The Effect Of Xanthan Gum Concentration Variations On The Physical Quality Of Serum Containing Ethanol Extract Of Brown Seaweed (*Sargassum Polycystum*)

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Abstract

Brown seaweed (Sargassum polycystum) is an Indonesian marine resource rich in secondary metabolites with potent antioxidant activity, making it a potential active ingredient for anti-aging cosmetics. Facial serum formulations require thickening agents, such as xanthan gum, to achieve optimal and stable physical characteristics during application. This study aimed to investigate the effect of varying xanthan gum concentrations on the physical quality of the serum and to determine the best formula based on physical quality parameters. The serum was formulated with varying xanthan gum concentrations F1 (0.5%), F2 (1%), and F3 (1.5%). Physical quality evaluations included tests for organoleptic properties, homogeneity, pH, spreadability, adhesiveness, viscosity, and drying time. Data analysis was conducted using both descriptive and quantitative methods, specifically calculating means and standard deviations. Phytochemical screening of the brown seaweed (Sargassum polycystum) ethanolic extract tested positive for flavonoids, phenolics, steroids, saponins, tannins, and triterpenoids. The obtained concentrated extract had a yield of 1.66%. Physical quality test results indicated that all formulas were homogeneous and met the requirements for viscosity (230–3000 cPs) and ideal drying time (< 5 minutes). Formulas II and III, containing 1% and 1.5% xanthan gum respectively, yielded the most ideal serum characteristics: homogeneity, optimal viscosity (within the 230–3000 cPs range), and a drying time of less than 5 minutes, allowing for effective absorption of the active ingredients into the skin.

Keywords : *Sargassum polycystum, Xanthan Gum, Solvent-Free Test, Serum, Physical Quality.*

Introduction

Indonesia is an archipelagic country with vast marine areas rich in biodiversity. One abundant marine commodity that has not been fully utilized in the modern cosmetic industry is brown seaweed (*Sargassum polycystum*). Previous studies have confirmed that brown seaweed possesses a wide range of biological activities, including antidiabetic, anti-inflammatory, and antimicrobial effects. Specifically, the ethanol extract of *Sargassum polycystum* has an (IC50) value of 5.32 µg/mL, classifying it as a very strong antioxidant, as this value is well below the threshold of 50 ppm. Free radicals are one of the main triggers of premature skin aging due to collagen degradation. Therefore, utilizing natural antioxidants from *Sargassum polycystum* offers significant potential for development as an anti-aging agent.

Despite its high antioxidant potential, applying crude extract directly to the skin is less effective due to low stability of the active compounds and poor aesthetic comfort during use. An ideal topical preparation for delivering these active ingredients is facial serum. Serums offer advantages such as low viscosity, high concentration of active compounds, and faster penetration into the epidermal layer compared to creams or lotions. However, research on optimizing a stable hydrogel base for *Sargassum polycystum* extract remains limited. Water-based serums require an appropriate thickening agent to maintain the homogeneity of the suspension or emulsion system and regulate the rheological properties of the preparation.

To address this issue of physical stability, this study proposes the use of xanthan gum as a natural thickening agent. Xanthan gum was selected because it maintains good stability across a wide pH range and provides a smooth, comfortable skin feel upon application. The objectives of this study are to identify secondary metabolite compounds through phytochemical screening, confirm the safety of the extract via solvent residue testing, and

evaluate the effect of varying xanthan gum concentrations on the physical quality characteristics of the facial serum. The findings of this research will contribute scientific knowledge to the development of pharmaceutical science regarding the utilization of marine natural resources, as well as provide a safe, nutrient-rich alternative cosmetic product with high economic value for the community.

Methods

This laboratory-based experimental study began with the collection of raw material: brown seaweed (*Sargassum polycystum*) obtained from the coastal area of Pacitan, East Java. The samples were cleaned of debris and adhering salt using running water, dried, and ground into a fine powder (simplicia).

Extraction was carried out using the maceration method. The powdered simplicia was extracted using 96% ethanol solvent at an appropriate ratio for 5 consecutive days (24 hours per day). The resulting macerate was filtered using filter paper, the filtrate was collected, and the solvent was evaporated using a water bath at 60°C until a concentrated extract was obtained. The yield of the concentrated extract was calculated, and the absence of solvent residue was tested qualitatively by reacting the extract with concentrated sulfuric acid (H2SO4) and potassium dichromate (K2Cr2O7). Phytochemical screening was performed to detect the presence of flavonoids, phenols, steroids, saponins, tannins, and triterpenoids through specific color reactions in test tubes.

Three formulations of facial serum were prepared, varying the concentration of xanthan gum as the independent variable: 0.5% (Formula 1), 1% (Formula 2), and 1.5% (Formula 3). Other excipients included TEA (pH adjuster), methylparaben and propylparaben (preservatives), glycerin (humectant/moisturizer), and distilled water as the solvent to reach a final volume of 100%. The preparation process began by hydrating the xanthan gum in a portion of warm water. Methylparaben and propylparaben were dissolved in glycerin and then mixed into the hydrated gum base. The ethanol extract of brown seaweed (0.6%) was dispersed into this mixture, stirred until homogeneous, and TEA was added drop by drop until the desired pH and gel consistency were achieved. The remaining distilled water was added to reach the final volume.

The resulting serum preparations were then subjected to physical quality testing in triplicate. Evaluated parameters included organoleptic properties, homogeneity, pH, spreadability, adhesiveness, viscosity, and drying time.

Results and Discussion

The maceration process produced concentrated extract of *Sargassum polycystum* weighing 8.3 grams, corresponding to an extraction yield of 1.66%. This yield is considered low, as yields above 10% are classified as good (Putra et al., 2020). The low yield may be influenced by several factors, including environmental growing conditions, plant maturity, particle size, solvent polarity, solvent-to-material ratio, and maceration duration.

Weight of Simplicia (g)	Weight of Concentrated Extract (g)	Yield (%)
500	8.3	1.66

Testing for residual 96% ethanol solvent was performed using a colorimetric method. The results showed negative, indicating that solvent evaporation using a temperature-controlled water bath successfully removed all ethanol residues, making the extract safe for use.

Sample	Reagent	Result	Description
Ethanol extract of *Sargassum polycystum*	5 drops of concentrated H2 SO4 + 2 mL potassium dichromate solution	Negative	Dark brown-golden color typical of brown seaweed; the extract adhering to the glass wall showed a thick, concentrated consistency.

Phytochemical screening confirmed the presence of flavonoids, phenols, steroids, saponins, and tannins in the concentrated extract. The presence of polyphenolic compounds (phenols and tannins) and flavonoids serves as the primary indicator of the extract's strong antioxidant activity. Phenolic and flavonoid compounds possess active hydroxyl groups that neutralize free radicals by donating hydrogen atoms to reactive molecules. This mechanism stops the oxidative stress chain reaction responsible for collagen degradation and premature skin aging. Steroids and saponins found in marine plants generally contribute to anti-inflammatory and antimicrobial activities, helping to soothe the skin and maintain its natural protective barrier. Meanwhile, the negative result for triterpenoids indicates that these compounds were not extracted using 96% ethanol or are not naturally present in *Sargassum polycystum* from the study area. Overall, these phytochemical findings confirm that the ethanol extract has high biological suitability for use as an active ingredient in skincare cosmetics.

Compound Class	Reagent	Result	Observation
Flavonoids	Magnesium powder + concentrated HCl	Positive	Orange color formed
Phenols	1% FeCl3	Positive	Dark green color formed
Steroids	Lieberman-Burchard reagent	Positive	Blue color formed
Saponins	Distilled water + concentrated HCl	Positive	Foam persisted for 7 minutes
Tannins	1% FeCl3	Positive	Green color formed
Triterpenoids	Lieberman-Burchard reagent	Negative	Green color observed

After formulation, all serum preparations underwent physical quality evaluation to compare the effect of varying xanthan gum concentrations. Organoleptic observations showed that increasing xanthan gum concentration visually increased the thickness and consistency of the serum. All formulations were completely homogeneous with no coarse particles, indicating even distribution of active ingredients and gel matrix. Viscosity values for all formulas fell within the acceptable range for serums (230–3,000 cPs). While viscosity values were similar across formulations due to mechanical factors during testing, significant differences were observed in spreadability and drying time. Spreadability is inversely related to viscosity. Formula 2, containing 1% xanthan gum, had a spread diameter of 6.73 ± 0.37 cm, which falls within the ideal range for topical preparations (5–7 cm). Optimal spreadability ensures even distribution of active ingredients over the skin without excessive pressure. In terms of pH, Formula 2 recorded a value of 6.7 ± 0.1, which is closest to the physiological pH of human skin (4.5–6.5), whereas Formulas 1 and 3 were more alkaline due to fluctuations in TEA addition. Drying time correlated with xanthan gum concentration; higher concentrations accelerated the formation of a thin film on the skin surface as water evaporated. Formula 2 (4.25 minutes) and Formula 3 (3.38 minutes) met the requirement for efficient drying time (< 5 minutes). Based on comparative analysis of all physical parameters, Formula 2 with 1% xanthan gum was selected as the optimal formulation due to its balanced physical characteristics, stability, and compatibility with skin pH. The novelty of this research lies in the utilization of local tropical macroalgae *Sargassum polycystum* to develop a functional

cosmetic product based on natural, environmentally friendly, and physically stable polymers, contributing to the diversification of herbal-based cosmetic products in Indonesia.

Parameter	Formula 1 (0.5%)	Formula 2 (1%)	Formula 3 (1.5%)
Organoleptic Properties	Dark brown, thick gel, slightly fluid	Dark brown, thick gel, slightly fluid	Dark brown, thick gel, slightly less fluid
Homogeneity	Homogeneous	Homogeneous	Homogeneous
pH	9.1 ± 0.1	6.7 ± 0.1	8.3 ± 0.1
Spreadability (cm)	8.9 ± 0.53	6.73 ± 0.37	7.95 ± 0.32
Adhesiveness (seconds)	4.66 ± 1.52	5.66 ± 2.08	4.33 ± 2.21
Viscosity (cPs)	1,252 ± 60.8	1,220 ± 28	1,200 ± 112

Conclusion

Phytochemical screening confirmed that the extract contains flavonoids, phenols, steroids, saponins, and tannins, which act as active antioxidants. Variations in xanthan gum concentration as a thickening agent significantly influenced the organoleptic characteristics, pH, spreadability, adhesiveness, viscosity, and drying time of the serum containing ethanol extract of *Sargassum polycystum*. Formula 2, containing 1% xanthan gum, was determined to be the best formulation, exhibiting the most ideal physical quality: a homogeneous structure, spreadability meeting topical preparation standards (6.73 cm), pH closest to the physiological range of skin (6.7), and efficient drying time (< 5 minutes), ensuring comfortable use and good absorption of active compounds into the skin.

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