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Research Article

Formulation and Physical Quality Evaluation of a Peel-Off Gel Mask Containing Eucheuma spinosum Extract

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Abstract

The increasing concern over the long-term use of synthetic cosmetic ingredients has driven the development of natural-based skincare products. Seaweed (Eucheuma spinosum) is an abundant marine resource in Indonesia rich in bioactive compounds with potential cosmetic benefits. This study aimed to formulate a peel-off gel mask containing E. spinosum extract and to evaluate its physical quality and consumer preference. Seaweed was extracted by maceration using 96% ethanol and incorporated into gel formulations at three concentrations: 3 g (F1), 5 g (F2), and 7 g (F3). Physical quality tests included organoleptic evaluation, pH, homogeneity, spreadability, viscosity, drying time, stability using a cycling test, and hedonic (preference) testing. All formulations met acceptable cosmetic standards, showing skin-compatible pH (4.5–6.5), good homogeneity, spreadability of 5–7 cm, viscosity within 5,183–6,017 cPs, drying time of 18–22 minutes, and stable characteristics during storage. Hedonic testing indicated that formulation F1 was most preferred by panelists and demonstrated the best overall characteristics. These results suggest that E. spinosum extract is a promising natural active ingredient for peel-off gel mask formulations.

Keywords: Peel-off Gel Mask; Eucheuma Spinosum; Natural Cosmetic; Formulation; Seaweed Extract

Abbreviations

UV: Ultraviolet; F1: Formula 1; F2: Formula 2; F3: Formula 3; cPs: Centipoise; PVA: Polyvinyl Alcohol; HPMC: Hydroxypropyl Methylcellulose

Introduction

Routine facial skin care is essential to maintain skin health and appearance [1]. However, prolonged use of synthetic active ingredients in cosmetics may cause adverse effects, encouraging a shift toward natural-based alternatives. Seaweed is a marine bioresource containing bioactive compounds such as flavonoids, phenolics, alkaloids, and polysaccharides that exhibit antioxidant [2], antibacterial [3], moisturizing, UV-protective, and anti-aging activities [4].

Among various cosmetic dosage forms, peel-off gel masks are popular because they are practical, form an elastic film after drying, and can be removed without rinsing [4]. They function through an

occlusive effect that enhances penetration of active compounds into the skin.

Eucheuma spinosum, a red seaweed widely cultivated in Indonesia, is particularly rich in K-carrageenan, a sulfated polysaccharide known for its strong water-binding and film-forming properties, which contribute to skin hydration and moisture retention [5]. In addition, this seaweed contains mycosporine-like amino acids (MAAs) that can absorb ultraviolet radiation, thereby providing natural photoprotective effects [6]. The presence of phenolic compounds and flavonoids such as catechin derivatives further supports its antioxidant capacity, helping to neutralize free radicals associated with skin aging. These bioactive constituents make E. spinosum a promising natural ingredient for improving skin hydration and protecting against UV-induced damage [7]. Incorporating this extract into a peel-off gel mask may therefore provide a safe and effective natural skincare product. Therefore, this study aimed to develop peel-off gel mask formulations containing E. spinosum extract and to evaluate their physical quality and user acceptability [8].

Materials and Methods

Materials

Dried Eucheuma spinosum was used as the active ingredient. Other formulation components included polyvinyl alcohol (PVA) as film former [9], hydroxypropyl methylcellulose (HPMC) as gelling agent [10], glycerin as humectant, methyl paraben and propyl paraben as preservatives, and distilled water as solvent.

Preparation of seaweed extract

The dried seaweed simplicia was extracted by cold maceration using 96% ethanol at room temperature [11]. After filtration, the solvent was evaporated to obtain a concentrated extract [12].

Formulation of peel-off gel mask

Three formulations were prepared containing different extract concentrations.

The gel base was prepared by dissolving PVA in hot water, dispersing HPMC in cold water, then mixing both phases with glycerin, preservatives, and the seaweed extract until a homogeneous gel was formed [9].

Tabel 1: Formulation of Peel-Off Gel Mask.

Bahan	F1 (gram)	F2 (gram)	F3 (gram)
Ekstrak Rumput Laut	3	5	7
Plovinyl alcohol (PVA)	10	10	10
Hydroxylpropyl methylcellulose (HPMC)	1	1	1
Gliserin	10	10	10
Metil paraben/nipagin	0,2	0,2	0,2
Propil paraben/nipasol	0,05	0,05	0,05
Aquadest	Ad 100	Ad 100	Ad 100

1. F1: 3 g extract
2. F2: 5 g extract
3. F3: 7 g extract

Physical quality evaluation

The following tests were performed [13]:

- Organoleptic test: Color, odor, and texture observation [12]
- Homogeneity: Absence of coarse particles between glass slides [14]
- pH: Measured after diluting 1 g gel in 10 mL water [12]
- Spreadability: Acceptable range 5–7 cm [14]
- Viscosity: Measured with Brookfield viscometer [4]
- Drying time: Time required to form peelable film (target 15–30 min) [4]
- Stability (cycling test): Six cycles at 4 °C and 40 °C [4]
- Hedonic test: Panelist preference scoring (1–5 scale) [15].

The user acceptability test involved 10 untrained panelists who were undergraduate students of the Cosmetology and Beauty Care Study Program, Universitas Negeri Jakarta, aged between 18–25 years. The evaluation was conducted based on three main aspects: color, aroma, and texture.

A 5-point Likert scale was used to assess preference, with the following categories: 1 = strongly dislike, 2 = dislike, 3 = moderately like, 4 = like, and 5 = strongly like. This scale provided a general overview of the panelists' subjective acceptance of the formulations, which is essential to determine the suitability of the formula according to consumer preference.

These parameters follow cosmetic quality standards for gel preparations.

Results and Discussion

All three formulations of peel-off gel mask containing *Eucheuma spinosum* extract exhibited acceptable physical characteristics.

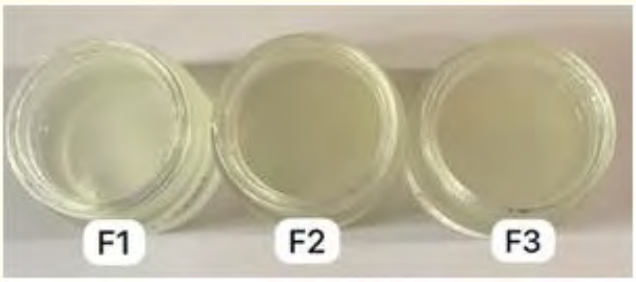

Figure 1: Organoleptic test.

Organoleptic evaluation showed that all formulations produced smooth, homogeneous gels with a brownish color and a characteristic seaweed odor. The absence of coarse particles indicated good homogeneity, suggesting that the extract and excipients were well dispersed within the gel base.

pH

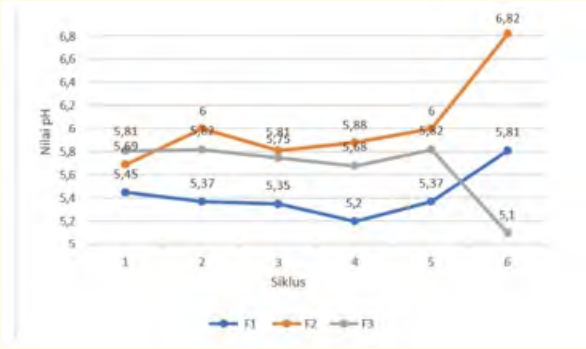

Figure 2: pH Measurement of the Preparations.

Tabel 2: Formulation of Peel-Off Gel Mask.

Formula	pH Rata-Rata	Standard
1	5.43	4.5-6,5
2	6.03	
3	5.66	

The initial pH values of all formulations were found to be within the range of 4.5–6 [16], which is considered safe and compatible with human skin. This pH range indicates a low potential for skin irritation and complies with general cosmetic requirements for topical preparations. Appropriate pH is essential to maintain skin barrier function and ensure user comfort during application [17].

Although most formulations maintained pH values within the acceptable cosmetic range (4.5–6) [16], formulation F2 exhibited an increase in pH to 6.82 in the final cycling test. This slight elevation beyond the recommended range may be attributed to changes in the chemical equilibrium of the gel system during temperature stress. The cycling test (4°C–40°C) can accelerate hydrolysis or degradation of certain components, particularly polymeric materials such as polyvinyl alcohol (PVA) and HPMC, which may alter ionization balance within the formulation. Additionally, interactions between the seaweed extract constituents (e.g., polysaccharides such as carrageenan) and the gel base may contribute to minor pH shifts under extreme temperature conditions [18].

An increase in pH beyond 6.5 may potentially affect skin compatibility and long-term product stability. Slightly alkaline conditions can disturb the skin's acid mantle, potentially increasing the risk of mild irritation with prolonged use [16]. From a formulation perspective, pH instability may also indicate reduced buffering capacity, suggesting the need for pH adjustment or incorporation of a buffering agent in future optimization. However, since the observed pH change occurred only in the final stress cycle and remained close to the acceptable limit, it does not indicate severe formulation instability but highlights the importance of monitoring pH during storage to ensure product safety and quality consistency.

Spreadability

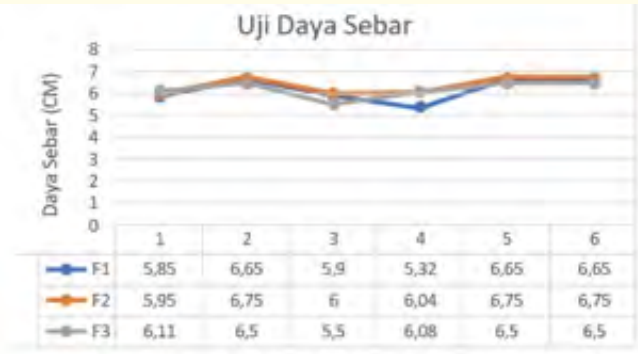

Figure 3: Spreadability Test Results.

Table 3: Spreadability Test Results.

Formula	Rata Rata	Standard
1	6,17	
2	6,37	5-7cm
3	6,2	

Spreadability testing demonstrated values within the standard requirement of 5–7 cm. These results indicate that the gel masks could be easily spread on the skin surface, allowing uniform application. Adequate spreadability is influenced by the balance between viscosity and gel structure, which is crucial for consumer acceptance and effective coverage of the facial area [19].

Viscosity

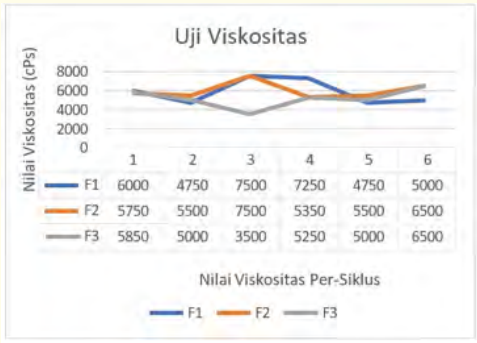

Figure 4: Viscosity Measurement Results.

Table 4: Effect of different pesticide concentrations on the Actinomycetes population (Actinomycetes Count ×10^3, cfu/g) at various time intervals.

Treatments	DAY 1	DAY 7	DAY 14	DAY 21
T1	13.97 ± 0.067	13.58 ± 0.09	11.37 ± 0.064	9.23 ± 0.12
T2	11.34 ± 0.15	8.922 ± 0.13	6.98 ± 0.11	5.93 ± 0.16
T3	9.72 ± 0.055	7.21 ± 0.153	5.91 ± 0.06	4.66 ± 0.22
T4	7.43 ± 0.13	5.53 ± 0.075	4.18 ± 0.09	2.633 ± 0.09
T5	12.96 ± 0.067	10.94 ± 0.154	7.93 ± 0.112	7.01 ± 0.054
T6	10.73 ± 0.175	7.8 ± 0.155	6.167 ± 0.082	5.91 ± 0.08
T7	8.32 ± 0.16	5.71 ± 0.089	5.07 ± 0.1	4.34 ± 0.13

Viscosity measurements ranged from 5,183 to 6,017 cPs, falling within acceptable limits for gel-based cosmetic formulations. This viscosity range is suitable for peel-off gel masks, as it provides sufficient consistency to form an even layer while maintaining the ability to be peeled off as a continuous film after drying. The presence of polyvinyl alcohol contributed to the film-forming properties of the formulation [20].

Drying time

Drying time evaluation showed that all formulations dried within 18–22 minutes, meeting the criteria for peel-off gel masks. This drying time is considered optimal, as excessively long drying times may reduce user convenience, while very short drying times may result in incomplete film formation [21].

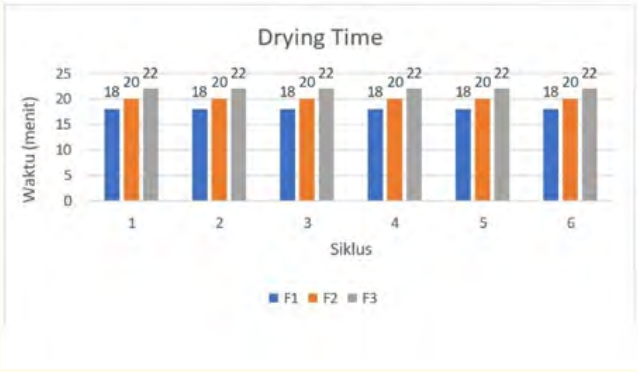

Figure 5: Drying Time of the Preparations.

Stability

Stability testing using cycling test methods revealed no significant changes in organoleptic properties, pH, homogeneity, spreadability, viscosity, or drying time. These results indicate that the formulations possessed good physical stability under stress conditions, suggesting that the peel-off gel masks are stable during storage and handling [22].

Hedonic test

The hedonic evaluation results showed differences in panelists' preferences among the three peel-off gel mask formulations containing *Eucheuma spinosum* extract. Based on mean scores, formulation 1 exhibited the highest overall acceptance across all sensory attributes evaluated.

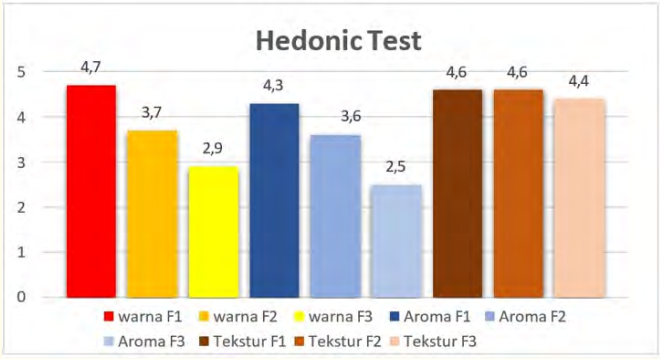

Figure 6: Hedonic Evaluation of the Preparations.

Figure 7: Peel-off Gel Mask Preparation Containing Seaweed (*Eucheuma spinosum*) Extract.

For color, formulation 1 achieved the highest mean score (4.7), indicating strong panelist preference compared to formulation 2 (3.7) and formulation 3 (2.9). In terms of aroma, formulation 1 also demonstrated the highest preference with a mean value of 4.3, followed by formulation 2 (3.6) and formulation 3 (2.5). These results suggest that formulation 1 provided a more visually appealing appearance and a more acceptable odor [21].

Texture evaluation showed that formulation 1 and formulation 2 were equally preferred, each obtaining a mean score of 4.6, while formulation 3 showed a slightly lower score (4.4). The high texture acceptance of formulations 1 and 2 was associated with their smooth, soft, and semi-solid gel consistency [21].

Overall, formulation 1 was identified as the most preferred based on combined color, aroma, and texture attributes, suggesting greater consumer acceptance potential.

Conclusion

This study successfully formulated a peel-off gel mask containing *Eucheuma spinosum* seaweed extract at three different concentrations. All formulations met the required physical quality standards for cosmetic gel preparations, including acceptable organoleptic properties, homogeneity, skin-compatible pH, appropriate spreadability, suitable viscosity, optimal drying time, and good physical stability during storage.

Hedonic evaluation revealed differences in consumer preferences among the formulations, with formulation F1 demonstrating the highest overall acceptance across color, aroma, and texture. The superior acceptance of F1 indicates that a lower concentration of *E. spinosum* extract provided a more favorable balance between physical characteristics and sensory attributes.

Overall, the findings of this study indicate that *Eucheuma spinosum* extract is a promising natural active ingredient for peel-off gel mask formulations, and formulation F1 represents the most suitable formulation for further development and potential application as a natural cosmetic product.

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Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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