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Formulation and Characterization of a Sleeping Mask Gel Utilizing Watermelon (Citrullus lanatus L.) White Rind Juice

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ABSTRAK

Sebuah studi laboratorium dilakukan untuk merumuskan dan mengevaluasi gel sleeping mask yang mengandung sari kulit putih buah semangka (Citrullus lanatus L.) dengan Hydroxypropyl Methylcellulose (HPMC) sebagai agen pengental. Sari kulit putih disiapkan dan dimasukkan ke dalam basis gel yang mengandung HPMC 2–5% dengan eksipien tetap. Karakterisasi mencakup sifat organoleptik, homogenitas, pH, daya lekat, daya sebar, dan viskositas sesuai kriteria mutu gel topikal. Atribut organoleptik yang dapat diterima serta keseragaman teramati pada semua formula. Nilai pH (~4,0–6,0) berada dalam rentang yang sesuai untuk kulit wajah. Peningkatan konsentrasi HPMC berkaitan dengan tingginya daya lekat, dengan pemenuhan kriteria minimum mulai pada HPMC 4%. Daya sebar yang diinginkan diperoleh pada kadar HPMC rendah hingga menengah, sedangkan pengujian viskositas menunjukkan bahwa HPMC 4–5% mencapai kenyamanan aplikasi sekaligus stabilitas struktural. Kinerja keseluruhan mengidentifikasi gel HPMC 4% sebagai kombinasi paling seimbang antara daya sebar, daya lekat, dan viskositas, menghasilkan sediaan yang jernih dan stabil. Temuan ini mendukung kelayakan pengembangan gel sleeping mask dari sari kulit putih semangka, dengan basis HPMC 4% direkomendasikan sebagai formulasi optimal.

Kata Kunci: Gel sleeping mask; Sari kulit putih semangka; HPMC; Evaluasi fisikokimia; Formulasi topikal

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ABSTRACT

A laboratory-based study was conducted to formulate and evaluate a sleeping-mask gel incorporating juice from the white rind of watermelon (Citrullus lanatus L.) with Hydroxypropyl Methylcellulose (HPMC) as the gelling agent. White-rind juice was prepared and incorporated into gel bases containing 2–5% HPMC with fixed excipients. Characterization encompassed organoleptic properties, homogeneity, pH, adhesion, spreadability, and viscosity according to topical gel quality criteria. Acceptable organoleptic attributes and uniformity were observed for all formulas. pH values (~4.0–6.0) lay within the facial-skin-compatible range. Increasing HPMC concentration was associated with greater adhesion, with minimum criteria satisfied from 4% HPMC. Desired spreadability was obtained at lower-to-intermediate HPMC levels, while viscosity testing indicated that 4–5% HPMC achieved application comfort alongside structural stability. Overall performance identified the 4% HPMC gel as providing the most balanced combination of spreadability, adhesion, and viscosity, yielding a clear and stable preparation. These findings support the feasibility of developing a sleeping-mask gel from watermelon white-rind juice, with a 4% HPMC base recommended as the optimal formulation.

Keywords: *Sleeping mask gel; Watermelon white rind juice; HPMC; Physicochemical evaluation; Topical formulation*

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1. Introduction

The utilization of natural resources as active ingredients in cosmetic formulations has gained growing attention in recent years due to their safety, biocompatibility, and environmental sustainability. The increasing global demand for natural-based skincare products has encouraged researchers to explore alternative raw materials derived from plants and agricultural by-products. Among these, the white rind of watermelon (Citrullus lanatus L.) represents a promising yet underutilized natural resource. Despite being commonly discarded as household waste, the white rind contains an abundance of bioactive compounds and essential nutrients, including vitamins, proteins, citrulline, and lycopene. These components are known for their antioxidant, moisturizing, and rejuvenating properties, which contribute to protecting the skin from oxidative stress, maintaining elasticity, and delaying the appearance of wrinkles and fine lines [1–3].

Oxidative stress caused by excessive free radicals is one of the main factors responsible for premature skin aging. Free radicals can trigger the breakdown of collagen fibers, interfere with natural skin repair mechanisms, and induce inflammation, ultimately resulting in a loss of firmness and elasticity. Antioxidants play an important role in neutralizing these free radicals, maintaining cellular integrity, and promoting healthy skin renewal. Consequently, the incorporation of natural antioxidant-rich extracts into topical cosmetic formulations has become a relevant approach in modern cosmetic science. Such innovations not only improve skin protection and rejuvenation but also contribute to environmentally friendly and sustainable product development by utilizing biodegradable materials [4,5].

Sleeping masks have emerged as an innovative form of skincare that provides intensive overnight nourishment. Unlike conventional night creams that may evaporate easily, a sleeping mask is a leave-on formulation designed to remain on the skin during sleep, forming a thin, occlusive film that enhances the absorption of active ingredients. This prolonged contact time allows bioactive components to penetrate deeper into the skin, leading to improved hydration, elasticity, and regeneration. The continuous release of actives during rest supports the skin's natural recovery process, resulting in a fresher, more supple complexion upon waking [6,7].

Hydroxypropyl Methylcellulose (HPMC) is one of the most widely used gelling agents in pharmaceutical and cosmetic formulations. It is highly valued for its non-toxic, non-irritating, and stable physicochemical properties. HPMC possesses hydrophilic characteristics that provide favorable effects such as excellent spreadability on the skin, a pleasant cooling sensation, ease of washing with water, and stable viscosity even after extended storage. Additionally, HPMC exhibits good microbial resistance and minimal swelling when exposed to water, which enhances its performance as a hydrogel-forming polymer. These attributes make HPMC an ideal base material for developing topical gels and facial formulations intended for sensitive skin [8–11].

Given the functional potential of watermelon white-rind extract and the advantageous characteristics of HPMC, this study focuses on the formulation and evaluation of a sleeping-mask gel containing watermelon white-rind juice. The research aims to examine the physicochemical properties of different formulations to determine the optimal composition that ensures desirable viscosity, spreadability, adhesion, and pH balance. Through this study, it is expected that a stable, effective, and environmentally friendly cosmetic gel can be developed, providing both scientific value and practical application in the field of natural-based skincare innovation[12–15].

2. Methods

Desgin Experimental

This research employed an experimental laboratory design focusing on the formulation of a sleeping-mask gel containing white rind juice of watermelon (Citrullus lanatus L.). The juice extract was prepared and incorporated into gel bases using Hydroxypropyl Methylcellulose (HPMC) at varying concentrations. Each formulation was evaluated for physicochemical characteristics including organoleptic properties, homogeneity, pH, viscosity, spreadability, adhesion, and stability to determine the optimal formulation.

Tools and Equipment

The study employed standard laboratory apparatus, including a blender, beakers, glass plates, stirring rods, spatulas, mortars and pestles, filter cloth, dropper pipettes, an analytical balance, a pH meter, a Brookfield viscometer, and scrapers. Reagents and materials comprised watermelon white-rind juice (Citrullus lanatus L.), Hydroxypropyl Methylcellulose (HPMC), propylene glycol, triethanolamine (TEA), methyl paraben, 70% ethanol, distilled water, aluminum foil, parchment paper, and tissue wipes. Equipment supported extraction, dispersion, and gelation processes; chemicals served as gelling polymer, humectant, neutralizer, preservative, solvent, and auxiliary materials for preparation and quality testing. All items were of analytical or cosmetic grade and used under laboratory conditions.

Preparation of Watermelon White Rind Juice (Citrullus lanatus L.)

The watermelon fruit was sectioned; the red mesocarp and the outer green epicarp were removed, leaving the white rind (albedo). The albedo was rinsed with distilled water, drained, and cut into small cubes (~1–2 cm). The pieces were transferred to a blender and homogenized without additives until a uniform slurry formed. The slurry was filtered through clean muslin/filter cloth, and the filtrate was collected as white-rind juice. The first 10–20 mL were discarded to minimize particulate carryover. The juice was kept in a covered container, protected from light with aluminum foil, and used immediately or stored at 4 °C until formulation

Preparation of Watermelon White Rind Sleeping Mask Gel

All ingredients were accurately weighed using an analytical balance. The watermelon white-rind juice was incorporated into a pre-swollen HPMC base and triturated in a mortar with a pestle until a uniform dispersion formed. Propylene glycol (humectant) and methyl paraben (preservative) were subsequently added and mixed until fully dissolved. Triethanolamine (TEA; ten drops) was introduced as a neutralizer to adjust gel formation, after which distilled water was added gradually to a final volume of 100 mL while continuous mixing was maintained. The mass was stirred gently to break lumps, minimize air entrapment, and achieve a smooth, homogeneous consistency with workable viscosity. The gel was allowed to stand for a short degassing period, then transferred to clean, dry, light-protected, airtight containers using sterile spatulas. Each container was labeled appropriately and stored at ambient conditions for further analyses, including organoleptic inspection, pH determination, viscosity, spreadability, adhesion, and preliminary stability observations prior to testing.

Table 1. Formulation of Watermelon White-Rind (Citrullus lanatus L.) Sleeping-Mask Gel

Ingredient	Function	FI	FII	FIII	FIV
Watermelon white-rind juice	Active ingredient	10%	10%	10%	10%
Hydroxypropyl Methylcellulose (HPMC)	Gelling Agent	2%	3%	4%	5%
Propylene glycol	Humectant	10%	10%	10%	10%
Methyl paraben	Preservative	0,4%	0,4%	0,4%	0,4%
Triethanolamine (TEA)	Alkalizing Agent	0,5%	0,5%	0,5%	0,5%
Essens Stroberi	Coloring agent	qs	qs	qs	qs
Distilled water	Solvent	Ad 100%	Ad100%	Ad100%	Ad100%

Evaluation of Watermelon White-Rind (Citrullus lanatus L.) Sleeping-Mask Gel Formulation

1. Organoleptic test

Organoleptic evaluation was performed by observing changes in appearance, color, and odor of the gel during storage at room temperature. The preparation is expected to remain stable from initial manufacture through the test period, showing no discoloration, phase separation, syneresis, or unpleasant odor. Consistency was noted together with spread and uniformity. The physical form or perceived concentration of the gel is influenced by its viscosity; higher viscosity indicates stronger intermolecular interactions within the three-dimensional gel network, which contributes to shape retention and resistance to flow. Any deviation from the initial organoleptic profile was recorded as a sign of reduced stability[16,17].

2. Homogeneity test

Homogeneity testing was conducted by spreading a thin layer of the sleeping-mask gel onto a clean, transparent glass plate. The film was inspected visually under adequate lighting and, when necessary, with low-power magnification. Criteria included a uniform distribution of the matrix, absence of visible agglomerates, crystals, phase separation, or air bubbles, and consistency of color and texture across the smear. Particular attention was paid to particle size and dispersion; smaller and more uniformly distributed particles indicate a more stable preparation with reduced risk of sedimentation or syneresis. Samples failing to meet these criteria were documented for reformulation or further adjustment [18–27].

3. pH test

pH measurement was performed to confirm dermal acceptability of the gel. A calibrated pH meter (two-point calibration with pH 4.01 and 7.00 buffers) was used at room temperature. Approximately 1 g of sample was dispersed in 10 mL of distilled water, allowed to equilibrate for 5 minutes, and measured in triplicate; the mean ± SD was recorded. Formulations were deemed stable and skin-compatible when the pH remained within the physiological range of 4.0–7.0 with minimal drift during storage. Values in this interval indicate low irritation potential and compliance with recommended physical and stability parameters for topical gels, supporting product safety and performance [18–27].

4. Adhesion test

Approximately 0.5 g of sleeping-mask gel was placed on a clean microscope slide and covered with a second slide to form a uniform film. A 1 kg load was applied centrally for 3 minutes at room temperature to standardize contact. The upper slide was then lifted vertically at a constant rate, and the time required for the two slides to separate was recorded as the adhesion time. Measurements were performed in triplicate, and results were expressed as mean ± SD. Formulations meeting an adhesion time greater than 1 second were considered acceptable, indicating sufficient tack for facial retention without excessive stickiness [16,17].

5. Spreadability test

The spreadability test evaluated the ability of the gel to distribute on the skin. A fixed volume of sample was placed at the center of a clean glass plate and covered with a second plate. Standard weights were applied vertically for a defined time, allowing the gel to spread into a circular film. The final diameter (or area) was measured in two perpendicular directions and reported as mean ± SD from triplicate trials. Spreadability is directly related to user comfort and ease of application; topical semisolid preparations are generally acceptable when the spread diameter falls within 3–5 cm, indicating adequate flow without excessive run-off [16,17].

6. Viscosity test

Viscosity was measured using a Brookfield rotational viscometer fitted with spindle 3 at 100 rpm. Each gel sample was transferred to a 250-mL beaker, minimizing air entrapment. The beaker was placed under the instrument, and the spindle was immersed to the calibration mark without contacting the beaker walls or bottom. After temperature equilibration (25 ± 2 °C), the motor was started and the torque allowed to stabilize. The dial (or digital) reading was recorded in triplicate and converted to apparent viscosity (cP) using the manufacturer's factor for spindle 3 at 100 rpm. Results were expressed as mean ± SD for comparison across formulations [16,17].

3. Result and Discussion

The organoleptic assessment aimed to characterize the gel through direct sensory observation, including visual inspection of color and texture and olfactory evaluation of aroma. Following the procedures summarized in Table 2, the prepared sleeping mask gel from watermelon white rind was examined under adequate lighting and at room temperature. The formulation exhibited a uniform pink hue, a coherent semisolid gel consistency without visible phase separation or clumping, and a pleasant sweet strawberry fragrance. These attributes indicate acceptable aesthetic quality and user appeal for a topical facial product. No off-odors, discoloration, or textural

irregularities were detected during the observation period, suggesting satisfactory initial stability [28,29].

Table 2. Organoleptic test

Formula	Color	Texture
F1	Pink	Liquid
F2	Pink	Slightly watery
F3	Pink	Thick
F4	Pink	Very thick

Homogeneity was assessed on a clear glass surface. A thin layer of the watermelon white-rind sleeping mask gel (Citrullus lanatus) was placed on a microscope slide and covered with a second slide to form a uniform film. The smear was inspected under adequate illumination, with low-power magnification when needed, to detect coarse granules, undissolved polymer, air bubbles, or evidence of phase separation. Color and texture uniformity across the film were also noted. The test demonstrated that the preparation was free from visible particulates or gritty material, indicating a homogeneous dispersion of ingredients and appropriate processing conditions for a cosmetically elegant gel [13,30].

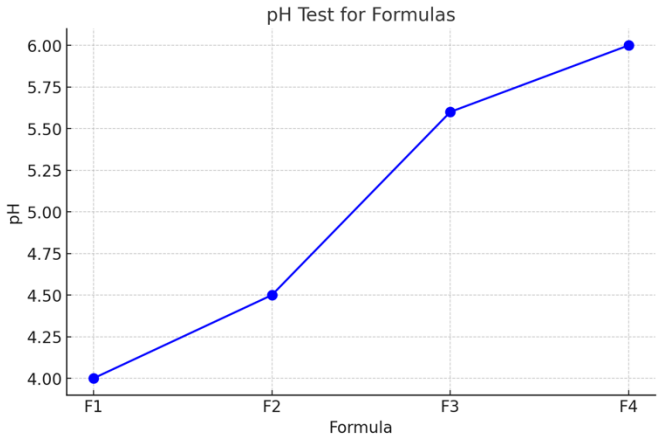

Figure 1. Graph pH test

Table 3. pH test

Formula	pH
F1	4
F2	4,5
F3	5,6
F4	6

This test determined whether the gel matched facial-skin pH to minimize irritation risk. A calibrated pH meter was immersed in the sample and allowed to equilibrate for ~30 seconds until a stable digital reading appeared. Measurements were performed in triplicate at room temperature, and mean ± SD values were recorded. The acceptable interval for normal facial skin in men and women is approximately pH 4.5–5.5. As

summarized in Table 3 and Figure 1, the sleeping-mask gel containing watermelon white-rind juice (Citrullus lanatus) exhibited pH values within this physiological range, with minimal drift during observation. The results indicate good dermal compatibility and a low likelihood of irritation.

This test is conducted to assess the adhesion properties of the gel formulation applied to the skin. A 0.5 g sample of the gel is placed on a glass slide, which is then covered with another glass slide. A 150 g weight is applied, and the setup is left undisturbed for 1 minute. The time it takes for the two glass slides to separate is then recorded. The formulation is considered satisfactory if the adhesive force between the slides persists for no less than 4 seconds, indicating good adhesion to the skin [31,32].

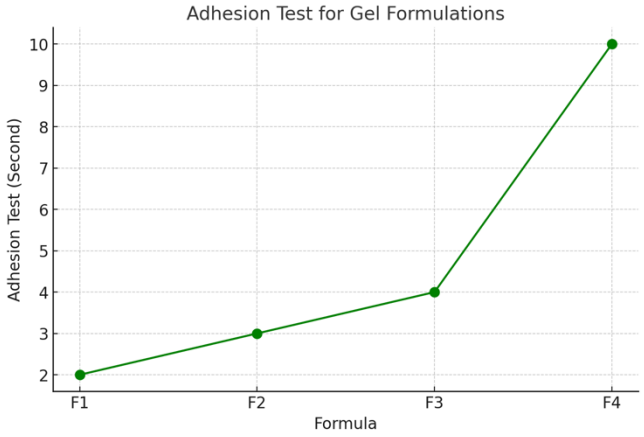

Figure 2. Graph Adhesion test

Table 4. Adhesion test

Formula	Adhesion test (Second)
F1	2
F2	3
F3	4
F4	10

Based on Table 4 and Figure 2, the results of the adhesion test indicate that the sleeping mask gel formulation made from watermelon rind extract (Citrullus Lanatus) meets the required adhesion standard for a gel formulation, which is no less than 4 seconds. This suggests that the formulation demonstrates satisfactory adhesion properties, making it suitable for its intended use.

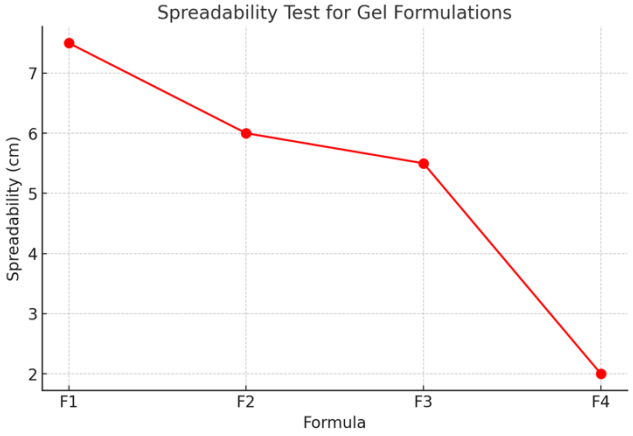

Figure 3. Graph Spreadability test

Table 5. Spreadability test

Formula	Spreadability (cm)
F1	7.5
F2	6
F3	5.5
F4	2

This test is conducted to ensure that the gel formulation spreads effectively on the skin, allowing the active ingredients within the gel to work efficiently. The good spreading property of a gel is essential for optimal performance, with the ideal spreading distance ranging from 5 to 7 cm. This criterion ensures that the formulation is suitable for topical application, providing sufficient coverage for the active compounds to interact with the skin effectively. Can be seen table 5 and figure 3.

The viscosity test is performed to measure the thickness of the sleeping mask gel formulation made from watermelon rind extract (Citrullus Lanatus). The test was conducted at 50 rpm using a Brookfield viscometer

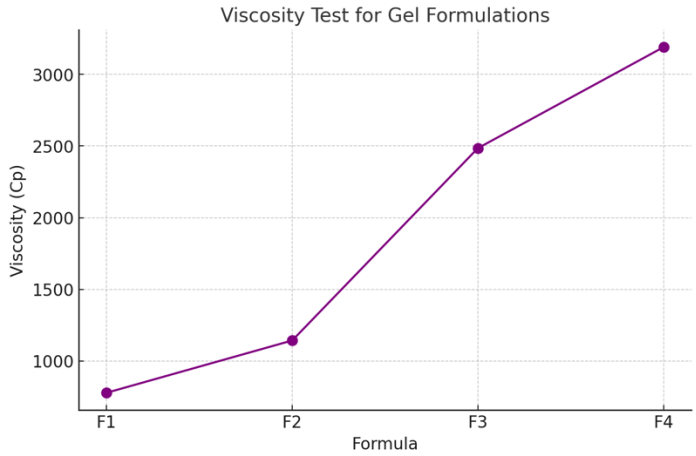

Figure 4. Graph Viscosity test

Tabel 6. Viscosity test

Formula	Viscosity (Cp)
F1	778
F2	1143
F3	2485
F4	3190

A good gel formulation typically falls within the 2000-4000 cPs viscosity range, as this consistency allows the gel to spread well upon application to the skin. Based on Table 6 and Figure 3, the viscosity results indicate that the sleeping mask gel formulation from watermelon rind extract falls within the optimal range for a good gel formulation.

4. Conclusion

Based on the research findings, the formulation of the sleeping mask gel using 4% HPMC as a base, made from watermelon rind extract (Citrullus Lanatus), produced a clear gel with optimal viscosity. The evaluation results from organoleptic testing, homogeneity, pH, adhesion, and spreadability tests concluded that the sleeping mask gel formulation has excellent physical properties. These results demonstrate that the gel possesses the desired characteristics, making it suitable for its intended application as a cosmetic product.

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