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Optimizing Carrageenan-Based Moisturizers: From Kappaphycus alvarezii Extraction to Formulation

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ABSTRACT

Carrageenan, a sulfated polysaccharide extracted from red seaweed (*Kappaphycus alvarezii*), possesses a high water-holding capacity and has been widely investigated for its potential application as a skin moisturizing agent. This study aimed to formulate isolated carrageenan into a topical cream and to evaluate its physicochemical characteristics and moisturizing efficacy. Carrageenan was isolated through sequential soaking, decantation, extraction, isolation, drying, and milling processes. The isolated material was characterized in terms of solubility, viscosity, loss on drying, and Fourier transform infrared (FTIR) spectroscopy. Cream formulations containing carrageenan at concentrations of 2.5%, 5%, 7.5%, and 10% (w/w) were prepared and compared with a 2% glycerin cream and a blank control. Physical quality evaluations included homogeneity, pH, emulsion type, stability testing for 12 weeks, skin irritation assessment, and in vivo moisturizing activity in 18 human volunteers. The isolated carrageenan complied with the requirements of USP XXX. All carrageenan-based creams exhibited acceptable homogeneity, skin-compatible pH, and satisfactory physical stability throughout the storage period. No signs of skin irritation were observed. Moisturizing efficacy increased proportionally with carrageenan concentration, with the 2.5% carrageenan cream demonstrating a moisturizing effect comparable to that of the 2% glycerin formulation. These findings support the potential of carrageenan derived from *Kappaphycus alvarezii* as an effective natural moisturizing agent in topical cream formulations.

Keywords: *Kappaphycus alvarezii*; carrageenan; isolation; cream formulation; moisturizer

ABSTRAK

Karagenan merupakan polisakarida tersulfatasi yang diekstrak dari rumput laut merah (*Kappaphycus alvarezii*) dan dikenal memiliki kapasitas menahan air yang tinggi, sehingga berpotensi digunakan sebagai agen pelembap kulit. Penelitian ini bertujuan untuk merumuskan karagenan hasil isolasi ke dalam sediaan krim serta mengevaluasi karakteristik fisikokimia dan efektivitas pelembapannya. Proses isolasi dilakukan melalui tahapan perendaman, dekantasi, ekstraksi, isolasi, pengeringan, dan penggilingan. Karagenan yang diperoleh dikarakterisasi berdasarkan kelarutan, viskositas, kehilangan pengeringan, dan analisis Fourier transform infrared (FTIR). Formulasi krim dibuat dengan variasi konsentrasi karagenan sebesar 2,5%, 5%, 7,5%, dan 10% (b/b), kemudian dibandingkan dengan krim gliserin 2% dan kontrol kosong. Evaluasi mutu fisik meliputi uji homogenitas, pH, jenis emulsi, stabilitas selama 12 minggu, uji iritasi kulit, serta pengujian kemampuan melembapkan secara *in vivo* pada 18 relawan manusia. Karagenan hasil isolasi memenuhi persyaratan USP XXX. Seluruh sediaan krim menunjukkan homogenitas yang baik, pH yang sesuai dengan kulit, serta stabilitas fisik yang memadai selama penyimpanan. Tidak ditemukan indikasi iritasi kulit. Efek pelembapan meningkat seiring dengan kenaikan konsentrasi karagenan, di mana krim karagenan 2,5% menunjukkan efektivitas yang hampir setara dengan krim gliserin 2%. Hasil penelitian ini mendukung potensi karagenan dari *Kappaphycus alvarezii* sebagai bahan pelembap alami dalam formulasi krim topikal.

Kata kunci: *Kappaphycus alvarezii*; karagenan; isolasi; sediaan krim; pelembap

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1. Introduction

One of the most widely cultivated seaweed species in Indonesia is *Kappaphycus alvarezii*, a red seaweed belonging to the class *Rhodophyceae* and recognized as a primary source of carrageenan. Carrageenan

is a hydrophilic, linear sulfated galactan that exhibits multifunctional properties, including its role as a stabilizing agent, thickener, and emulsifier in pharmaceutical and cosmetic formulations. In cream preparations, emulsion stabilizers are essential to ensure physical stability during prolonged storage, and carrageenan has been extensively utilized for this purpose due to its ability to enhance viscosity and stabilize oil–water interfaces [1].

The growing consumer preference for cosmetic products derived from natural ingredients has created significant opportunities for the utilization of marine biopolymers, particularly seaweed-based materials, as cosmetic raw ingredients. Carrageenan extracted from seaweed has been reported to exhibit high compatibility in cosmetic formulations, making it suitable for topical application and skin care products [2]. Moisturizers are cosmetic preparations specifically designed to maintain the structure and physiological function of the skin by protecting it against environmental stressors such as low humidity, excessive ultraviolet exposure, strong winds, aging, and certain pathological conditions that accelerate transepidermal water loss, ultimately leading to skin dryness [3].

The skin is a vital organ composed of multiple layers, including a thin lipid layer that plays a crucial role in preventing excessive water evaporation and maintaining hydration. Under normal conditions, the skin secretes sebum as a natural lubricant to preserve softness, elasticity, and barrier integrity. Loss or reduction of sebum can result in increased skin fragility, cracking, dryness, and scaliness. Therefore, additional protection through the application of moisturizing cosmetic products is often required. Cream formulations are commonly classified as skin care cosmetics and are typically semi-solid emulsions containing at least 60% water, intended for external application [4]. An ideal cream formulation should provide adequate moisturizing effects, impart a soft and pleasant skin feel, and avoid excessive greasiness [5].

In various dermatological conditions, adequate moisturization is essential to preserve skin integrity and function. Both intrinsic and extrinsic factors can exacerbate skin dryness through unnoticed evaporation of water from the skin surface. Carrageenan, as a galactan with a high water-binding capacity, is capable of retaining moisture and forming a protective film on the skin. In addition, carrageenan is believed to contribute to skin smoothing and softening, further supporting its suitability for incorporation into skin care formulations [6]. These properties provide a strong scientific rationale for investigating the incorporation of carrageenan derived from *Kappaphycus alvarezii* into moisturizing cream formulations based on natural ingredients.

2. Materials and Methods

2.1 Materials

Red seaweed (*Kappaphycus alvarezii*), calcium chloride 1%, hydrogen peroxide 1%, sodium hydroxide, distilled water, calcium stearate, cetyl alcohol, triethanolamine, methyl paraben, glycerin, and distilled water were used in this study. All reagents were of pharmaceutical or analytical grade.

2.2 Preparation of Seaweed Simplisia

Red seaweed (*Kappaphycus alvarezii*) was collected from Bone Beach, South Sulawesi Province, Indonesia, and taxonomically identified at the Oceanographic Research Center, Indonesian Institute of Sciences (LIPI), Jakarta (authorization number: B-1377/IPK.2/IF/V/2016). The raw material was processed into simplisia at the Pharmacognosy Laboratory, Faculty of Pharmacy, Universitas Sumatera Utara.

Fresh seaweed was cleaned thoroughly under running water to remove adhering impurities, followed by aeration drying. The material was subsequently dried in a drying oven until a constant weight was achieved. The dried seaweed was then cut into small pieces, pulverized using a blender, and sieved to obtain a uniform simplisia powder.

2.3 Characterization of Seaweed Simplisia

The characterization of the seaweed simplisia included macroscopic and microscopic examination, determination of moisture content, evaluation of water-soluble extractive value, determination of ethanol-soluble extractive value, total ash content, and acid-insoluble ash content, conducted in accordance with standard pharmacognostic procedures [7], [8].

2.4 Isolation of Carrageenan from Seaweed Simplisia Powder

Prior to carrageenan isolation, the simplisia powder underwent sequential soaking, blanching, and extraction processes. Following extraction, the mixture was filtered using calico cloth and gently pressed to obtain the filtrate. A volume of 50 mL of the filtrate was mixed with 5 mL of 0.3 N potassium chloride (KCl) solution and allowed to stand for 24 hours to facilitate carrageenan precipitation. The precipitated carrageenan

was collected and dried in an oven at 50 °C, followed by grinding using a mortar and pestle to obtain carrageenan powder [9].

2.5 Characterization of Carrageenan

The isolated carrageenan was characterized by evaluating its viscosity, loss on drying, total ash content, acid-insoluble ash content, and functional group profile using Fourier transform infrared (FTIR) spectrophotometry [10].

2.6 Cream Preparation

Cream formulations were prepared by melting stearic acid and cetyl alcohol in a porcelain cup over a water bath to form the oil phase (mass I). Methyl paraben (nipagin) was dissolved in hot distilled water, followed by the addition of triethanolamine, and stirred until completely dissolved to form the aqueous phase (mass II). Mass II was gradually added to mass I in a preheated mortar while continuously stirring until a homogeneous cream base was obtained.

For the glycerin cream, 2% glycerin was incorporated into the cream base by trituration, followed by gradual addition of the base until a uniform preparation was achieved. The formulation design of carrageenan cream preparations is presented in Table 1.

Table 1. Red Seaweed Carrageenan Cream Formulation

Composition (g)	**A**	**B**	**C**	**D**	**E**	**F**
Cream base	100	98	97.5	95	92.5	90
Carrageenan	–	–	2.5	5	7.5	10
Glycerin	–	2	–	–	–	–

Description:
Formula A: Blank (cream base without active ingredient)
Formula B: Cream containing 2% glycerin
Formula C: Cream containing 2.5% carrageenan
Formula D: Cream containing 5% carrageenan
Formula E: Cream containing 7.5% carrageenan
Formula F: Cream containing 10% carrageenan

2.7 Physical Quality Evaluation of Cream Preparations

2.7.1 Homogeneity Test

A small amount of each preparation was spread on a glass slide or other transparent surface and visually examined to ensure a uniform appearance without the presence of coarse particles.

2.7.2 Determination of Emulsion Type

A portion of the cream was placed on a glass slide, followed by the addition of one drop of methylene blue solution. The sample was gently mixed, covered with a cover glass, and observed under light. Uniform distribution of methylene blue indicated an oil-in-water (o/w) emulsion, whereas the appearance of blue spots indicated a water-in-oil (w/o) emulsion [11].

2.7.3 pH Measurement

The pH of the preparations was measured using a calibrated pH meter. Calibration was performed using standard buffer solutions at pH 4.01 and 7.01. A sample solution was prepared by dispersing 1 g of the cream in 100 mL of distilled water (1% w/v). The electrode was immersed in the sample solution, and the pH value was recorded after stabilization.

2.7.4 Emulsion Stability Test

Each formulation was stored in a tightly closed plastic container and evaluated immediately after preparation and after 1, 4, 8, and 12 weeks of storage at room temperature. Observations included physical changes such as phase separation, color alteration, and odor development.

2.8 Irritation Test and Evaluation of Moisturizing Effect

2.8.1 Volunteers

A total of 18 healthy volunteers participated in the irritation test and moisturizing efficacy evaluation. Volunteer selection was based on predefined inclusion criteria as described previously [4].

2.8.2 Skin Irritation Test

A small amount of each cream formulation was applied to the area behind the ear and left in contact with the skin for 24 hours. The application site was observed for signs of erythema, itching, or swelling [12].

2.8.3 Evaluation of Skin Moisturizing Effect

The moisturizing effect was evaluated by measuring the ability of the preparations to reduce water evaporation from the skin. The 18 volunteers were divided into six groups, with each formulation tested on three volunteers. The cream was applied daily to the dorsal surface of the left hand for 28 days. Baseline skin moisture levels were measured prior to application, followed by subsequent measurements on days 7, 14, 21, and 28.

Before each measurement, the skin surface was gently cleaned with tissue paper. The moisture checker sensor was cleaned using lens tissue, and the device was calibrated until the display showed 00.0. The probe was then placed on the skin surface, and the displayed value was recorded as the percentage of skin moisture content.

3. Results and Discussion

3.1 Characterization of Kappaphycus alvarezii Simplisia

The characterization of *Kappaphycus alvarezii* simplisia powder included the determination of moisture content, water-soluble extractive value, ethanol-soluble extractive value, total ash content, and acid-insoluble ash content. These parameters are essential to ensure the quality, purity, and suitability of the raw material for further pharmaceutical processing. The results obtained in this study showed several differences when compared with previously reported data [12], which may be attributed to variations in geographical origin, environmental conditions, harvesting time, and post-harvest processing.

The detailed characterization results are presented in Table 2. The moisture content of the simplisia was within acceptable limits, indicating adequate drying and reduced risk of microbial growth. The relatively high water-soluble extractive value reflects the abundance of hydrophilic constituents, consistent with the polysaccharide-rich nature of red seaweed. Meanwhile, the total ash and acid-insoluble ash contents provide an indication of the mineral composition and the presence of inorganic impurities, respectively, confirming the acceptable quality of the simplisia for carrageenan isolation.

Table 2. Simplisia Characterization Parameters of *Kappaphycus alvarezii* Thallus

No.	Parameter	Result (%)	Result (%) [12]
1	Water content	7.81	8.64
2	Water-soluble extractive content	46.49	22.50
3	Ethanol-soluble extractive content	4.02	1.10
4	Total ash content	29.14	3.20
5	Acid-insoluble ash content	0.47	0.13

3.2 Isolation of Carrageenan

Carrageenan isolation from *Kappaphycus alvarezii* thallus yielded a white powder, indicating effective removal of impurities during processing. The addition of potassium chloride as a precipitating agent contributed to the successful recovery of carrageenan [13]. The yield data obtained from four isolation runs are presented in Table 3, with an average yield of approximately 30%. Carrageenan yield is calculated as the ratio of the dry carrageenan weight to the initial dry seaweed weight, expressed as a percentage. Potassium ions play a critical role in carrageenan gel formation, particularly for κ-carrageenan, which exhibits high reactivity toward potassium ions, while ι-carrageenan is more sensitive to calcium ions. Both κ- and ι-carrageenan can be precipitated using potassium chloride due to the ability of potassium ions to promote intermolecular aggregation [9].

The presence of potassium ions facilitates the formation of double-helix structures through glycosidic bond interactions upon cooling, resulting in gel formation. Increasing potassium ion concentration has been reported to enhance gel elasticity and increase both the sol–gel transition temperature and gelation temperature of carrageenan solutions [14]. These mechanisms explain the satisfactory yield and physical characteristics of the isolated carrageenan obtained in this study.

Table 3. Carrageenan Yield Obtained from *Kappaphycus alvarezii* Using KCl as Precipitating Agent

No.	Carrageenan Isolation Result (g)	Yield (%)
1	15.510	31.02
2	14.143	28.28
3	14.820	29.64
4	15.585	31.17
Total	**60.058**	—

3.3 Characterization of Isolated Carrageenan

The characterization results confirmed that the isolated carrageenan met established quality requirements. Based on physicochemical parameters and functional group analysis, the carrageenan obtained was identified as κ-carrageenan rather than ι- or λ-carrageenan [15]. The measured viscosity, loss on drying, total ash content, and acid-insoluble ash content were all within the acceptable ranges specified in the literature and pharmacopeial references [10], [16]. As shown in Table 4, the viscosity value exceeded the minimum requirement, indicating adequate molecular weight and functional performance as a thickening agent. The loss on drying value was below the maximum limit, reflecting acceptable moisture content. Total ash and acid-insoluble ash values were also within specified limits, confirming low levels of inorganic contamination and good overall purity of the isolated carrageenan.

Table 4. Physicochemical Characteristics of Isolated Carrageenan Compared with Literature Values

No.	Parameter	Result	Literature [10]
1	Viscosity	7.5 cP	> 5 cP
2	Loss on drying	10.14%	< 12.5%
3	Total ash content	16.11%	< 35.0%
4	Acid-insoluble ash content	1.33%	< 2.0%

3.4 FTIR Spectrophotometric Analysis of Carrageenan

FTIR spectrophotometric analysis was employed to identify the functional groups present in the isolated carrageenan. The absorption bands observed in the FTIR spectrum corresponded well with characteristic carrageenan functional groups, as summarized in Table 5. The presence of absorption bands associated with hydroxyl groups (O–H), aliphatic C–H stretching, sulfate ester groups, glycosidic bonds, 3,6-anhydro-D-galactose, and galactose-4-sulfate confirmed the carrageenan structure. Notably, the absorption band corresponding to galactose-4-sulfate and 3,6-anhydrogalactose is characteristic of κ-carrageenan, supporting the identification results [12], [13]. The close agreement between the observed spectrum, reference data, and standard spectra further validates the successful isolation of κ-carrageenan.

Table 5. FTIR Spectral Characteristics of Isolated Carrageenan Compared with Literature and Standard Values

No.	Functional group	Wavenumber (cm^{-1}) – Result	Literature [12] (cm^{-1})	Standard (cm^{-1})
1	O–H stretching	3421.72	3325.28	3400
2	Aliphatic C–H stretching	2924.09	2930	2954
3	C=O stretching	1635.64	1697.36	1639
4	Sulfate ester (S=O)	1230.58	1260.73	1249
5	Glycosidic bond (C–O–C)	1029.99	1041.56	1029
6	3,6-anhydro-D-galactose	921.97	933.55	1080–1010
7	Galactose-4-sulfate	840.96	848.68	850–840

3.5 Physical Quality Evaluation of Cream Preparations

3.5.1 Homogeneity

Organoleptic observation and homogeneity testing demonstrated that all cream formulations, including the blank, glycerin, and carrageenan-containing creams, exhibited uniform texture without the presence of coarse particles. This indicates that the formulation process successfully produced homogeneous dispersions of all components. The homogeneity results are summarized in Table 6 and illustrated in Figure 1.

Table 6. Homogeneity Observation of Cream Formulations Using an Object Glass

Formula	Composition Description	Homogeneity*
A	Blank (cream base without active ingredient)	+
B	Cream containing 2% glycerin	+
C	Cream containing 2.5% carrageenan	+
D	Cream containing 5% carrageenan	+
E	Cream containing 7.5% carrageenan	+
F	Cream containing 10% carrageenan	+

* **(+)** homogeneous (no coarse particles observed)

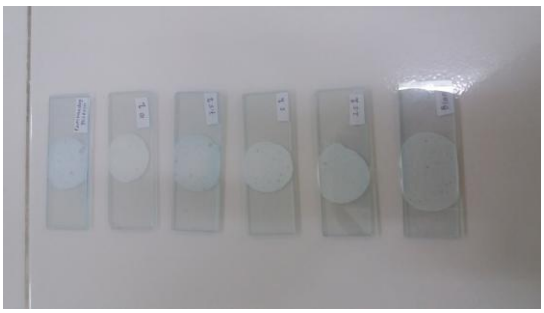

Figure 1. Homogeneity test results of carrageenan cream formulations

3.5.2 Emulsion Type

The emulsion type test using methylene blue showed uniform dye distribution in all formulations, confirming that the creams were oil-in-water (o/w) emulsions. This emulsion type is preferred for topical moisturizers due to its non-greasy feel, ease of application, and favorable skin absorption profile [4]. The results are presented in Table 7 and Figure 2.

Table 7. Emulsion Type Determination of Cream Formulations Using Methylene Blue

Formula	Solubility of Methylene Blue	Emulsion Type
A	+	Oil-in-water (o/w)
B	+	Oil-in-water (o/w)
C	+	Oil-in-water (o/w)
D	+	Oil-in-water (o/w)
E	+	Oil-in-water (o/w)
F	+	Oil-in-water (o/w)

* **(+)** indicates uniform distribution of methylene blue

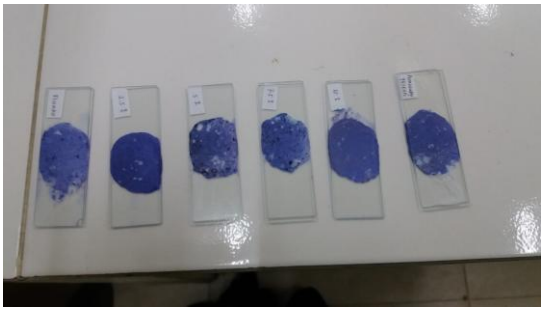

Figure 2. Emulsion type test results of carrageenan cream formulations

3.5.3 pH Evaluation

The initial pH values of the formulations ranged from 6 to 7, indicating compatibility with normal skin pH and suitability for topical application. As shown in Table 8, the incorporation of carrageenan resulted in a gradual decrease in pH, which can be attributed to the intrinsic acidic nature of carrageenan (pH ≈ 5.5).

Table 8. pH Values of Cream Formulations Immediately After Preparation

Formula	pH I	pH II	pH III	Mean pH
A	7.04	7.04	7.06	7.05
B	7.18	7.16	7.19	7.18
C	6.68	6.70	6.72	6.70
D	6.39	6.33	6.34	6.35
E	6.36	6.33	6.35	6.35
F	6.23	6.13	6.12	6.16

After 12 weeks of storage, a slight decrease in pH was observed in all formulations (Table 9). However, the pH values remained within the acceptable range for skin application, indicating good formulation stability and minimal risk of skin irritation during storage.

Table 9. pH Values of Cream Formulations After 12 Weeks of Storage

Formula	pH I	pH II	pH III	Mean pH
A	6.46	6.44	6.49	6.46
B	6.61	6.52	6.52	6.55
C	6.25	6.20	6.23	6.23
D	6.03	6.04	6.03	6.03
E	5.95	6.00	6.04	6.00
F	5.90	6.00	5.92	5.94

3.5.4 Stability of Preparations

Stability evaluation demonstrated that all cream formulations remained physically stable throughout the 12-week storage period. No changes in color, odor, or emulsion integrity were observed at any observation point (Table 10). These findings indicate that carrageenan incorporation did not negatively affect the physical stability of the cream base. Representative images of the preparations before and after storage are shown in Figures 3 and 4.

Table 10. Physical Stability Observation of Cream Formulations During Storage

Formula	Composition Description	After Preparation	1 Week	4 Weeks	8 Weeks	12 Weeks
A	Blank (cream base without active ingredient)	–	–	–	–	–
B	Cream containing 2% glycerin	–	–	–	–	–
C	Cream containing 2.5% carrageenan	–	–	–	–	–
D	Cream containing 5% carrageenan	–	–	–	–	–
E	Cream containing 7.5% carrageenan	–	–	–	–	–
F	Cream containing 10% carrageenan	–	–	–	–	–

Notes:
(–) No change observed in color, odor, or emulsion integrity
Stability parameters evaluated: color change, odor change, and emulsion rupture

Figure 3. Initial appearance of cream formulations after preparation

Figure 4. Appearance of cream formulations after 12 weeks of storage

3.5.5 Skin Irritation Test

The skin irritation test conducted on 18 volunteers revealed no signs of erythema, itching, or swelling for any formulation, including the blank, glycerin, and carrageenan creams. These results indicate that all preparations were well tolerated and safe for topical use under the test conditions. Detailed irritation test results are provided in Table 11.

Table 11. Skin Irritation Test Results of Cream Formulations in Human Volunteers

Formula	Composition Description	Volunteer	Redness	Itching	Swelling
A	Blank (cream base without active ingredient)	1	–	–	–
		2	–	–	–
		3	–	–	–
B	Cream containing 2% glycerin	1	–	–	–
		2	–	–	–
		3	–	–	–
C	Cream containing 2.5% carrageenan	1	–	–	–
		2	–	–	–
		3	–	–	–
D	Cream containing 5% carrageenan	1	–	–	–
		2	–	–	–
		3	–	–	–
E	Cream containing 7.5% carrageenan	1	–	–	–
		2	–	–	–
		3	–	–	–
F	Cream containing 10% carrageenan	1	–	–	–
		2	–	–	–
		3	–	–	–

Notes:
(–) No signs of skin irritation observed

3.5.6 Skin Moisturizing Effect

Evaluation of the moisturizing effect demonstrated that all formulations increased skin moisture to varying extents over the 28-day application period. As shown in Table 12 and Figure 5, the blank formulation exhibited minimal improvement, while the glycerin-containing cream showed a moderate increase in skin moisture.

Table 12. Skin Moisture Levels of Volunteers Before and During 28 Days of Cream Application

Formula	Volunteer	Initial (%)	Day 7 (%)	Day 14 (%)	Day 21 (%)	Day 28 (%)
A	1	31.0	31.2	31.3	31.8	31.8
	2	31.7	32.2	32.7	32.9	33.0
	3	30.3	31.0	31.2	31.3	31.7
	Mean	**31.0**	**31.4**	**31.7**	**32.0**	**32.1**
B	1	32.0	34.1	34.9	35.5	35.8
	2	31.1	32.6	34.6	35.4	37.9
	3	31.7	33.5	33.7	35.3	36.9
	Mean	**31.6**	**33.4**	**34.4**	**35.4**	**36.9**
C	1	31.0	32.7	33.5	35.1	36.4
	2	31.0	33.8	34.0	35.8	36.2
	3	31.3	33.5	33.7	35.7	36.7
	Mean	**31.1**	**33.3**	**33.7**	**35.5**	**36.4**
D	1	31.0	32.5	35.0	37.3	39.3
	2	30.7	31.5	33.4	35.5	37.3
	3	32.0	33.0	39.2	40.1	40.7
	Mean	**31.2**	**32.3**	**35.8**	**37.6**	**39.1**
E	1	32.1	32.8	35.9	37.2	41.5
	2	31.5	31.8	34.5	37.9	40.3

	3	31.1	32.5	42.0	44.0	44.7
	Mean	**31.5**	**32.3**	**37.4**	**39.7**	**42.1**
F	1	31.0	35.0	42.0	45.7	46.0
	2	31.3	38.3	43.5	49.0	50.0
	3	31.4	39.5	42.6	49.9	50.9
	Mean	**31.2**	**37.6**	**42.7**	**48.2**	**48.9**

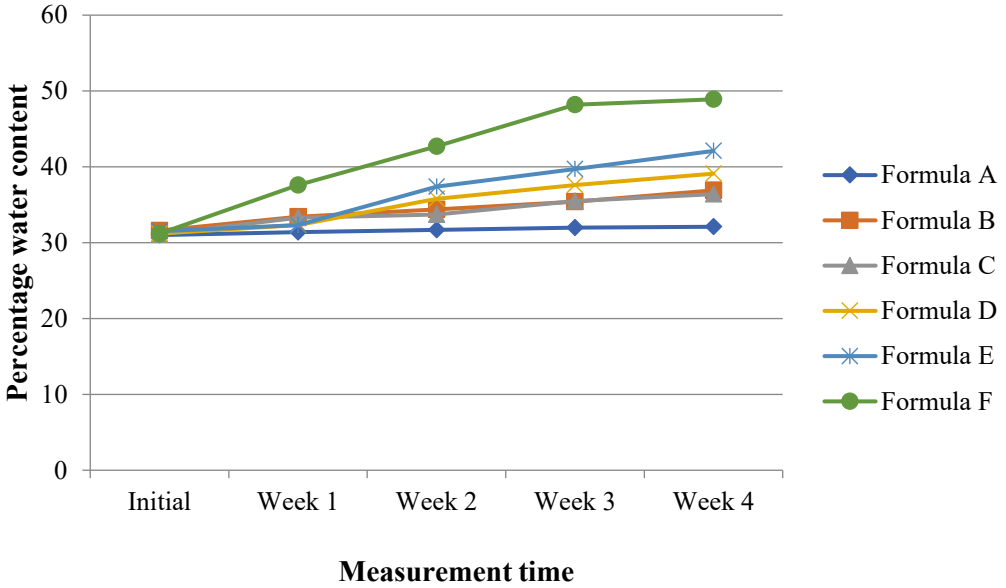

Figure 5. Mean increase in skin moisture levels of volunteers during the study period

Carrageenan-based creams demonstrated a concentration-dependent increase in skin moisture. The formulation containing 10% carrageenan exhibited the highest moisturizing effect, with an average moisture increase of 48.9% on day 28. This effect is attributed to the high water-binding capacity and film-forming properties of carrageenan, which reduce transepidermal water loss. The percentage increase in skin moisture is summarized in Table 13 and illustrated in Figure 6.

Table 13. Percentage Increase in Skin Moisture Levels of Volunteers During 28 Days of Application

Formula	Volunteer	Initial (%)	Day 7 (%)	Day 14 (%)	Day 21 (%)	Day 28 (%)
A	1	31.0	0.6	0.9	2.5	2.5
	2	31.7	1.5	3.1	3.7	4.1
	3	30.3	2.3	2.9	3.5	4.6
	Mean increase (%)	—	**1.2**	**2.2**	**3.2**	**3.5**
B	1	31.1	6.5	9.0	10.0	11.0
	2	31.7	4.8	11.2	13.8	21.8
	3	31.6	5.6	6.3	11.3	16.4
	Mean increase (%)	—	**5.6**	**8.8**	**12.0**	**16.7**
C	1	31.0	5.4	8.0	13.2	17.0
	2	31.0	9.0	9.6	15.4	17.4
	3	31.3	7.0	8.3	14.0	17.2
	Mean increase (%)	—	**7.0**	**8.3**	**14.1**	**17.0**
D	1	31.0	4.8	12.9	20.3	26.7
	2	30.7	2.6	8.7	15.6	21.4
	3	32.0	3.1	22.5	25.3	27.1
	Mean increase (%)	—	**3.5**	**14.7**	**20.5**	**25.3**
E	1	32.1	2.1	11.8	15.8	29.2
	2	31.5	0.9	9.5	20.3	27.9
	3	31.1	4.5	35.0	41.4	43.7
	Mean increase (%)	—	**2.5**	**18.7**	**26.0**	**33.6**
F	1	31.0	12.9	35.4	47.4	48.3

	2	31.3	22.3	38.9	56.5	59.7
	3	31.4	25.7	35.6	58.9	62.1
	Mean increase (%)	—	**20.5**	**36.8**	**54.4**	**56.7**

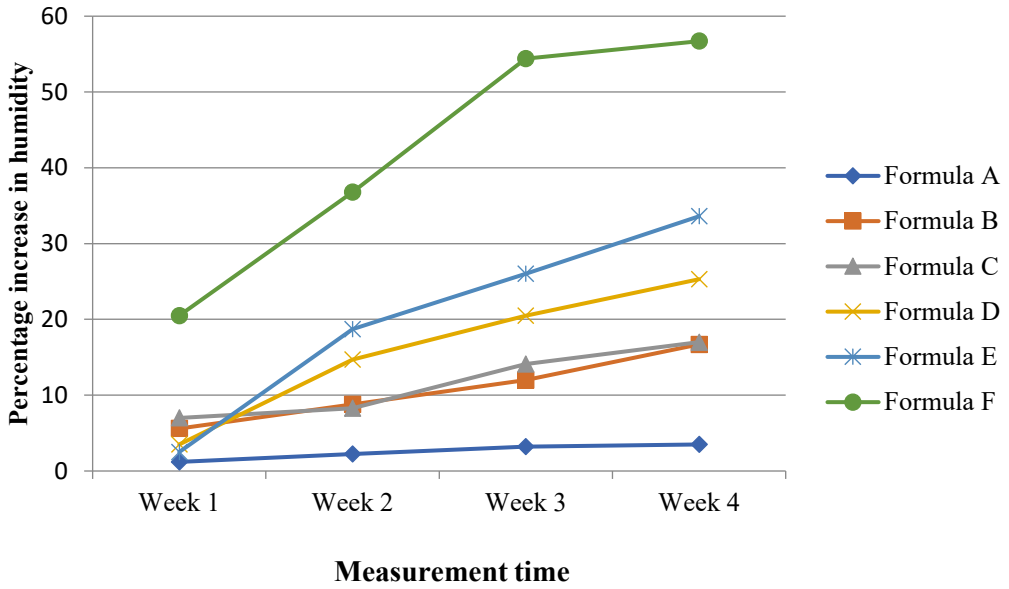

Figure 6. Percentage increase in skin moisture levels of volunteers during weeks 1–4

Interestingly, the 2.5% carrageenan formulation exhibited a moisturizing effect comparable to that of the 2% glycerin cream, suggesting that carrageenan may serve as an effective natural alternative to conventional humectants. Overall, these results demonstrate that increasing carrageenan concentration significantly enhances skin hydration, supporting its potential application as a natural moisturizing agent in topical cream formulations.

4. Conclusion

Based on the results of this study, carrageenan isolated from red seaweed (*Kappaphycus alvarezii*) was successfully formulated into an oil-in-water (o/w) cream with satisfactory physicochemical characteristics, stability, and skin compatibility. The formulation containing 2.5% carrageenan demonstrated a moisturizing effect comparable to that of a 2% glycerin cream, indicating its potential effectiveness at relatively low concentrations. Furthermore, an increase in carrageenan concentration was associated with a corresponding enhancement in skin moisturizing ability, reflecting its high water-binding and film-forming properties. Overall, these findings support the potential application of carrageenan derived from *Kappaphycus alvarezii* as a natural moisturizing agent in topical cream formulations.

5. Conflict of Interest

No conflict of interest is associated with this work.

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