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AGROCOSMETICS: SUGAR CANE MOLASSES A SPECIAL RAW VEGAN MATERIAL FOR COSMETICS HANDS HYDRATION

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ABSTRACT

The COVID-19 pandemic has increased awareness and the importance of hand hygiene, with frequent use of disinfectants potentially causing dryness and increasing the demand for hand creams. While handwashing and disinfectant use are essential to reduce the spread of viruses and bacteria, they can damage the skin, causing dryness, cracking, and sores. Excessive use alters the skin's pH and causes loss of natural hydration, making users more vulnerable to viral and bacterial infections as a result of this water loss. Therefore, this research aims to produce a natural product with moisturizing potential for hands, evaluating its moisturizing power in vitro. For this purpose, sugarcane molasses was chosen, associated with hydroxy ethyl cellulose and low molecular weight (HMW) sodium hyaluronate. The results demonstrate the potential use of Sugar Cane Molasses as an occlusive and moisturizing agent, compared to formulation components and industrial products.

KEYWORDS: Agro cosmetics**;** Sugar Cane Molasses; hand hygiene; moisturizing hand gel; vegan cosmetics; *in vitro* hydration evaluation

INTRODUCTION

The increase in sales of hand creams is mainly due to the change in consumer awareness and preference, opting for the benefits of natural and organic ingredients, available in environmentally friendly and skin-safe formulas.

The use of hand cream has increased due to the COVID-19 pandemic, highlighting public awareness of the importance of hand hygiene. There has also been an increase in the use of

hand sanitizer, which, although causing skin dryness, is used more frequently than hand cream. COVID-19 transmission can be reduced with thorough hand hygiene. While handwashing and the use of disinfectants are essential to reduce the spread of the virus, they can also damage the skin, causing dryness, cracking, and sores. Furthermore, excessive use alters the skin's pH levels and reduces natural hydration, making consumers more vulnerable to viral and bacterial infections due to skin dryness.

Dry hands skin is in most cases provoked by environmental factors such as cold weather and personal habits such as frequent washing or exposure to chemicals/detergents. The hands become dry and rough, red and susceptible to cracks, which are often painful, allowing the entry of microorganisms. This skin conditions are associated with a water/lipid imbalance in the stratum corneum (SC), causing an increase in transepidermal water loss (TEWL) and, consequently, a reduction in skin hydration [1,2].

The skin's natural moisturizing factor (NMF) is basically composed of free amino acids and their derivatives, inorganic salts, sugars, lactic acid and urea. They are concentrated in the corneocytes of the stratum corneum and maintain skin hydration and they have the ability to attract water from the atmosphere to the corneocytes. The basic and neutral amino acids of NMF when hydrated, form ionic interactions with the keratin fibers of the skin, reducing the intermolecular forces between them and, consequently, increasing the elasticity of the stratum corneum [3].

The reduction of NMF can occur due to a decrease in its production, excessive bathing or exposure to UV light, which can compromise the natural desquamation of the skin, in addition to being associated with diseases such as atopic dermatitis, psoriasis, ichthyosis and xerosis [4].

The pH value of the skin is related to hydration and the use of alcohol-based hand cream can change the pH value and consequently reduces skin hydration. With the loss of the natural barrier, the skin profile is altered causing dryness and cracks, through which bacteria and viruses can penetrate, and perhaps the coronavirus. To properly hydrate and balance the skin's pH value, it is recommended to apply a cream based on petrolatum/mineral oil, odorless, dye-free and non-comedogenic (World Health Organization [WHO, 2009] [5]

The effects of hand hygiene products vary considerably depending on factors such as climate and environmental conditions. For example, in tropical countries and during the summer months in temperate climates, the skin remains more hydrated than in cold and dry environments. The effects of products also vary according to skin type. The need for moisturizing products varies among consumers, health service professionals, according to

geographic locations and climatic conditions (SULTANA, 2003) [6].

People, such as doctors or nurses, who wash their hands a lot or use hand sanitizer multiple times a day, are more likely than some other people to have dry hands. Other professions, such as dishwashers or hairdressers, may be more prone to dry hands due to repeated exposure to chemicals and soaps also bricklayers, mechanic persons. Due to the unavoidable use of hands, the skin can become dry, rough, and cracked, making it susceptible to the penetration of microorganisms; therefore, applying hand lotions or creams is advisable for protection.

Superficial or minor cracks therefore make easier the penetration of microorganisms, and in these cases is recommended the application of hygiene products, with or without healing agents [7].

Healthy skin is structured to maintain water balance by maximizing water retention and minimizing evaporative loss. The water-holding and barrier functions of the skin can be impaired by several factors that lead to dry skin. Skin hydration can be restored (figure 1) by occlusive components (petrolatum, silicones), humectants (glycerin, hyaluronic acid) and/or basic emollients (ceramides, fatty acids) that act through the physicochemical properties of their constituents [8].

Hand creams are designed to care for and moisturize hands, keeping them soft. Hand creams are also labeled differently to consumers depending on the active ingredients incorporated into the formula. Depending on their composition, they are recommended as intended for different purposes, such as anti-aging (e.g., retinol, peptides) to minimize the appearance of fine lines and wrinkles on the hands, whitening, night creams, hand repair products and protection, particularly against environmental factors.

The demand for natural and organic cosmetic products in the hand cream market has been steadily increasing, considering the level of consumer awareness about the products they apply to their skin [9]. It should be also, considered the transparency and sustainability of ingredients, personalization, packaging, and sustainability solutions.

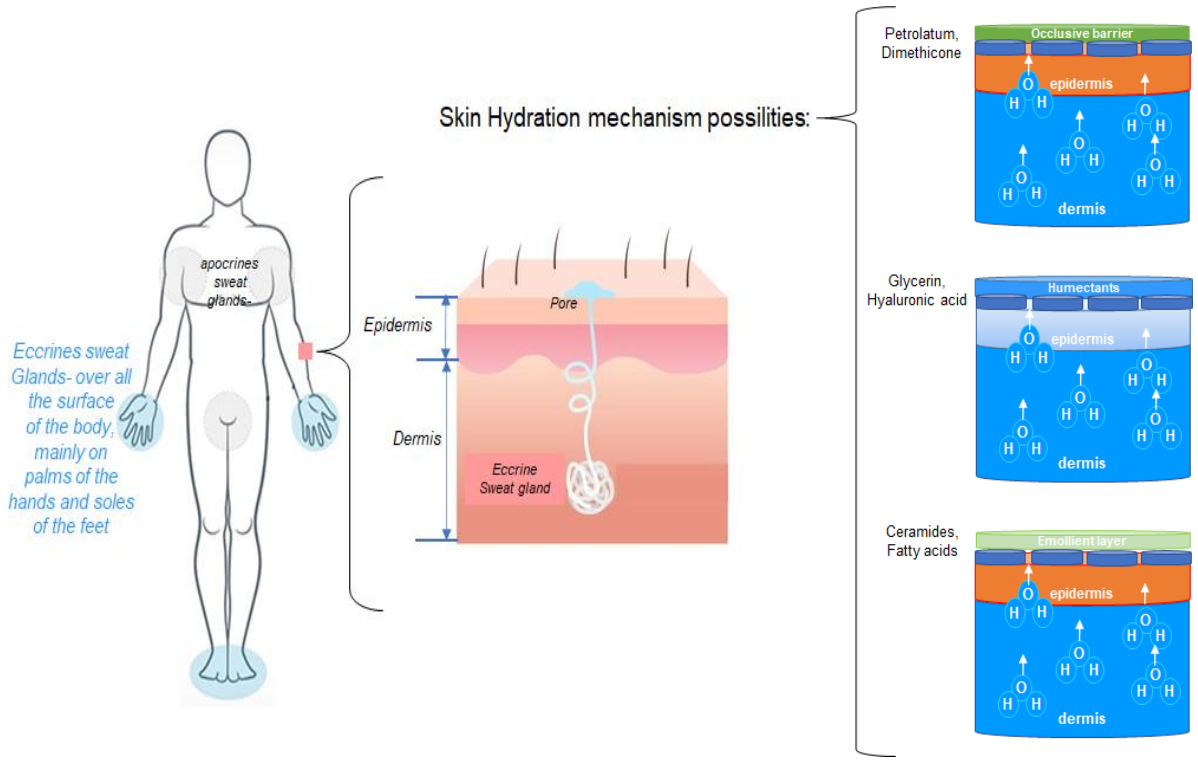


Figure 1. Restoration of hand skin humectation.

Various plant-derived active components naturally possess properties to repair and protect the skin from environmental pollution, chemical exposures, atmospheric temperature fluctuations, and UV radiation, making them preferred sources of photoprotective agents [10,11].

There is a surge in demand for ingredients derived from nature, such as aloe vera, green tea, and essential oils, which are used to heal and rebuild skin. Hand creams can contain ingredients such as herbs and essential oils, which repair and provide deep hydration to the skin, leaving hands comfortable and soft.

The inclusion of cannabidiol (CBD) and botanical extracts in multifunctional formulas is now a major driver in the hand cream market, reflecting a shift in consumer behavior towards a preference for natural, plant-based therapeutic solutions for well-being. The current trend is driven by the growing demand for multifunctional products that offer not only basic hydration, but also anti-aging, skin-repairing, and anti-inflammatory properties. Skincare products using CBD, in addition to the conventional market, are projected to experience significant growth due to their anti-inflammatory and antioxidant properties, which also aid in the recovery of skin affected by eczema and irritations, and soften signs of aging [9].

SUGAR CANE MOLASSES

Brazil is the chief sugarcane producer in the world, manufacturing about 511 million tons of sugarcane and 26.7 billion liters of bioethanol and, India is the second largest producer with an annual production of about 10–12 million tons of molasses. Succeeding Brazil and India, China produces about 4800,000 tons/year of cane molasses.

Molasses is one of the wastes generated from the sugarcane processing industry by repeated crystallization during sugar preparation. The yield varies from 2.2 to –3.7% per tons of sugarcane.

In recent years, these materials have been used to produce high value products for several applications: molasses is used in various industries such as food and beverage, healthcare, pharmaceutical, personal care products, animal feeds, and others. It possesses numerous health benefits, such as antioxidant, anti-obese, anti-cancerous, antimicrobial, anti-anaemic, improves bone and hair health, used for the treatment of skin and anaemia. Also, it can increase defense against bacterial and viral infections, enhances immune reactions and possesses antioxidant and hepato-protective properties [12,13,14].

The rich chemical composition of sugar cane molasses can be explored as a source for phenolic compounds extracts, for the development of bioactive ingredients for the cosmetic and skin care products. Phenolic compounds present in sugarcane extracts possess antioxidant, antimicrobial and anti-inflammatory activity, as well as inhibitory activity against skin ageing related enzymes and promotes collagen synthesis [15,16].

A sugarcane concentrate obtained as a patent extraction method had showed a high polyphenol content acting as strong antioxidants [17]. Sugar cane polyphenol exerted antioxidant, anti-inflammatory and anti-aging effects and acted synergistically. However, it was observed that the phenolic compounds predominantly reached the skin's surface, indicating a limited ability to penetrate deeper layers of the skin [15,16,17,18].

Due to its high antioxidant content and minerals, molasses may promote wound healing and can be used topically as a paste or in gel. Antioxidant as copper found within molasses that helps remove free radicals from the body. Also, vitamins and others minerals in molasses include vitamin B6 and zinc promote healing.

GELATIN

Gelatin is a polymer resulting directly from the transformation of collagen. It has a diverse chemical composition and a unique ability to form gels, making its use fundamental in different industrial segments such as food, pharmaceuticals, and cosmetics.

Gelatin is mainly composed of 50.5% carbon, 6.8% hydrogen, 17% nitrogen, and 25.2% oxygen. It has a high content of acidic and basic amino acids, with the acidic amino acids present in amide form (glutamine and asparagine), with a minimal percentage of methionine. The chemical composition of gelatin, particularly its amino acid components, is highlighted by glycine, proline, and hydroxyproline, which define its structural properties and also its melting and gelling temperatures.

Due to the presence of these hydrophilic and hydrophobic amino acids, it has an amphiphilic character that can reduce surface tension in aqueous solutions. This characteristic allows gelatin to bind to surfaces of different chemical natures, leading to the migration of both the hydrophilic and hydrophobic portions towards the surface, thus contributing to the reduction of surface tension in aqueous solutions [20,21].

The gelatin prepared by an alkaline process show an acidic pH value and, the deamination of amino acids occurred, converting the amide groups of asparagine and glutamine into aspartic acid and glutamic acid with a predominance of negative charges (carboxyl groups). This causes a decrease in the isoelectric point (charge equilibrium) to values between 4.8 and 5.5 in the gelatin molecule.

Gel Formation

Gelatin gel formation is a complex process involving the transition from an unwound structure to a triple helix structure. The junction zones formed during gelation are formed by triplets of specific amino acids, such as Gly-Pro-Hyp. The stability of these regions is maintained by hydrogen bonds, van der Waals interactions, and the incorporation of water molecules, resulting in the formation of long, rigid domains [22].

Temperature plays a crucial role in the transition of a gelatin solution between the solid and liquid states, known as gelling and melting temperatures. These properties are influenced by the ratio of the amino acid proline and hydroxyproline, the molar mass, and the complex interactions between the molecular chains in gelatin. When gelatin is placed in cold water, it swells due to water absorption. Upon heating above its melting point (34°C), the gelatin dissolves. The resulting gel is composed of long, flexible molecular chains, cross-linked in various positions, making it extensible and predominantly elastic.

This gel consists of a three-dimensional network of molecules, linked by junction zones, capable of retaining large amounts of water. Although it exhibits solid characteristics, it is, in fact, a viscoelastic material [23].

OBJECTIVES

Hand hygiene is the first defense action against the coronavirus and if soap and water are not available, it is recommended to use alcohol-based hand sanitizer. However, the use of hand sanitizers can alter pH levels in the skin, making users more vulnerable to bacteria or viruses. This research aims to develop vegan cosmetic formulations with moisturizing potential for the hands and to evaluate their moisturizing power *in vitro*. Therefore, the main objective was to develop a gel-based product capable of controlling, restoring, and maintaining hand hydration by repairing the dermal barrier.

MATERIAL & METHODS

Material

Betaine (and) Sodium PCA (and) Sorbitol (and) Serine (and) Glycine (and) Glutamic Acid (and) Alanine (and) Lysine (and) Arginine (and) Threonine (and) Proline (and) Methylparaben (and) Propylparaben; Betaine (and) Sodium PCA (and) Sodium Lactate (and) PCA (and) Serine (and) Alanine (and) Glycine (and) Glutamic Acid (and) Lysine HCl (and) Threonine (and) Arginine (and) Proline (and) Water (Prodew 400 and Prodew 600-Ajinomoto Brasil).

Gelatin (EML Brasil);

PCA Na (Ajinomoto Brasil);

PEG 75 lanolin (50%) (Croda Pharma Brasil);

Urea (Anidrol Brasil);

Sugar Cane Molasses (SCM) (Terra dos Grãos Ind. Com. Alimentos- Brasil);

Bio-sodium hyaluronate (HMW) (HA) (Innovacell Fine Ingredients & actives);

Hydroxy Ethyl Cellulose (HEC) (Ashland Brasil);

Purified water;

Rosemary extract (Mapric Brasil) was used as a preservative.

Methods

1. Formulation of Sugar Cane Molasses gel

1.1. Hydroxy Ethyl Cellulose (HEC) was initially moistened with a partial volume of water at 25± 2°C. After 24 hours, it was homogenized and the water volume was made up to 100 g to obtain a transparent gel;

1.2. Hyaluronic acid (HA) (0.50 g w/w) was added to gel (1.1);

1.3. Sugarcane molasses (SCM) [25 g (w/w)] was prepared in the same way to obtain a

second gel named as SCM+ HA; SCM+ HEC and SCM+ HA+HEC.

2. Physicochemical stability analyses

2. 1. Determination of the pH values of gels

1.0g of sample was diluted in 9.0g of freshly purified water. With the aid of a tube mixer (Phoenix-mod. AP56) the sample was homogenized and then the pH value (triplicate) determined (Peagometer Digimed® mod. DM 22) at a temperature of 25±2ºC. The measures were made for a period of 1, 15 and 30 days [24,25,26,27].

2.2. Determination of electrical conductivity

Electrical conductivity (Digimed model DM-32) was evaluated in triplicate on the third and thirtieth days, inserting the electrode directly into the sample. The measures were made for a period of 1, 15 and 30 days 24,25,26,27].

2.3. Centrifugation Test

5.0g of the samples were placed (triplicate) in a graduated tube and centrifuged (Centrífuge Centrilab model CE801), in thirty-minute cycles at speeds of 3000 rpm at 25±2ºC and evaluated for phase separation 24,25,26,27].

2.4. Thermal stress

10 g of each sample were placed in transparent, closed polystyrene plastic bottles (triplicate) and heated in a water bath (Nova Técnica Ltda. - mod. 281 NT). The temperature was increased by five degrees, starting at 40ºC to 80ºC, keeping each temperature for thirty minutes. At each increase in temperature and at the end of the experiment, signs of instability such as creaming or phase separation were observed macroscopically [28].

Freeze/Thaw cycles were also performed, where the samples were subjected alternately to 4±2ºC for 24 h and 45±2ºC for 24h, making a total of 6 cycles (each cycle corresponding to 48 hours; 24h refrigerator and 24h oven) and the samples were evaluated after 24 hours of preparation and at the end of the 6th cycle [28].

2.6. Exposure to different temperatures

The formulations in hermetically sealed polystyrene bottles considered stable in the preliminary tests were subjected to different temperature values 25±2ºC, 4±2ºC and 45±2ºC and evaluated after 24 hours, 7, 15, and 30 days (prolonged storage [24, 28].

3. In vitro hydration gel evaluation on gelatin support cells [29].

The gelatin support cell (Figure 2) consists of a 3 cm diameter glass cylinder closed at one end by a cover containing 1 mL of purified water to ensure 100% relative humidity inside the cylinder. At the other end, the cylinder was closed by a 1 cm thick gelatin disc (12% w/w aqueous solution or gelatin plus NMF components – Table 1) to simulate the skin.

Cosmetic-grade gelatin, when added to cold water, expands and, when heated, hydrates and dissolves, forming a clear solution. When aqueous solutions of gelatin cool, there is a progressive increase in viscosity, leading to the formation of a gel. While still warm, it is distributed into Petri dishes, followed by the placement of the support cells.

The cells were placed in a desiccator (inner diameter ±250mm, height ±325mm depth ±130mm and porcelain plate diameter ±230mm) containing activated silica as desiccant agent. The humidity inside the desiccator was determined by the Sundo Model Praecisions Hygro Multitherm hygrometer. The desiccator was placed in a temperature-controlled room. The amount of product applied was 300± 4mg/cm^2. Water loss was determined (Eq.1) gravimetrically at time zero, 25 and 50 minutes before application of the test product, and the cells were weighed at 25, 50 and 100 minutes after application of the test product while E (%) was the efficacy of occlusion (Eq.2).

Table 1. Gelatin cell composition normal and plus NMF (G+).

Components	**Quantities (w/w)**
Normal gelatin cell composition (NG)	
Gelatin (pharmaceutical grade)	*12.0*
Purified water qsp	*100.0*
Gelatin cell composition plus NMF (G+)	
Gelatin (pharmaceutical grade)	12.0
PCA Na	1.0
PEG 75 lanolin (50%)	1.0
Urea	1.0
Glutamic acid	0.5
Betaine (and) Sodium PCA (and) Sorbitol (and) Serine (and) Glycine (and) Glutamic Acid (and) Alanine (and) Lysine (and) Arginine (and) Threonine (and) Proline (and) Methylparaben (and) Propylparaben	1.0
Betaine (and) Sodium PCA (and) Sodium Lactate (and) PCA (and) Serine (and) Alanine (and) Glycine (and) Glutamic Acid (and) Lysine HCl (and) Threonine (and) Arginine (and) Proline (and) Water	1.0
Bio-sodium hyaluronate 1.0 %(HMW)	1.0
Purified water q.s.p.	100.0

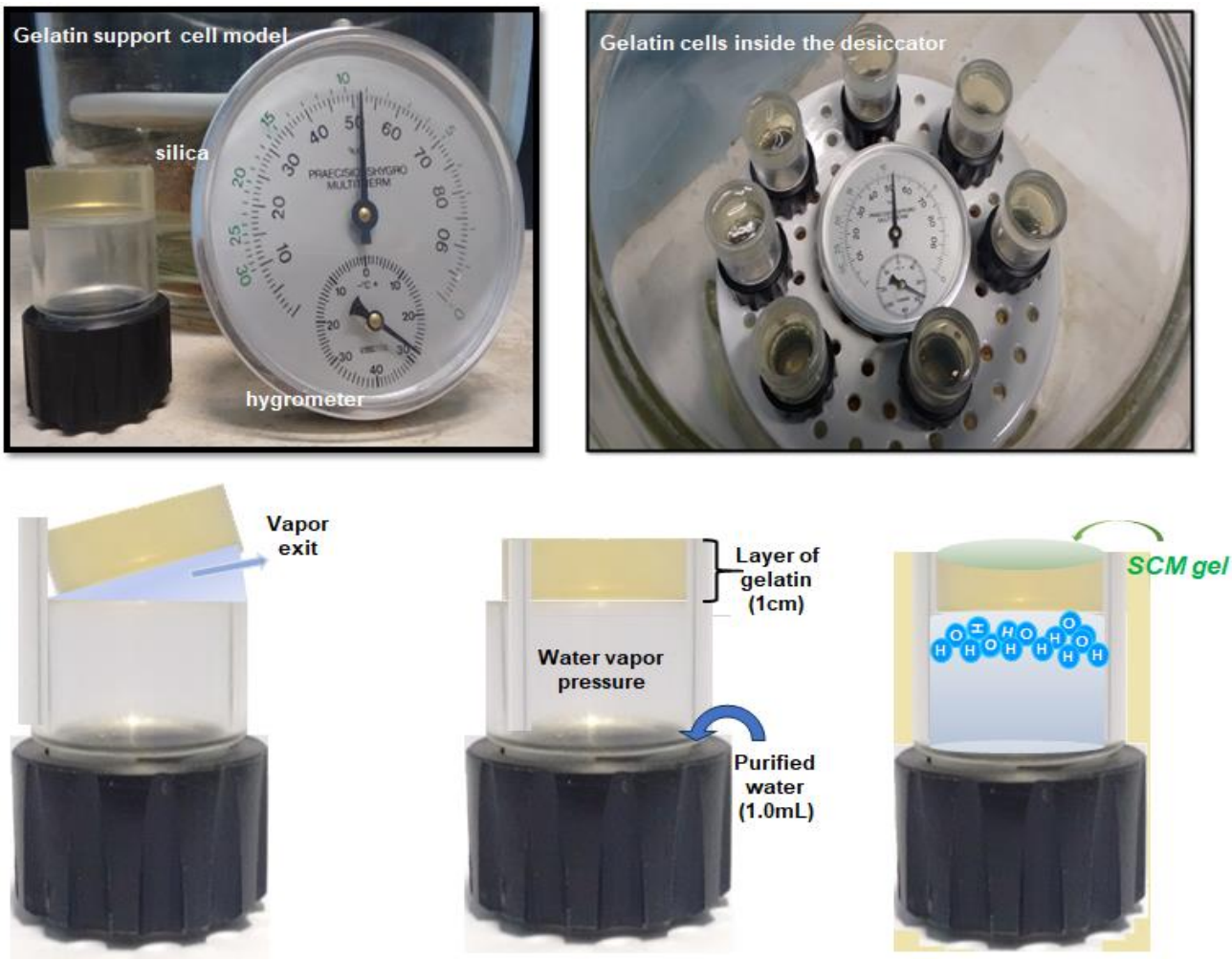


Figure 2. Gelatin cell composition before SCM gel application.

Gelatin cell with volatile solvents (alcohol, ether, chloroform) instead purified water	Gelatin cell before sample application	Gelatin cell after sample application

PA (mg/cm²) = $\frac{Pt_o - Pt_x}{7} \times 1000$ (Eq. 1)

Where:

PA= water loss;

Pt_o = initial weight of the gelatin cell (g);

Pt_x = weight of the gelatin cell after x minutes (g);

denominator (7) = cell surface (cm²).

E (%) = $\frac{at - ap}{at} \times 100$ (Eq. 2)

Where:

at = angular coefficient before the application of the sample

ap = angular coefficient after the application of the sample

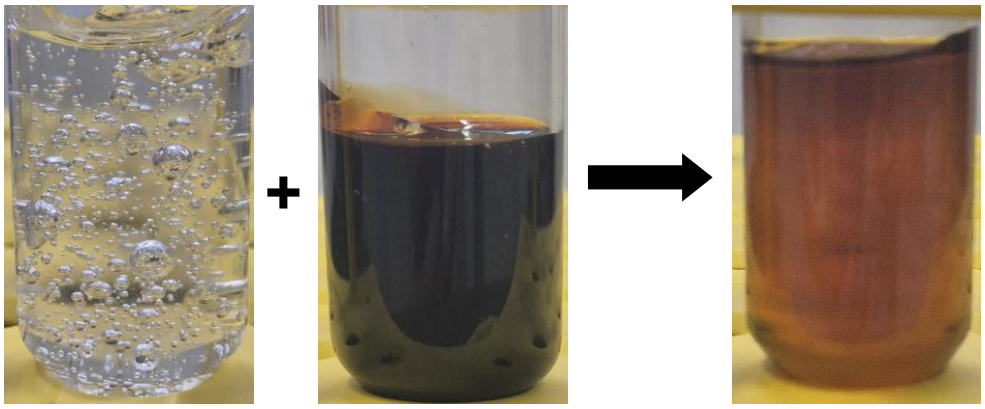
RESULTS

1. Formulation of Sugar Cane Molasses gel

After 24 hours HEC gel was obtained (Figure 3A) (Table 2), to which pure SCM was added (Figure 3B) to produce SCM gel (Figure 3C). Macroscopically, the gel was transparent; the SCM already had a black color, characteristic odor (Rosmary extract plus SCM). The SCM gel is brown in color and has a mild sugarcane odor and non-sticky sensorial.

Table 2. Hand gel composition.

Components	Concentration (w/w)
HEC	5.0
SCM	25.0
HA	0.50
Purified water	qsp. 100.0



(A-HEC gel) **(B- pure SCM)** **(C- SCM gel)**

Figure 3. Macroscopic aspects of formulas.

2. Physicochemical stability analyses

2. 1. Determination of the pH values of gels

The pH value of the aqueous gelatin solution is 4.6. This means it was prepared by an alkaline process; therefore, the deamination of amino acids occurred, converting the amide groups of asparagine and glutamine into aspartic acid and glutamic acid with a predominance of negative charges (carboxyl groups). This causes a decrease in the isoelectric point (charge equilibrium) to values between 4.8 and 5.5 in the gelatin molecule.

The pH value varies from person to person and body region to body region, and depends on diet, hygiene habits, and the use of skincare products. Achieving balance is essential for healthy skin. The pH value is measured on a scale of 0 to 14.0, so a value of 7.0 is considered

neutral pH, a pH value below 7.0 is acidic, while values above 7.0 are considered basic.

The normal pH value for adult skin is around 5.5, which helps maintain the balance of the skin barrier and protect against the penetration of harmful bacteria. If changes in pH value occur, the skin barrier can be damaged, potentially causing dryness and peeling of the skin. The hands are frequently exposed body regions and have a more alkaline pH value than other body regions [30,31].

pH value for SCM gel after 30 days was maintained acidic- 4.05 compared with SCM pure- 4.22 and HEC gel equal to 4.96, indicating a good value as skin care gel hands use (Table 3). As mentioned above was compatible with pH value.

Table 3. Gels pH values.

Time (days)→	**1**	**15**	**30**
HEC gel	4.67	4.42	4.96
SCM pure	3.63	3.81	4.22
SCM gel	4.21	4.19	4.05

2.2. Determination of electrical conductivity (µ) (mS)

The electrical conductivity value of cosmetic gels varies according to the gel-forming agent and the application area. For medical/aesthetic use, the ideal value is 262 µS/cm. As shown in Table 4, pure SCM (undiluted) presented values around 76.0 µS/cm after 30 days. For HEC and SCM gel, the values were higher (≈740.0 1300.0 µS/cm, respectively), justified by the presence of water, thus indicating the hydrophilic nature of the formulation.

Table 4. Electrical conductivity values. (mS)

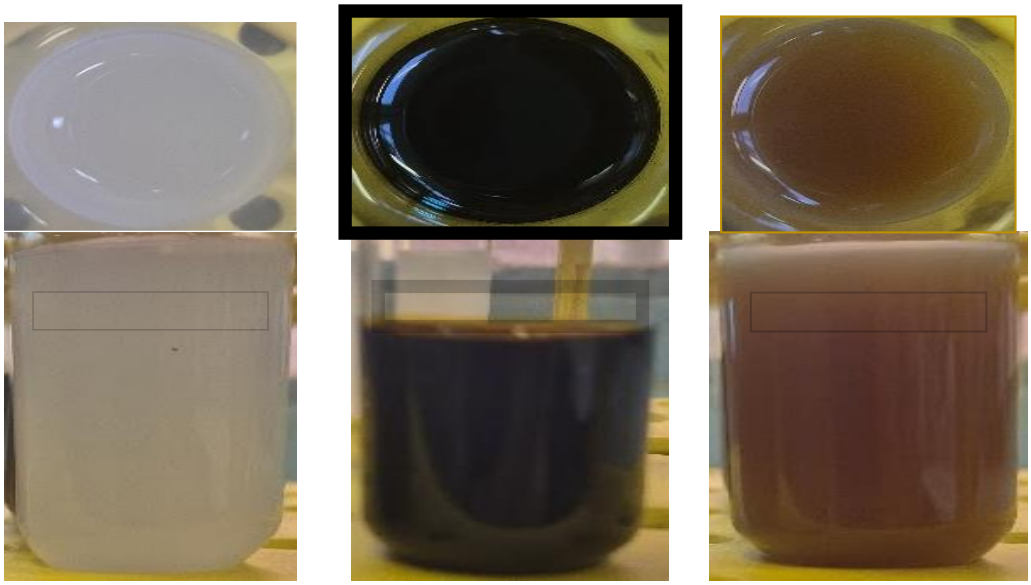
Time (days) →	1	15	30
HEC gel	731.3	752.08	713.36
SCM pure	72.51	78.49	75.79
SCM gel	1485.0	1358.3	1285.3

2.3. Thermal stress (Table 5)

The formulations containing HEC gel, pure SCM and aqueous SCM solution, when subjected to temperature variations from 30 to 70± 2ºC and maintained for 30 minutes at each temperature value, remained stable; that is, no physical instability was observed in the samples (Figure 4).

Table 5. Thermal stress.

Thermic stress (±2°C)	30	35	40	45	50	55	60	65	70
Stable (S)	S	S	S	S	S	S	S	S	S



(A-HEC gel) **(B- pure SCM)** **(C- SCM gel)**

Figure 4. Macroscopic aspect of samples after thermal stress.

2.5. Freeze/thaw cycle

The formulations containing pure HEC gel, pure SCM and aqueous SCM solution remained stable, showing no sign of physical alteration during the test.

2.6. Exposure to different temperatures

The formulations containing pure HEC gel, pure SCM and aqueous SCM solution remained stable (Table 6), showing no sign of physical alteration during the test.

Table 6. ***Exposure to different temperatures***

Stability (± 2°C)	4			25			45		
Stable (S)	S	S	S	S	S	S	S	S	S

2.7. *In vitro water loss evaluation from gelatin support cells*

Figure 5 (A) schematically shows the loss of water from the surface of the gelatin support cell and the loss of water from the surface of the hands. It is simulated that the amount of water loss occurs in greater quantity because there is no application of cosmetic products that inhibit water loss. After applying the pure SMC-based gel, figure 5 (B), it is observed that possible skin barrier failures may be reconstituted, thus minimizing water loss by evaporation and allowing adequate hydration of the hands.

Due to the different components of the gel associated with Sugar Cane Molasses (pure or in aqueous solution), Ethanol (70% and 92.8%), Hydroxy Ethyl Cellulose, Hyaluronic Acid, several experiments were carried out with the components isolated or associated and also in isolated (G) or added (G+) gelatin support cells with components of the Natural Moisturizing Factor (NMF).

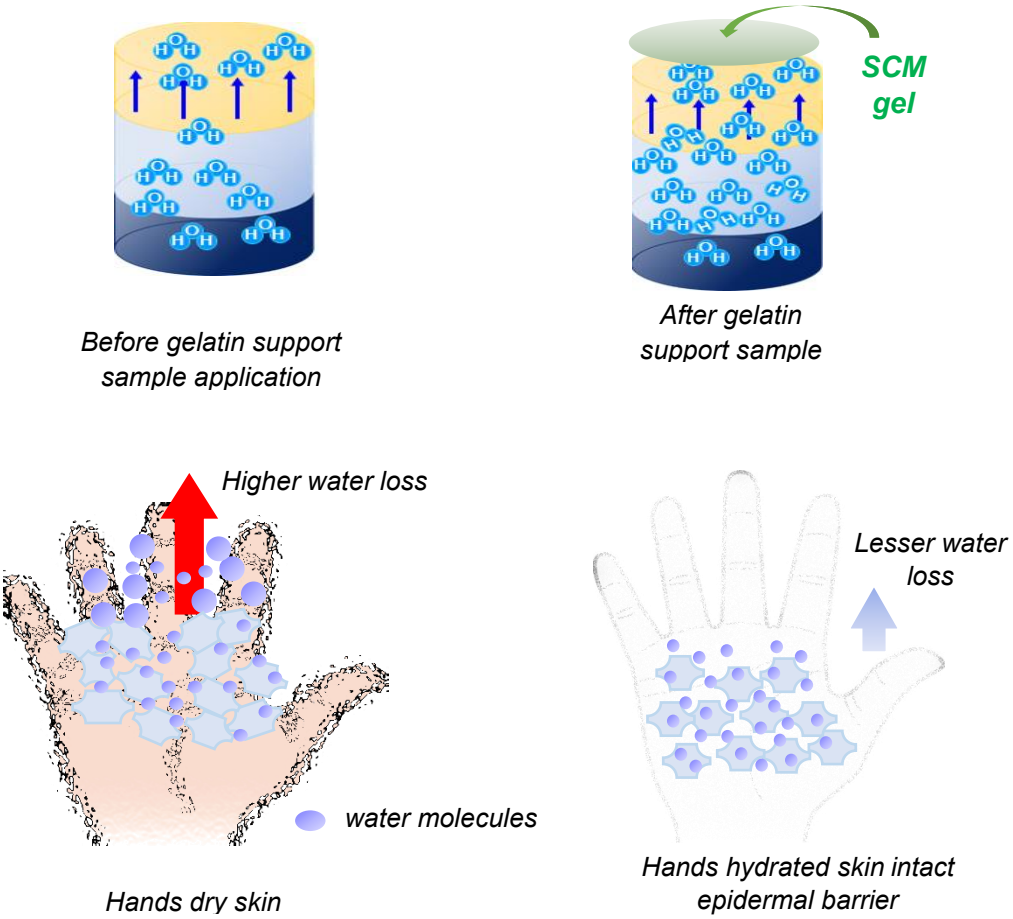


Figure 5. Schema shows the water loss from the surface of the gelatin cell and the water loss from the surface of the hands before sample application (A) and after sample application (B).

Hand hygiene is defined as rubbing hands with an alcohol-based product (Alcohol-Based Hand Sanitisers- ABHRs) or washing them with soap and water. The amount of product used, the duration of hand rubbing, fingernail length, or the presence of jewelry are not taken into account by the WHO's for gel efficacy evaluation method [32].

Alcohol in hand rubs is not recommended because can cause skin dryness, particularly over frequent exposure and the evaporation rates of alcoholic ingredients may vary in gel and liquid-based sanitizers and may directly correlate to the time when hands start to feel dry

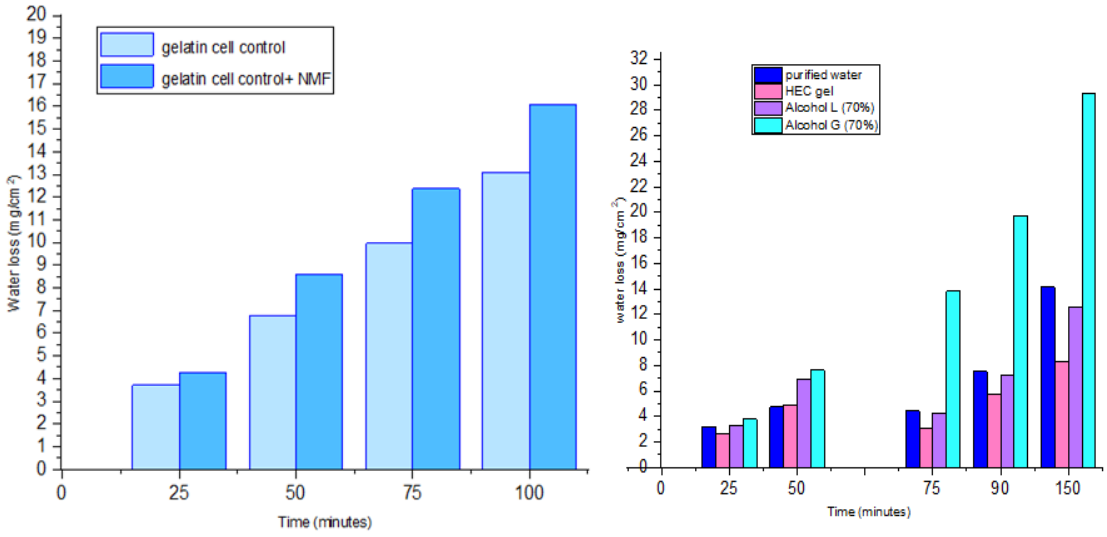
after application. This can, therefore, directly influence healthcare professionals' perception of the sufficient rubbing time [33, 34]. The recommended time for rub the ABHRs by various public health organizations varies from as low as 10s to 60s [35] affected by various other factors such as the dose of the sanitizer, the hand size (application surface area), and the formulation itself [36].

Emollients, as well as other skin conditioners, have been shown to decrease the drying effect of alcohol on the skin [37,38]. Aloe Vera gel has also been used for long in various cosmetic products as a humectant, being able to retard water evaporation from formulations. Aloe Vera-based healthcare products, being considered natural, constitute nowadays a large and growing market [38]. This is probably related to an increasing interest of consumers towards natural products. Thus, the incorporation of Aloe Vera gel in hand rubs can be considered a good marketing strategy for ABHRs.

The main purpose of this research was the employ of Sugar Cane Molasses (SCM) as vegan and emollient raw material. HEC has been used as a thickener, rheological modifier, colloidal protective, stabilizer and suspending agent. The viscosity of aqueous dispersions increases with increasing the concentration and molecular weight (MW) of HEC used. So, HEC gel formulation for hand hydration can or not contain Hyaluronic acid (HA) to increase hydration levels. HEC was used as a thickener, rheological modifier and stabilizer agent [33].

Bio-Sodium Hyaluronate (HMW) was used as hydrating agent acts as a lubricant and protective barrier to minimize external damage and help to create a dense, hydrating film on the skin's surface. It attracts and retains moisture maintaining elasticity and providing an immediate occlusive effect [33].

The following figures 6 to 12, contain comments on the results obtained from the *in vitro* evaluation of water loss over time from the raw materials used in the formulation, as well as the possible formula composition of the Sugar Cane Molasses-based gel, developed for hand protection on Normal Gelatin cells (NG) and with natural moisturizing factor (G+).



(A) **(B)**

Figure 6. Comparison between gelatin cell control, Purified water, HEC gel, Alcohol L (70%) and Alcohol G (70%).

(A) For the control gelatin cell (NG) the water loss was (13.0 mg/cm²), while for the (G+) gelatin cell it was 16.0 mg/cm²;

(B) The order of greatest effectiveness with respect to least water loss was: HEC gel (8.0 mg/cm²) < Alcohol L (70%) (12.0 mg/cm²) < purified water was close to (14.0 mg/cm²) and for Alcohol G (70%) it was (29 mg/cm²). Purified water showed the lesser water loss (14 mg/cm²) compared to alcohol G (70%) 29 mg/cm².

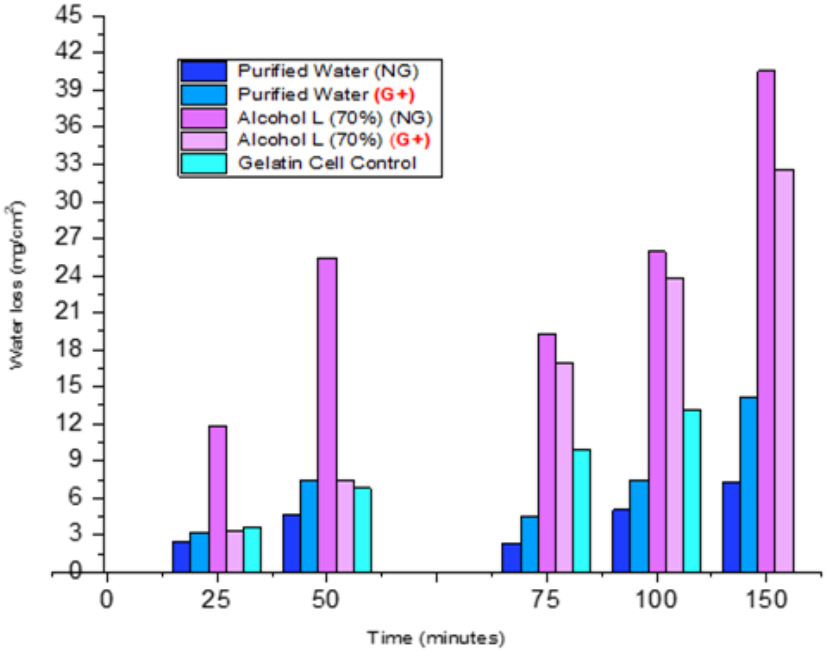


Figure 7. Comparison between Purified water, HEC gel and Alcohol (70%) on gelatin cell control (NG) and G+.

In this figure it was compared the water loss of Purified water and Alcohol L (70%) when applied on normal gelatin support cell (NG) and gelatin cell added with Natural Moisturizing Factor (NMF) (G+). For purified water on NG was 7.0 mg/cm², while for (G+) 14.0 mg/cm². We can assume that the hydrophilic amino acids added to (G+) contributed to the formation of microchannels, facilitating the passage of water and slightly increasing water loss. Observing the results for alcohol L (70%) on NG 40.0 mg/cm² and on (G+) 33.0 mg/cm² and we can suppose that polar solvents like alcohol L, can precipitate some amino acids with nonpolar (hydrophobic) side chains and blocking possible water passage microchannels causing the minor value for occlusion.

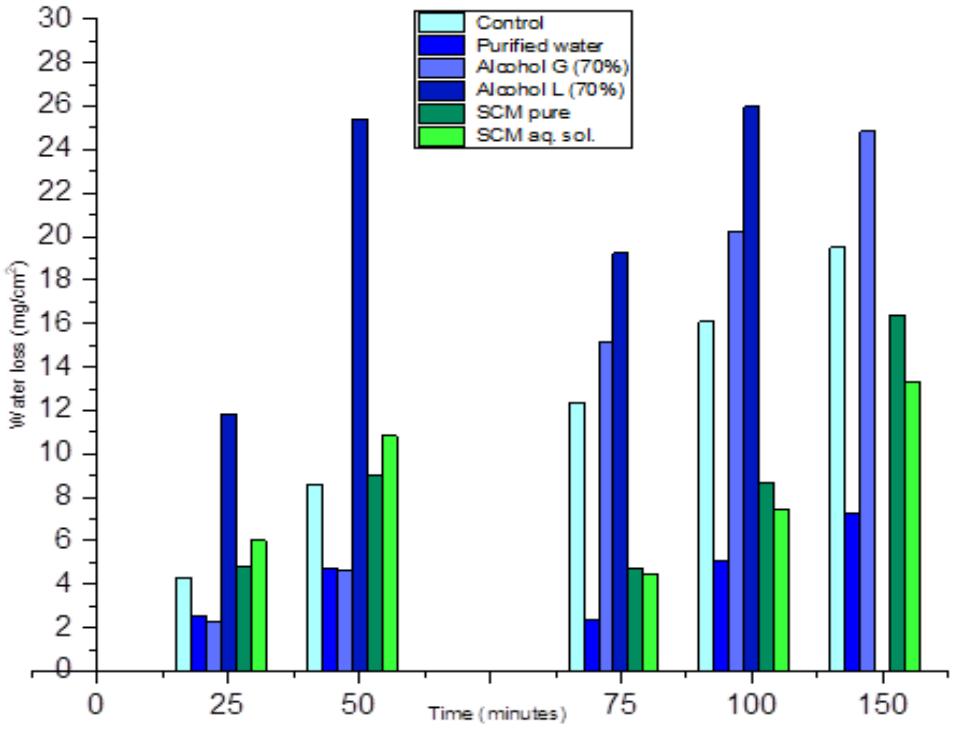


Figure 8. Comparison between Control (NG), Purified water, Alcohol G (70%), Alcohol L (70%), pure SCM and SCM aqueous solution.

Gelatin cell control show water loss near to 20 mg/cm². Purified water applied on gelatin surface was more occlusive (7 mg/cm²) than the SCM aqueous solution (13 mg/cm²) and more occlusive than pure SCM (16 mg/cm²). For both Alcohol G (70%) and Alcohol L (70%) the water loss was greater than 24mg/cm² being superior for Alcohol L (70%) (26mg/cm²). Alcohol G was used for CMC gel production and was able to avoid water loss (24.5 mg/cm²) from gelatin surface.

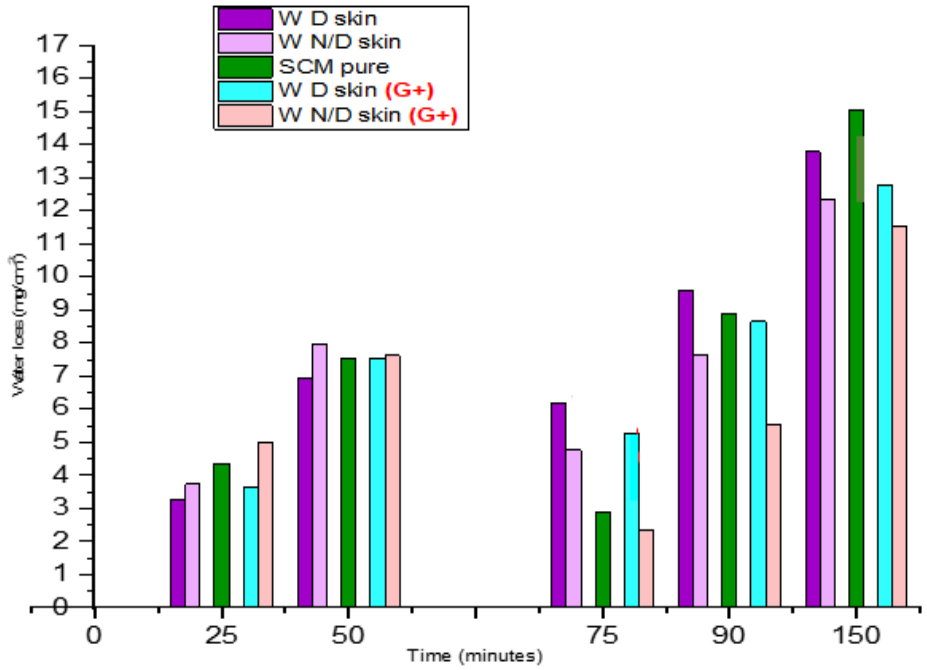


Figure 9. Comparison between commercial product and Pure Sugar Cane Molasses on gelatin cell control.

Pure Sugar Cane Molasses water loss (G+) was compared with commercial products (W) recommend for Dry skin (D) and Normal/ Dry (N/D) skin. Pure SCM show water loss value of 15.0mg/cm².Water loss results for commercial products were about (14mg/cm²) for dry skin cream (D/NG) and 13.0mg/cm² (DG+) which was considered a slight difference, while for N/D NG 12.5 mg/cm² N/D G+ 11.5 mg/cm² and the last one was considered with the minor water less capacity (major action moisturizing cream).

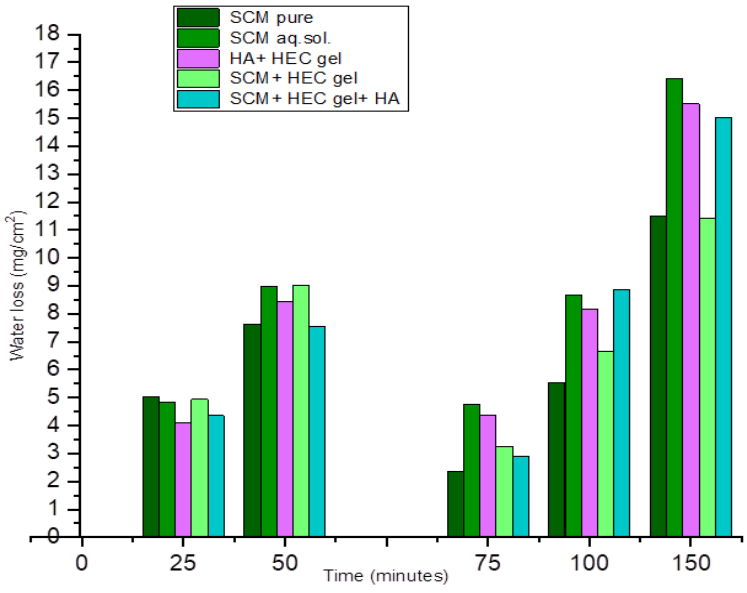


Figure 10. Comparison between pure SCM, SCM aq. solution with gel HA and HEC gel.

ConsConsidering that both HEC and HA can participate in the composition of SCM gel, a compar NG as made of water loss from gelatin support cells without NMF. In this way, it can be verified that the water loss values we can be considered in the following order: Pure SCM= SCM + HEC gel 11.5 mg/cm² > pure SCM+ HEC gel+ HA 15.0 mg/cm² > HA+ HEC gel 15.5 mg/cm² > SCM aqueous solution 16.5 mg/cm².

Gelatin cells with natural moisturizing factor (G+)

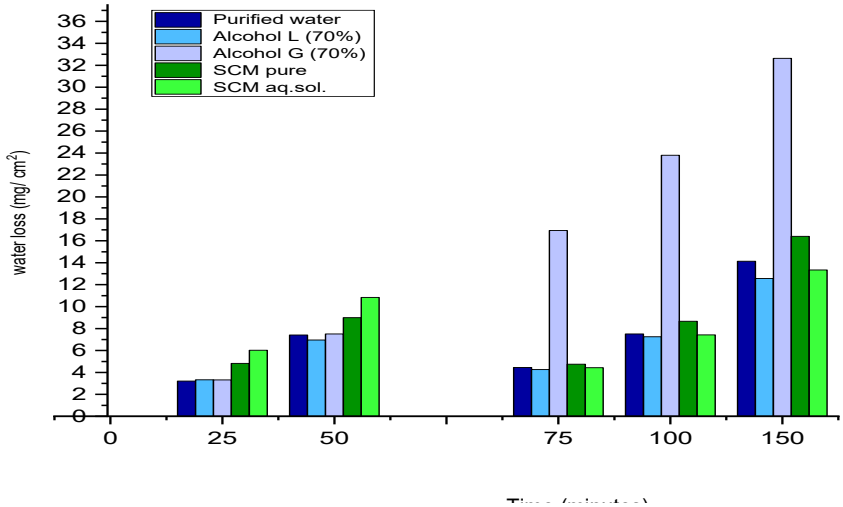


Figure 11. Comparison between purified water, Alcohol L (70%), Alcohol G (70%), pure SCM and aqueous SCM solution.

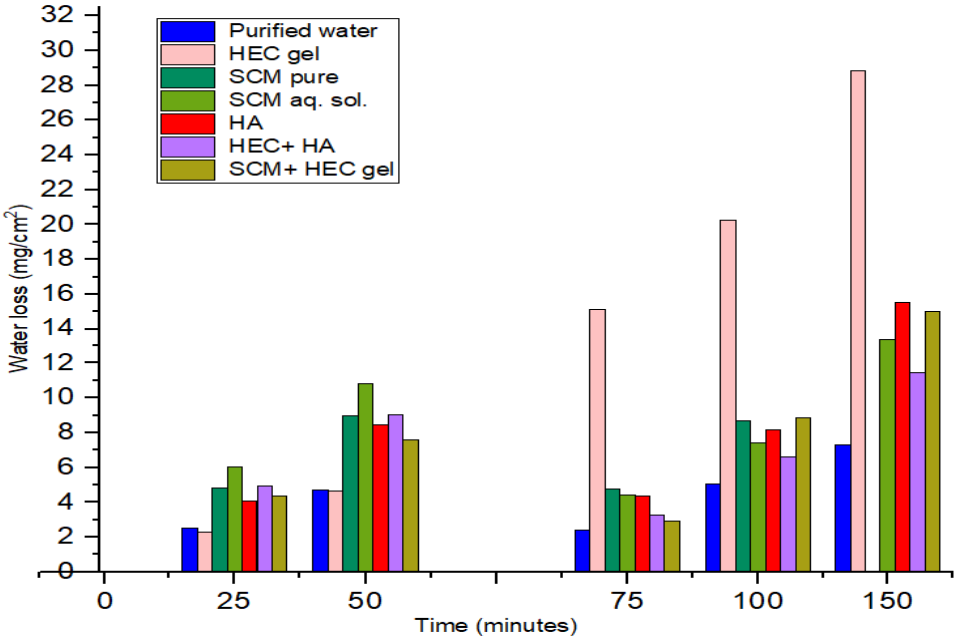


Figure 12. Comparison between purified water, HEC gel, pure SCM, aqueous SCM solution with HA gel and HEC+ HA gel and HA gel+ HEC+ Pure SCM.

CONCLUSION

The Sugar Cane Molasses (SCM) gel has a transparent appearance with acceptable organoleptic and cosmetic properties, including a brown color, a mild and pleasant odor, ease of spreading, a non-greasy feel, and the absence of any residue.

SCM gel can help form an antiseptic, protective film on the skin. However, to be well-received by users, a hand cream must offer specific qualities beyond its moisturizing effect. It needs to be rapidly absorbed, allowing the hands to be ready for immediate use right after application. The SCM gel has a feel neither oily nor sticky and must instantly relieve the tightness and roughness typical of dry hands. The used HEC polymer forms a stable gel and contributes to sensory properties- such as good spreadability, a non-oily and non-sticky feel, and moisturizing action- while being complemented by naturally derived sodium hyaluronate to boost hydration. The sugarcane molasses-based gel provides superior moisturizing capabilities compared to commercial products.

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