medicine due to the development of antimicrobial resistance.[6]

Punica granatum is a worldwide known species of pomegranate fruit belonging to the Lythraceae family (formerly Punicaceae) and the genus Punica.[3]

The pomegranate fruit can be divided into three parts: the pericarp, which includes the thick peel and internal membranes containing flavonoids, tannins, anthocyanins, and organic acids, making up about 50% of its weight; the juice, consisting of amino acids, anthocyanins, and flavonoids; and the seeds, which contain oil rich in polyunsaturated fatty acids like punic acid.[12,13]

The bioactive composition of pomegranate consists mainly of various phenolic compounds found in its different parts, including hydrolysable tannins, anthocyanins, ellagic acid, and punic acid. Pomegranate also contains complex polysaccharides and minerals like magnesium, calcium, and phosphorus. Scientific studies have shown a wide range of pharmacological effects associated with pomegranate, such as anti-inflammatory, antioxidant, antilipoperoxidative, antibacterial, and antitumor activities. Research has also explored pomegranate's potential in treating conditions like cardiovascular diseases, diabetes, sore throat, diarrhea, erectile dysfunction, obesity, and cancer.[6,7]This work focuses on the anti-inflammatory and antibacterial activities of pomegranate.[5]

Phenolic compounds can be extracted from the pomegranate peel using the solid-liquid extraction technique. Ethanol is an efficient solvent for extracting phenolic compounds and is considered safe for human health and the environment. Therefore, ethanolic pomegranate extract was chosen for the formulation. Pomegranate extract is beneficial for acne treatment as it exhibits bacteriostatic action, reduces sebum production, decreases keratinocyte proliferation, and has anti-inflammatory effects.[7,14]

Facial masks have been used since ancient times for skin cleansing and rejuvenation. They should be applied topically to the face and neck, excluding the eye and mouth area. Facial masks can be classified based on their properties, application technique, rheological behavior, and skin effects. Modern cosmetic facial masks contain innovative ingredients and offer immediate effectiveness. They promote cell renewal, skin revitalization, cleansing, toning, moisturizing, and overall well-being.[1,15,16]

The technology that comprises a facial mask includes a base, active substances, preservatives, antioxidants, dyes, and essences. The facial mask functions as a pseudoplastic non-Newtonian fluid (its viscosity decreases with applied shear force) to make application easier and must be safe for the skin with an inert base.[2]

Facial masks are categorized into different systems based on their ingredients: waxes - a blend of waxes with a suitable melting point, typically recommended for dry skin to help regulate epidermal hydration; gums - made from gum latex, forming an occlusive film when dry, providing hydration suitable for all skin types; vinyl resins - peel-off masks made from film-forming agents like PVA or polyvinyl acetate,

creating an occlusive film suitable for all skin types; hydrocolloids - gel masks made from hydrogels like carboxymethylcellulose, ideal for sensitive skin with refreshing and calming properties; and clays - where the mask's function depends on the clay type used, for example, green clay is recommended for acne treatment.[1,2,17]

Various options are available on the cosmetic formulations market to cater to different skin types, age groups, and specific needs such as hydration, oil control, blackhead removal, and rejuvenation. Masks come in different forms, including sheet masks, cream masks, jelly masks, and peel-off masks.[17]

The main advantages of masks over traditional creams are their practicality, accessibility, quick action due to higher concentrations of active ingredients, and increased absorption from skin occlusion. Masks can also provide a relaxing experience for the user with unique textures and colors, and their removal can be satisfying, especially with film-forming masks. However, it's important to note that facial masks should complement a skincare routine and not be the sole focus.[17]

The vinyl resin-based facial mask, commercially known as a peel-off mask, is named for its ability to be peeled off and removed. This type of mask is classified as such because it is applied as a thin and uniform layer, dries to the consistency of plastic film, and forms a film that can be removed after complete drying.

The most commonly used film-forming agent for this type of facial mask is polyvinyl alcohol (PVA). PVA is a synthetic polymer that typically appears either as a white or yellowish powder, or translucent granules, with no odor. The synthesis of PVA involves two consecutive reactions of vinyl acetate, polymerization, and hydrolysis. While it is soluble in water and some organic solvents, increasing the temperature is often necessary to break inter and intramolecular hydrogen bonds, thereby increasing solubility. Once dissolved, PVA remains stable in aqueous solution, even at room temperature. PVA is versatile, serving various industrial applications as a stabilizer, film former, in packaging and adhesive manufacturing, as a non-ionic surfactant, thickener, emulsion stabilizer, among other uses.[2,18]

PVA exhibits good resistance to solvents and excellent oxygen barrier properties, making it an ideal adhesive. Its use in peel-off facial masks is due to its flexibility as a film-forming agent with superior adhesion, ability to increase viscosity in formulations, compatibility with other ingredients, and safety for sensitive and irritated skin.[15,17]

These types of facial masks are easy to apply, dry relatively quickly, allow for sufficient skin contact with active ingredients, and are easily removed, making them more convenient than clay masks, for example.[15]

Therefore, the aim of this study was to develop a facial mask formulation using an effective, affordable anti-acne vinyl resin that is biocompatible and biodegradable. The formulation utilizes PVA as a film-forming agent and *Punica granatum* extract as active ingredient.

METHODOLOGY

DEVELOPMENT OF FACIAL MASKS

The development of facial mask formulations featuring a system based on vinyl resin with anti-acne action was conducted in a teaching laboratory at the Institute of Biological and Health Sciencesof the Federal Rural University of Rio de Janeiro (UFRRJ). All materials were provided by the laboratory. Initially, three formulations were developed using different PVA concentrations: 7%, 10%, and 12%, respectively, to determine the influence of its concentration on the formulations. Subsequently, formulations 4 and 5 were manipulated by varying the type and concentration of glycerin and sorbitolhumectants/plasticizers, while keeping constant the remaining components concentration. After, 50mL of

each formulation were prepared following a standardized method, which involved dispersing PVA in distilled water at 80°C with constant stirring until its complete solubilization. After partial cooling, the humectant and ethyl alcohol were added, and the volume was adjusted to 50 mL with distilled water.

All the prepared formulations were then packaged in transparent containers with screw caps, and quality control tests were conducted, including determining pH and organoleptic characteristics.

The ethanolic extract of *Punica granatum* was selected as the active ingredient for its proven effectiveness against acne vulgaris. The 100% natural pomegranate extract was sourced from Rac Nature company.[7]

FACIAL MASKS QUALITY CONTROL

Organoleptic Tests

Organoleptic tests were conducted in accordance with the Quality Control Guide for Cosmetic Products. To assess the characteristics of the anti-acne facial mask using the sense organs, the color and odor aspects were evaluated. The samples were visually compared at room temperature (25°C) to determine if they maintained their initial characteristics or if any changes like phase separation, precipitation, turbidity, or other noticeable changes occurred. The sample color was compared under natural white light with the initial data. The initial and final odor of the sample were compared directly through smell.[18]

pH Determination

The pH of the samples was determined using a portable digital pH meter (LCD Aquário Lago) previously calibrated with buffer solutions of pH 6.86, 4, and 9.18.

DRYING TIME AND FILM FORMATION

The test was conducted after preparing the facial mask bases (F1, F2, F3, F4, and F5) and the final formulation containing the anti-acne active ingredient. To mimic drying on real skin, approximately 1mL of each sample was spread evenly in circular movements with the fingers, forming a thin layer on the back of two volunteers' hands. Drying time and film formation were monitored.

THERMAL STRESS TEST

After addition of 1mL-samples to an Eppendorf tube, these were heated in a water bath at the ranges 40, 45, and 50 ± 2.0°C. The samples were kept for thirty minutes at each temperature, and the organoleptic characteristics were evaluated at each cycle end to check for possible instabilities. Additionally, the samples were cooled in a conventional refrigerator atthe temperature range of 5.0 to 2.0°C for 24 hours, and at the end, the organoleptic characteristics were evaluated.[19,20]

FREEZE-THAW CYCLE

The samples were subjected to 5.0°C ± 2.0°C for 24 hours, and then placed at room temperature (25°C) for 24 hours, completing one cycle. Analyses were performed before the start of the trial and at the end of the sixth cycle (12 days). The same parameters were used to evaluate the thermal stress test.[20]

RESULTS

HANDLING OF FACIAL MASKS

First, 50 mL of each formulation was prepared, which proved to be sufficient for all tests in the study. The influence of the PVA

concentration on the formulations was analyzed. The literature describes that cosmetic formulations can contain PVA at different concentrations; however, the higher the concentration, the longer the time to solubilize its granules in water, in addition to significantly increasing the viscosity of the solution. In general formulations, the concentration of this polymer is between 5% and 15% w/v. During the experiment, a concentration of 7% PVA was used in formulation 1. This initial concentration did not provide adequate viscosity, resulting in a liquid consistency that flowed quickly, making application difficult and not ensuring good spreadability. Formulation 2 contained10% PVA, resulting in a longer process but guaranteeing good viscosity to the facial mask. In formulation 3, 12% PVA was used, which considerably increased the handling time due to the difficulty in solubilizing the PVA granules. The viscosity of the mask was high, making the filling process and subsequent tests difficult. Therefore, the concentration of 10% was chosen and replicated in the other base formulations (4 and 5). Base formulation 5 was used to incorporate the active ingredient at 5%. Regarding the variation of the wetting/plasticizing agent, the base formulation chosen for incorporating the active ingredient was composed of a mixture of sorbitol and glycerin (3:2). Double-distilled glycerin, also known as glycerol or propanetriol ($C_3H_8O_3$), is a clear, syrupy liquid widely used in cosmetics to improve the appearance of skin and hair. Sorbitol, or glucitol ($C_6H_{14}O_6$), is also a clear and colorless syrupy liquid used in the cosmetic industry as a humectant, plasticizer, emollient, and vehicle.[21,22,23] Due to their characteristics, a mixture of these two plasticizers was used to ensure the mask good viscosity.

FACIAL MASKS QUALITY CONTROL

Organoleptic Tests

The organoleptic characteristics of the developed formulations are outlined in Table 1. The samples were stored at room temperature, and the analysis was conducted at 0, 30, and 60 days. It was observed that the organoleptic characteristics of the formulations remained consistent throughout the testing period. Upon visual inspection, the results showed a uniform appearance, free of precipitates, with a clear and smooth consistency. These characteristics are considered ideal for ensuring attractiveness, ease of application to the skin, and good spreadability of the facial mask. The odor of the formulations remained distinct, with a noticeable alcohol scent from the formulation. In terms of color, formulations 1, 2, 3, 4, and 5 were colorless, while formulation 6 had a yellowish hue due to the pomegranate fluid extract.

Table 1. Determination of the organoleptic characteristics of face masks.

Formulation	Aspect			Color			Odor		
Time (days)	0	30	60	0	30	60	0	30	60
F1	H	H	H	I	I	I	C	C	C
F2	H	H	H	I	I	I	C	C	C
F3	H	H	H	I	I	I	C	C	C
F4	H	H	H	I	I	I	C	C	C
F5	H	H	H	I	I	I	C	C	C
F6	H	H	H	A	A	A	C	C	C

For aspect. H – homogeneous. For color: I – colorless; A – yellow. For odor: C – characteristic.
Source: Author's own work.

pH Determination

Initially, the pH of the formulations was measured using a digital pH meter after 60 days and the following results were collected (Table 2).

Table 2. Determination of pH of facial masks using a digital pH meter.

Formulation	pH
F1	5.72
F2	5.72
F3	5.69
F4	6.01
F5	5.81
F6	5.48

Source: Author's own work

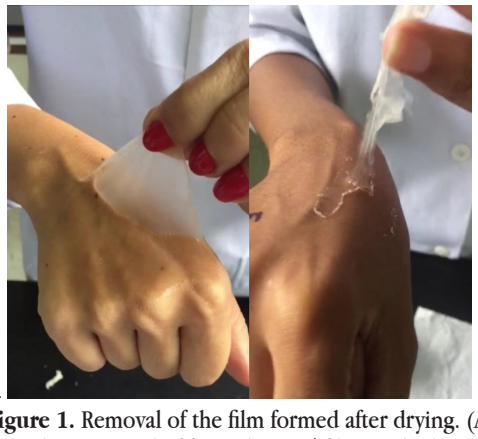
The pH of glycerin (4.8), sorbitol (5.51), and pomegranate extract (4.47) used in the formulations was measured at the same time. This explained the slight increase in pH from base formulations 1, 2, and 3 to base 4 formulation in which only sorbitol was used as a humectant. The formulation with the most acidic pH is 6, which is justified by the use of 5% ethanolic pomegranate extract, the pH of which is 4.47. The pH of cosmetics varies according to the area of application, and the skin pH can vary according to the region of the body, gender, ethnicity, and skin pathologies. The surface of the skin is covered by the so-called "acid mantle" which gives it an acidic nature. Publications suggest that the skin pH is between 4.5 and 5.5, while more recent studies state that the skin pH varies from 4.1 to 5.8, with the exception of armpits, groin, interdigital spaces, and anus that have a pH between 6.1 and 7.4. There are some theories to explain the origin of protons on the skin's surface; Among them, the acid mantle would be composed of endogenous sources (sebum and sweat) and exogenous sources (microbiota), while more current research clarifies that the acidification and maintenance of the skin surface pH is the result of phospholipids hydrolysisinto free fatty acids; the exchange of protons for sodium ions by the Na+/H+ type 1 antiporter (NHE1), the degradation of the filaggrin protein, the persistence and extrusion of melanin granules through the release of protons from the acidic environment of phagolysosomes, for example.[24,25]

The importance of the acidic skinpH is due to it being a regulatory factor for maintaining the homeostasis of the stratum corneum and the permeability of the skin barrier. Furthermore, the first and one of the main functions of the skin acidic pH is the protection against pathogenic microorganisms. Although the acidic pH helps create a hostile environment for pathogens, acidity is necessary to maintain the skin's natural microbiota. Inflammatory skin diseases such as atopic dermatitis and acne have dysbiosis in the skin microbiota as one oftheir causes, in these cases the skinpH is generally high. That said, products intended for prolonged contact with the skin must have a pH between 4.0 and 7.0. As extrinsic factors affect the skin's pH, topically applied products with adequate pH can contribute to maintaining skin health; Therefore, the facial mask samples analyzed are compatible withhealthy skin pH, requiring no adjustments.[24,25]

DRYING TIME AND FILM FORMATION

This analysis was carried out by spreading the sample on the back of the hand with circular movements and timing the period necessary for the product to drycompletely. During drying, water present in the preparation evaporates with the help of ethyl alcohol, which acts as a drying agent. To simulate use by the end consumer, the film obtained after complete drying of each formulation was removed. Exception made to formulation 3, which, in addition to the longer time required for drying, difficulty for removal and sticky skin after film removal, the characteristicsof the thin films formed from the formulations

wereuniform thickness, flexibility, good adhesion to the skin, in addition to remaining intact during removal and leaving no residue on the skin. ,



A **B**

Figure 1. Removal of the film formed after drying. (A) Complete removal of formulation 4 film applied to the back of the hand without leaving residue. (B) Formulation 3 with a brittle, thick film and sticky consistency. Source: author's own work.

Peel-off facial masks form films within 10 to 30 minutes after application. In the study by Vieira (2009), it was observed that using PVA at 15% (m/m), the drying time was approximately 37 minutes.[26]

In the present work, the maximum time observed for complete drying was 21 minutes (formulation 3), and,as shown in Table 3, the final formulation containing *Punica granatum* extract was completely dry in 13 minutes.

Table 3. Time in minutes of drying of each formulation and film formation.

Formulation	Time (minutes)	Film
F1	16	Yes
F2	15	Yes
F3	21	Yes
F4	18	Yes
F5	12	Yes
F6	13	Yes

Source: author's own work.

THERMAL STRESS

The results of the macroscopic evaluation of organoleptic characteristics of the base formulations after exposure to extreme temperature conditions are shown in Table 4.

Table 4. Macroscopic analysis of the base formulations and the final formulation exposed to high temperature conditions

Temperature	Formulation	Appearence	Color	Odor
5 - 2°C	1	N	N	N
	2	N	N	N
	3	N	N	N
	4	N	N	N
	5	N	N	N
	6	N	N	N
40°C	1	N	N	N
	2	N	N	N
	3	N	N	N
	4	N	N	N
	5	N	N	N
	6	N	N	N
45°C	1	N	N	N
	2	N	N	N
	3	N	N	N
	4	N	N	N
	5	N	N	N
	6	N	N	N
50°C	1	N	N	N
	2	N	N	N
	3	N	N	N
	4	N	N	N
	5	N	N	N
	6	N	N	N

For color and odor: N - normal, no change; LM - slightly modified; M - modified; IM - intensely modified. For appearance: N - normal, without change; LM - slightly separated, slightly precipitated, or slightly cloudy; M - separated, precipitated, or cloudy. Source: author's own work.

None of the formulations showed changes in appearance, color, or odor when subjected to high temperatures (40, 45, and 50°C) for thirty minutes, proving to be stable at high temperatures. At a temperature of 50°C, all masks had a more liquid consistency compared to the initial consistency, which can make application difficult as it drains faster. No instabilities were observed in the formulations cooled in a conventional freezer at the temperature range of 5.0 to 2.0°C ± 2.0°C for 24 hours. The only noticeable change was the increase in viscosity of the samples with longer flow time and stickier texture. However, the color, appearance, and odor were not changed; the formulations remained stable after freezing without forming precipitates or breakdown of the formulation.

FREEZE-THAW CYCLE

The results obtained after the freeze-thaw cycles are shown in Table 5.

Table 5. Macroscopic analysis of the base formulations and final formulation exposed to freeze-thaw cycles.

Formulations	1	2	3	4	5	6
Aspect	N	N	N	N	N	N
Color	N	N	N	N	N	N
Odor	N	N	N	N	N	N

For color and odor: N - normal, no change; LM - slightly modified; M - modified; IM - intensely modified. For appearance: N - normal, without change; LM - slightly separated, slightly precipitated, or slightly cloudy; M - separated, precipitated, or cloudy. Source: author's own work.

All samples remained stable after the freeze-thaw cycles, as they did not show changes in organoleptic characteristics. The purpose of thermal stress tests and freeze-thaw cycles is to anticipate any possible instability. The results presented corroborate that the anti-acne facial mask with 5% *Punica granatum* extract can be stored at room temperature, protected from light and humidity, and also tolerates being kept in the refrigerator, which will provide a refreshing sensation to the user, in addition to ensuring its stability on hotter days.

PRACTICAL APPLICATIONS OF FACIAL MASK WITH POMEGRANATE EXTRACT

Based on the studies carried out in this work and the cited bibliography, due to the potential benefits for the skin offered by pomegranate extracta PVA facial mask with pomegranate extract can have several practical applications.

In addition to its potential acne treatment, the pomegranate extract is known for its antioxidant and moisturizing properties. A facial mask containing this extract can help hydrate and nourish the skin, especially in dry climates or during seasons that tend to dry out the skin. The antioxidants in the pomegranate extract can help fight free radicals, which can cause skin damage and contribute to premature aging. A facial mask with pomegranate extract can help reduce signs of aging, such as wrinkles and fine lines.

Furthermore, the pomegranate extract has anti-inflammatory properties, which may benefit people with acne or irritation-prone skin. Regularly using a facial mask with pomegranate extract can help reduce inflammation and soothe the skin.

It's important to note that results may vary from person to person, and it's always recommended to do a sensitivity test before using any new product on your skin. Additionally, to achieve the best results, it's advisable to follow the instructions provided by the facial mask manufacturer.

In conclusion, the development of a *Punica granatum* anti-acne facial mask showed that it was easy to apply and remove from the skin due to the effectiveness of PVA as a film-forming agent besides the other components of the formulation. All masks formed a removable film after drying, except for formulation 3, which did not form a flexible and intact film. The study of varying the PVA concentration and the type of plasticizer (glycerin and sorbitol) determined that the best base for the anti-acne facial mask is formulation 5. The 10% concentration of ethyl alcohol used in all formulations worked efficiently

as a solvent and drying agent. Except for base formulation 3, all masks dried completely in less than 20 minutes during testing. Quality control analyses (pH, organoleptic characteristics, thermal stress, freeze-thaw cycle) resulted in positive outcomes. While no tests have been conducted on the effectiveness of *Punica granatum* ethanolic extract, existing literature supports its benefits. The next step is to conduct further *in vitro* studies using the final formulation created in this work to eventually confirm the anti-acne action of the developed facial mask through *in vivo* tests.

CONCLUSION

The development of the *Punica granatum* anti-acne facial mask of this work revealed that it is easy to apply and remove from the skin, thanks to the effectiveness of PVA as a film-forming agent and the other components in the formulation. All masks formed a removable film after drying, except for formulation 3, which had a higher concentration of PVA and did not form a flexible and intact film. Through studying the variation in PVA concentration and the type of plasticizer (glycerin and sorbitol), it was determined that formulation 5 is the best base for the anti-acne facial mask. The 10% concentration of ethyl alcohol used in all formulations was efficient in acting as a solvent and drying agent. Apart from base formulation 3, all masks dried completely in less than 20 minutes during the test conducted on the back of the hand.

Quality control analyses (pH, organoleptic characteristics, thermal stress, freeze-thaw cycle) yielded positive results in the experimental study. Although no tests have been conducted on the effectiveness of the *Punica granatum* ethanolic extract, existing literature supports its benefits. The next step is to conduct further *in vitro* studies using the final formulation revealed in this work to proceed with *in vivo* tests in the future and confirm the anti-acne action of the developed facial mask.

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