Characteristic of body scrub based *Ulva lactuca* seaweed salt residue with addition *Aloe vera* gel

Nurjanah Nurjanah[1,*], *Asadatun* Abdullah[1], *Faradilla Ratna* Jati[1], *Anggrei Viona* Seulalae[2], and *Zahrah* Afifah[1]

[1]Aquatic Products Technology Department, Faculty of Fisheries and Marine Science, Bogor Agricultural University (IPB University), Bogor 16680, Indonesia
[2]Study Program of Fisheries Products Technology, Faculty of Marine Sciences and Fisheries, Maritim Raja Ali Haji University, Jl. Politeknik, Senggarang-Tanjungpinang, 29124, Indonesia

Abstract. *Ulva lactuca* salt residue can act as a natural scrub to replace the microbeads. The combination with *Aloe vera* gel can improve the function of body scrubs on the skin. This study aimed to determine the optimal concentration of *A. vera* gel for making body scrubs from *U. lactuca* seaweed salt residue based on physical properties, total phenolic content and antioxidant activity. Body scrub was formulated by adding 7% *U. lactuca* salt residue and *A. vera* gel at concentrations of 0, 3, 5, and 7%. The parameters analyzed included the pH, viscosity, emulsion stability, humidity, spreadability, homogeneity, hedonic test, total phenolics, and antioxidants using the DPPH method. The results showed that differences in *A. vera* gel concentrations did not significantly affect the preferences of the panelists (aroma, colour, texture, appearance). Spreadability, pH, and viscosity of body scrub ranged from 4.02-4.55 cm; 6.38-6.53; and 8,600-13,160 cP, respectively. Body scrub with *A. vera* gel can increase the humidity with stable emulsion physical properties and a homogeneous mixture of ingredients. The best treatment was the addition of 3% *A. vera* with antioxidant activity of IC_{50} value, namely 278.02 ppm and the highest total phenolic of 0.528 mg GAE/g.

1 Introduction

Seaweed has been widely researched and developed as a raw material for cosmetic products [1] including peel-off masks [2], sunscreen [3], lighting [4], body lotion [5-6], body scrub [7-8], lip balm [9], and gel masks [10]. The primary and secondary metabolite compounds in seaweed are very beneficial for skin health because they contain antioxidants, vitamins, minerals, and other secondary metabolite compounds, such as alkaloids, glycosides, tannins, steroids, hydroquinone phenols, flavonoids, saponins, triterpenoids, and phenolic compounds [11-14].

Cosmetics are available in various preparations, one of which is in the form of body scrub or body scrub. Body scrub is a skin care cosmetic product that contains rough ingredients or is commonly called cosmetic observer to remove dead cells from the epidermis [15]. Body

* Corresponding author: nurjanah@apps.ipb.ac.id

scrubs also aim to open pores so that the skin becomes brighter, whiter, and firmer. Rough ingredients or scrubbing ingredients in body scrubs generally come from plastic, which are also called plastic microbeads. Plastic microbeads contribute to plastic pollution worldwide because of their small size and damage to aquatic environments. This is certainly not in accordance with sustainable development goals (SDGs), which are expected to maintain aquatic ecosystems in the future. The solution that can be offered to prevent this problem is the use of natural ingredients that have the same characteristics as silica and plastic microbeads, but are safer for the environment.

Seaweed salt is one of the low sodium salt innovations from brown seaweed *Turbinaria conoides* and *Padina minor* [16,17], *Sargassum* sp. [17-21], green seaweed *U. lactuca* [22-24], *Halimeda opuntia* and *Caulerpa lentillifera* [25], *Chaetomorpha* sp. [26] also red seaweed *Actinotrichia fragilis* [27]. Seaweed salt production produces by-products in the form of coarse granule residues, with a yield of 70-80%. Seaweed salt residues have high carbohydrate and ash content, primary and secondary metabolite active compounds, macro and micro minerals, and antioxidant activity [8]. Seaweed salt residues have a granular form and coarse texture that can be used as raw materials for cosmetics, namely body scrubs. This granular form can replace the silica and plastic microbeads in body scrubs to act as exfoliators. Making body scrubs from seaweed salt residue can be done by adding natural ingredients. Previous studies have shown that body scrubs based on seaweed salt residue and the addition of coffee dregs have slightly dry final products and low spreadability [8]. Alternative natural ingredients to increase body scrub humidity and spreadability as well as functional value through primary and secondary metabolite compounds based on seaweed salt residues need to be developed.

A. vera is a medicinal plant for skin health that is easy to find and is widely cultivated in Indonesia [28]. *A. vera* gel has been widely studied for its role as a natural ingredient in skin treatment and wound healing [29]. *A. vera* contains lignin, which can easily prevent the skin from becoming dry, wrinkled, or scaly [30]. *A. vera* contains flavonoid compounds that are antioxidants that ward off free radicals [31]. *A. vera* can provide moisturizing and brightening effects on the skin [32]. *A. vera* can stimulate fibroblasts to produce collagen fibers, making the skin more elastic and wrinkle-free. *A. vera* has a cohesive effect on the surface of exfoliating epidermal cells by attaching them together. [33]. Body scrub based on seaweed salt residue with the addition of *Aloe vera* gel is expected to improve physical properties, especially humidity and spreadability, as well as other functional values. The aim of this study was to determine the optimal concentration of *A. vera* gel for making body scrubs from *U. lactuca* seaweed salt residue, based on physical properties, total phenolic content, and antioxidant activity.

2 Materials and method

2.1 Materials

The raw materials used were *U. lactuca* seaweed from the waters of Cibuaya Beach, Ujung Genteng Village, Ciracap District, Sukabumi Regency, West Java. Seaweed salt residue from *U. lactuca* was obtained from PT. Akuanutrindo Sukses Makmur (Gamy Bahari), Dramaga, Bogor, West Java, and *A. vera* from the Cikarawang Farm, Dramaga, Bogor, West Java. The ingredients used in body scrub formulation were distilled water, glycerin, propylene glycol, TEA, stearic acid, cetyl alcohol, phenoxyethanol, and fragrance. Materials used in testing include distilled water, DPPH (Sigma-Aldrich, USA), 70% ethanol (Merck, Germany), 99% ethanol (Merck, Germany), neucropin (Sigma-Aldrich, USA), trolox (6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid) (Sigma-Aldrich, USA), gallic acid (Sigma-Aldrich,

USA), ammonium acetate buffer (Sigma-Aldrich, USA), $CuCl_2$ (Sigma-Aldrich, USA), 100% Folin (Sigma-Aldrich, USA), H_2SO_4 (Merck, Germany), HCl (Merck, Germany), $K_2S_2O_8$ (Merck, Germany), chloroform (Merck, Germany), Na_2CO_3 (Sigma-Aldrich, USA), and NH_4OH (Sigma-Aldrich, USA). The tools used were a dehydrator (B-One FCD-3000series), UV-VIS spectrophotometer 2500, centrifuge (D-7200 Tuttlingen), Brookfield viscometer (RV DV-E230 SN E9419, USA), pH meter (HI 2210, Leighton Buzzard, UK), skin analyzer FCM1, and infrared digital thermometer (IR thermometer TG – 8806 C).

2.2 Methods

2.2.1 Preparation and characterization of raw materials

The preparation and characterization of the raw materials were carried out on *U. lactuca* seaweed salt residue and *A. vera*. The dried *U. lactuca* seaweed salt residue was sieved using a 60-mesh to obtain uniform particles of both shape and size. Next, *A. vera* gel was prepared by washing the leaves that had been separated from the stem. Cleaned *A. vera* leaves were peeled to separate the skin from the flesh. The *A. vera* flesh was blended and filtered to obtain the *A. vera* gel. The *U. lactuca* seaweed salt residue and *A. vera* gel were analyzed for proximates [34] and phytochemical [35].

2.2.2 Preparation and characterization of body scrub formulation

The body scrub formulation was prepared in two phases: the oil phase and water phase. The oil phase was prepared by mixing cetyl alcohol with stearic acid at 55°C. The aqueous phase was prepared by mixing glycerin, propylene glycol, triethanolamine (TEA), and distilled water at 55°C. Both phases were combined in the same container at 55°C and stirred until cream-like consistency was achieved. The cream was mixed with phenoxyethanol and stirred. The next step was to add a fragrance to neutralize the odor of the seaweed salt residue. *U. lactuca* seaweed salt residue and *A. vera* gel were added at varying concentrations and stirred. The formulations of the seaweed salt residue and *A. vera* body scrub are shown in Table 1.

Table 1. Formulation of body scrub from *U. lactuca* seaweed salt residue and *A. vera* gel

Materials (% w/w)	**Without Aloe vera gel**	**Aloe vera gel 3%**	**Aloe vera gel 5%**	**Aloe vera gel 7%**
Glycerin	3	3	3	3
Triethanolamine (TEA)	0.5	0.5	0.5	0.5
Propylene glycol	3	3	3	3
Aquades	75.2	72.2	70.2	68.2
Cetyl alcohol	1	1	1	1
Stearic acid	7.9	7.9	7.9	7.9
Phenoxyethanol	0.9	0.9	0.9	0.9
Aroma	1.5	1.5	1.5	1.5
U. lactuca seaweed salt residue	7	7	7	7
A. vera gel	0	3	5	7

The body scrub was analyzed for pH refers to the method [34], hedonic test refers to the method [36], viscosity refers to the method [37], emulsion stability refers to the method [38], humidity refers to the method [39], spreadability refers to the method [40], homogeneity refers to the method [41], total phenolic content refers to the method [42] and antioxidant activity (DPPH method) refers to the method Molyneux & Songklanakarin [43].

2.2.3 Statistical analysis

Data analysis in this study used a Completely Randomized Design with a single factor, the difference in *A* gel concentrations, consisting of three replicates. Data on pH, spreadability, viscosity, total phenolic content, and IC_{50} values were analyzed using Oneway ANOVA (Analysis of Variance). Significant data ($p<0.05$) were further analyzed using Duncan's test. The hedonic body scrub test data were analyzed non-parametrically using the Kruskal-Wallis test. The data were processed using the Statistical Product and Service Solution (SPSS) version 25.

3 Result and discussion

3.1 Physical characteristics of body scrub

The results showed that the difference in *A. vera* gel concentration in the body scrub formulation did not affect the pH value and spreadability ($p>0.05$) but affected the viscosity ($p<0.05$). The resulting body scrub was homogeneous with an emulsion that did not separate (stable). The physical characteristics of the scrubs are shown in Table 2.

Table 2. Physical characteristics of body scrub

Parameter	Without Aloe vera gel	Aloe vera gel 3%	Aloe vera gel 5%	Aloe vera gel 7%
pH	6.48±0.08[a]	6.42±0.09[a]	6.53±0.08[a]	6.38±0.10[a]
Spreadability (cm)	4.02±0.34[a]	4.55±0.15[a]	4.52±0.06[a]	4.25±0.20[a]
Viscocity (cP)	8.600±360[a]	8.740±1.294[a]	11.580±2.133[b]	13.160±3.667[b]
Homogenity	Homogeneous	Homogeneous	Homogeneous	Homogeneous
Emulsion stability	Stable	Stable	Stable	Stable

Superscript font different groups showed a significant difference ($p<0.05$).

3.1.1 pH level of body scrub

The pH test results for body scrubs made from *U. lactuca* seaweed salt residue ranged from 6.38-6.53. These pH results fall within the safety standards for cream-based products ranging 4.5-8.0 that stated in National Standard Indonesia [44]. Different concentrations of *A. vera* gel did not affect the pH of the body scrubs. Body moisturizers with addition 5% *A. vera* gel has a pH range of 5.82-6.30 during 8 weeks of storage [45]. This shows that the addition of *A. vera* gel is in a pH range that is neither too alkaline nor too acidic. Changes in pH are also caused by environmental factors such as temperature, poor storage, and unstable products due to oxidation [45]. An extremely low pH is considered acidic and can be detrimental to the skin, potentially causing irritation. Conversely, a pH that is too high is alkaline and may lead to dry and scaly skin [46].

3.1.2 Spreadability of body scrub

The spreadability test results for body scrubs made from *U. lactuca* seaweed salt residue ranged from 4.02-4.55 cm. Different concentrations of *A. vera* gel did not affect the spreadability of the body scrubs. Body moisturizers with addition 5% *A. vera* gel experienced a decrease in spreadability before and after 8 weeks of storage [45]. Spreadability reflects the ability of a product to be applied to the skin. The control body scrub did not contain *A. vera* and instead used aquades as a substitute. The control results demonstrated that without the addition of *A. vera*, the body scrub was more difficult to apply. Body scrubs with the addition of *A. vera* gel had a slightly greater spreadability, although not significantly. The thinner material had a larger absorption diameter because it flowed more easily, whereas the thicker material had a smaller absorption diameter. *A. vera* gel has a slightly thicker so that the absorption diameter is smaller, making it more difficult to flow so that the product spread is not optimal. The best gel spreadability in product was around 5-7 cm [45].

3.1.3 Homogenity of body scrub

The results of the homogenity test indicated that the control body scrub and all the treatment concentrations did not exhibit any clumping. The body scrub products displayed a uniform formulation with no separation of the components observed. A homogeneous preparation ensures optimal results for the materials used, as each portion contains the same effects [47].

3.1.4 Emulsion stability of body scrub

The results of the emulsion stability test for the control and *A. vera* gel body scrub indicated that the products did not experience phase separation, thus demonstrating stability. Centrifugal forces can damage the emulsifier layer, potentially leading to the separation of oil phases. The phases remained inseparable owing to the presence of emulsifiers, allowing for easy mixing of the formulation with propylene glycol [48].

3.1.5 Viscosity of body scrub

The viscosity test results for the control body scrub were 8.600±360 cP. The viscosity value of the control did not significantly differ from that of the product with 3% *A. vera* addition, but it was significantly different from those of the products with 5% and 7% *A. vera*. The viscosity of body scrubs with varying concentrations of *A. vera* ranged from 8.600-13.160 cP. The higher the concentration of *A. vera* gel, the higher is the viscosity of the body scrub. *A. vera* gel has a slightly thicker so that the viscosity of body scrub more bigger, making it more difficult to flow [45]. Viscosity is influential in determining the stability of the formulation and the density of the materials. Changes in viscosity can also result from prolonged storage, which may lead to decreased emulsion stability [46]. Temperature factors can induce viscosity changes as molecular cohesion decreases, causing particles to become more dispersed [49].

3.1.6 Humidity of body scrub

Humidity were measured using a skin analyzer on 15 panelists, before and after using the product. The results of the moisture test for body scrubs containing *U. lactuca* seaweed salat residue and *A. vera* gel are presented in Table 3.

Table 3. Humidity of body scrub

Sample	Before	After	%Increase
Control	33.27	39.65	6.38
Body scrub 3%	34.93	42.48	7.55
Body scrub 5%	34.60	41.92	7.32
Body scrub 7%	36.40	43.30	6.90

The results indicate an increase in skin moisture after using the body scrub product. The body scrub formulations with 3%, 5%, and 7% *A. vera* initially showed an improvement in humidity levels ; however, this effect diminished over time. The moisture level of the skin throughout the body was divided into five groups: very dry (0-27%), slightly dry (28-37)%, moist (38-47%), more moist (48-57%), and very moist (>57%) [50]. The results of the study showed that before using the body scrub with *A. vera* gel, skin moisture was in a slightly dry range, but after use, it became in the moist range. *A. vera* contains lignin, which can easily prevent the skin from becoming dry, wrinkled, or scaly [30]. *A. vera* can provide moisturizing and brightening effects on the skin [32]. The increase in humidity can be attributed to the ingredients used in the formulation, specifically glycerin, which acts as a humectant to help maintain skin hydration [51].

3.2 Bioactive compounds, total phenolic content, and antioxidant activity of body scrub

3.2.1 Bioactive compounds

Phytochemical analysis was conducted to determine the active compounds in the raw materials of *U. lactuca* seaweed salt residue and *A. vera* gel, as well as in the control body scrub and treatments with *A. Vera* addition (3%, 5%, and 7%). The results of the bioactive component tests of the raw materials and body scrubs are presented in Table 4.

Table 4. Bioactive compounds of *U. lactuca salt* residue, *A. vera* gel, and body scrub

Active compounds	*U. lactuca* salt residue[52]	*A. vera* [53]	Without Aloe vera gel	Aloe vera gel 3%	Aloe vera gel 5%	Aloe vera gel 7%
Alkaloid	+	+	+	+	+	+
Flavonoid	+	+	-	-	-	-
Saponin	+	+	+	+	+	+
Steroids/ Triterpenoid	+	+	+	+	+	+
Fenol	-	+	+	+	+	+
Tanin	-	+	-	-	-	-

Note : + (detected), - (not detected).

The results of the study showed that the salt residue of *U. lactuca* did not contain phenol; *A. vera* gel detected all components; body scrub control and *A. vera* treatment did not contain flavonoids and tannins. Analysis of the active components revealed alkaloids in the seaweed salt residue. Active components such as flavonoids, saponins, and steroids were detected in both raw materials *U. lactuca* seaweed salt residue [52] and *A. vera* gel [53]. Phenols and tannins were not detected in the seaweed salt residue [52], but were present in *A. vera* [53]. Body scrubs with and without *A. vera* gel contained alkaloids, saponins, steroids/triterpenoids, and phenol compounds. Flavonoid compounds were not detected in body scrub treatments with or without *A. vera* gel. Flavonoids are natural antioxidants widely used in cosmetics. The main obstacle is not detected because the bioavailability of cosmetic

preparations is relatively low [54]; therefore, further quantitative testing is required to determine the presence of flavonoid compounds.

Alkaloids, which originate from sources that exhibit physiological activities in humans and animals, are among the most significant secondary metabolites found in plants. Flavonoids are phenolic compounds derived from a combination of two biosynthetic pathways that play a role in defense mechanisms. Free phenolic compounds in plants are primarily hydroquinones. Under certain conditions, saponins act as surfactants, producing foaming or bubbling effects. Steroids are derivatives of the triterpenoid squalene that serve as key building blocks in biosynthesis. Tannins impart a bitter or astringent taste and can interact with proteins and other organic compounds containing amino acids and alkaloids, leading to their precipitation [55].

3.2.2 The total phenolic content and antioxidant activity of body scrub

The total phenolic content was measured using the Folin-Ciocalteu method based on the reducing power of the phenolic hydroxyl groups. Antioxidants prevent the oxidation of other compounds. They play a vital role in shielding the skin from various types of cellular damage induced by UV radiation and protecting against reactive oxygen species (ROS) [56]. The total phenolic content and antioxidant activity of the body scrubs are listed in Table 5.

Table 5. Total phenolic content and antioxidant activity (IC_{50}) of body scrub

Parameter	**Without Aloe vera gel**	**Aloe vera gel 3%**	**Aloe vera gel 5%**	**Aloe vera gel 7%**
Total phenolic content (mg GAE/g sample)	0.491 ± 0.01^{a}	0.528 ± 0.03^{a}	0.465 ± 0.01^{a}	0.427 ± 0.02^{a}
IC_{50} (ppm)	478.80 ± 0.10^{a}	278.02 ± 0.08^{b}	515.97 ± 0.02^{a}	653.44 ± 0.04^{a}

Superscript font different groups showed a significant difference ($p<0.05$).

The total phenolic analysis of the body scrub showed no significant differences among the products, ranging from 0.427 to 0.528 mg GAE/g. The phenolic compound content in the body scrub results from the addition of *U. lactuca* salt residue and *A. vera*. Phenolic compounds are synthesized in the chloroplasts via the shikimic acid pathway. The leaves contain a high concentration of chloroplasts, which allows for the active synthesis of phenols.

The IC_{50} values of the body scrub showed no significant differences among the control, body scrub 5% and 7% but significant differences for body scrub 3%. The antioxidant test results for the body scrub indicated a very weak antioxidant activity, with IC_{50} values ranging from 278.02-653.44 ppm. Antioxidant activity, based on the IC_{50} value, is classified into five categories: very strong (less than 50 ppm), strong (50-100 ppm), moderate (100-150 ppm), weak (150-200 ppm), and very weak (greater than 200 ppm) [43]. The antioxidant activity of the seaweed salt residue fell into the moderate category [52], whereas that of *A. vera* was classified as strong [53]. The low antioxidant activity in body scrubs is thought to be caused by the extracted phenol compounds containing a mixture of complex compounds that still have different polarities, antioxidant properties, and prooxidants [57]. Antioxidant activity can also decrease during storage at room temperature, where the environmental conditions cannot be controlled. Direct contact with heat and oxygen can decrease antioxidant activity [58].

3.3 Hedonic characteristics of body scrub

Hedonic testing was conducted to assess the degree of preference of the panelists for body scrub products. The panelists who participated included 30 people consisting of female and

male students. The hedonic test assessment scale ranges from 1 to 9: (1) extremely dislike, (2) extremely dislike, (3) dislike, (4) somewhat dislike, (5) neutral, (6) somewhat like, (7) like, (8) extremely like, and (9) extremely like [34]. The hedonic test utilizes organoleptic evaluation, which includes four parameters: appearance, color, aroma, and texture. The body scrub hedonic test results are shown in Table 6. The results of the study showed that differences in *A. vera* gel concentration did not affect the panelists' hedonic assessments ($p>0.05$).

Table 6. Hedonic test result of body scrub

Sample	Aroma	Color	Texture	Apperance
Control	7.67±092[a]	7.00±1.26[a]	7.07±1.174[a]	7.03±1.40[a]
Body scrub 3%	7.50±1.43[a]	7.00±1.53[a]	6,87±1.17[a]	7.17±1.21[a]
Body scrub 5%	7.13±1.59[a]	6.70±1.78[a]	7.33±1.40[a]	6.73±2.03[a]
Body scrub 7%	7.63±1.27[a]	7.13±1.36[a]	7.27±1.31[a]	7.63±1.13[a]

Superscript font different groups showed a significant difference ($p<0.05$).

The aroma parameters revealed that the hedonic scores for the body scrub made from *U. lactuca* seaweed salt residue with added *A. vera* ranged from 7.13 to 7.63. The addition of *A. vera* to the body scrub did not affect the panelists' preference, remaining within the 'like' range of 7. This finding is consistent with that of a previous study [59] that stated that the characteristic aroma of *A. vera* is favored by panelists. The color parameter for the body scrub with added *A. vera* scored between 6.70 to 7.13, while the appearance parameter yielded scores ranging from 6.73 to 7.63. The results for the body scrub with 3% and 7% *A. vera* addition were above 7, indicating a 'like' preference according to the panelists, whereas the body scrub with 5% *A. vera* addition was rated as 'somewhat like.

The addition of *A. vera* did not significantly affect panelists' preferences for the parameters of color and appearance. The gel of *A. vera* is transparent, making it difficult to observe any changes in the color and appearance of the body scrub [28]. The texture parameter for the body scrubs with added *A. vera* ranged from 6.87 to 7.33. The body scrub formulations with 5% and 7% *A. vera* were rated as 'like' by the panelists, while the formulation with 3% *A. vera* received a rating of 'somewhat like.' The addition of 5% *A. vera* was the most favored, achieving the highest score of 7.33. Texture is related to the comfort of a product when applied to the skin. The inclusion of *A. vera* in lotions can enhance smoothness and nonstickiness on the skin [60].

4 Conclusion

Body scrub with the addition of 3% *A. vera* gel was the best treatment, with the best IC_{50} value and total phenolic content compared to the others and controls. The higher the addition of *A. vera* gel, the weaker the antioxidant activity of the body scrub. The addition of *A. vera* gel to a seaweed salt-residue-based body scrub increased the moisture content of the product in the moist category.

References

1. Nurjanah, A. Abdullah, T. Hidayat, A.V. Seulalae, K. Rahmawati, Pemanfaatan rumput laut sebagai bahan baku kosmetik (Unsyiah Press, Banda Aceh, 2022a)
2. Nurjanah, S. Fauziyah, A. Abdullah, JPHPI. **22**, 2 (2019)

3. N. Luthfiyana, Nurjanah, M. Nurilmala, E. Anwar, T. Hidayat, JPHPI **19**, 3 (2016)
4. M.T. Dolorosa, Nurjanah, S. Purwaningsih, E. Anwar, T. Hidayat, JPHPI **20**, 3 (2017)
5. Nurjanah, M. Nurilmala, A. Abdullah, A. V. Seulalae, R. Fauzan, Int J Agric Technol **17**, 4 (2021)
6. Nurjanah, A. M. Jacoeb, E. Bestari, A.V. Seulalae, J. Akuatek **1**, 2 (2020a)
7. Nurjanah, R.L. Ramli, A.M. Jacoeb, A.V. Seulalae, J. Standardisasi **23**, 3 (2021a)
8. Nurjanah, A.M. Jacoeb, N.D. Amanda, A.V. Seulalae, *Characteristics of seaweed salt residue Sargassum polycystum and coffee dregs as raw materials for body scrubs*, in The 5th EMBRIO International Symposium: Sustainable Development of Fisheries and Marine Resource Amidst Covid-19 Era and Beyond, EIS, 6-7 September 2022, Online (2022b)
9. Nurjanah, A. Abdullah, R. Fachrozan, T. Hidayat, *Characteristics of seaweed porridge Sargassum sp. and Eucheuma cottonii as raw materials for lip balm*, in IOP Publishing IOP Conference Series: Earth and Environmental Science. Sustainable Agriculture Transformation for The Nations Welfare of Indonesia and Malaysia, 6-8 November 2018, Serdang, Selangor, Malaysia (2018a)
10. Nurjanah, B.E. Aprilia, A. Fransiskayana, M. Rahmawati, T. Nurhayati, JPHPI **21**, 2 (2018b)
11. S.H. Manteu, Nurjanah, T. Nurhayati, JPHPI. **21**, 3 (2018)
12. Nurjanah, Ramlan, A.M. Jacoeb, A.V. Seulalae, JPBKP **18**, 1 (2023)
13. C. Nufus, Nurjanah, A. Abdullah, JPHPI **20**, 3 (2017)
14. F. Meiyasa, Nurjanah, N. Tarigan, R. M. S. Putri, A. V. Seulalae, M. M. A. Hutar, A. T. Hana, U. Fery, Egypt J Aquat Biol Fish **28**, 5 (2024)
15. G. Kalčíková, B. Alič, T. Skalar, M. Bundschuh, A. Z. Gotvajn, Chemosphere. **188**, (2017)
16. Nurjanah, A. Abdullah, S. Diachanty, Pharmacogn. J **12**, 3 (2020b)
17. S.H. Manteu, Nurjanah, A. Abdullah, T. Nurhayati, A.V. Seulalae, JPHPI **24**, 3 (2021)
18. Nurjanah, A. Abdullah, H.S. Darusman, J.V.G. Diaresty, A.V. Seulalae, Int. J. Res. Pharm. Sci. **12**, 4 (2021b)
19. Nurjanah, A. Abdullah, A. Rahmadhani, A.V. Seulalae, Kuwait J. Sci **49**, 3 (2021a)
20. Nurjanah, A. Abdullah, A. M. Jacoeb, D. K. Prameswari, A. V. Seulalae, *Effect of the ratio Limnocharis sp. and Sargassum sp. on the characteristics of seaweed salt*, in The 5th EMBRIO International Symposium; Sustainable Development of Fisheries and Marine Resource Amidst Covid-19 Era and Beyond, EIS, 6-7 September 2022, Online (2022a)
21. A.V. Seulalae, E. Prangdimurti, D.R. Adawiyah, Nurjanah, JPHPI **26**, 1 (2023)
22. Nurjanah, A. Abdullah, C. Nufus, JPHPI **21**, 1 (2018c)
23. R. Kurniawan, Nurjanah, A.M. Jacoeb, A. Abdullah, R.M. Pertiwi, JPHPI **22**, 3 (2019)
24. Nurjanah, A.M. Jacoeb, Ramlan, A. Abdullah, JPHPI **23**, 3 (2020b)
25. C. Nufus, A. Abdullah, Nurjanah, *Characteristics of green seaweed salt as alternative salt for hypertensive patients*, in The 3rd EMBRIO International Workshop on Marine Biodiversity: Understanding, Utilization, Conservation, 9-10 October 2019, Bogor, Indonesia (2019)
26. Nurjanah, M. Nurilmala, S. Alfarizi, E. Rochima, D. S. Wahyuni, A. V. Seulalae. *Characterization of seaweed healthy salt from Indonesian Ulva*

lactuca and Chaetomorpha sp. flour, in The 6th EMBRIO International Symposium: "Ocean for Prosperity: Sustainably Use of the Ocean Resources for Economic Growth, Improvement of Livelihoods, and Preserve its Ocean Ecosystem Health" (EIS 2023), Bogor, Indonesia (2024)

27. Nurjanah, A.M. Jacoeb, A. Abdullah, J. A. Priyanto, N. M. Nurdin, A.V. Seulalae, Squalen. **18**, 1 (2023a)
28. T. Y. Hendrawati, R. A. Nugrahani, S. Utomo, A. I. Ramadhan, Proses Industri Berbahan Baku Tanaman *Aloe vera*. (Penerbit Samudra Biru, Yogyakarta, 2017)
29. D. Komatsu, D. V. Mistura, A. Motta, J. A. Domingues, M. A. Hausen, E. Duek, J. Biomater. Appl, **32**, 3 (2017)
30. L. S. Marhaeni, J Ilmu-Ilmu Pertanian, **13**, 1 (2020)
31. M. Indriastuti, K. R. S. Rahmah, M. S. Fatimah, Jurnal Kesehatan, **7**, 2 (2020)
32. G. F. Hanzola, R. Rahmiati, M. Astuti, J.Home Econ. Tourism, **8**, 1 (2015)
33. K. Sharma, A. Mittal, N. Chauhan, International Drug Development and Research, **7**, 1 (2015)
34. Association of Official Analytical Chemists. Official method of analysis of the association of official analytical of chemists 18th Edition (AOAC International, Maryland, 2005)
35. J. B. Harborne, Metode Fitokimia. Institut Teknologi Bandung. Terjemahan dari phytochemical Methods (1987)
36. Badan Standardisasi Nasional. SNI 01–2346–2006. Petunjuk Pengujian Organoleptik dan atau Sensori. (2006)
37. Brookfield Manual. Digital Viscometer Model DV-E: Operating Instruction, Manual No. M/98-350-E1203. Brookfield Engineering Laboratories, INC
38. Y. M. Navarro-Pérez, E. Cedeño-Linares, O. Norman-Montenegro, V. Ruz-Sanjuan, Y. Mondeja-Rivera, A. M. Hernández-Monzón, M. M. González-Bedia, J. Pharm. Pharmacogn. Res., **9**, 1 (2021)
39. A. C. Erungan, S. Purwaningsih, S. B. Anita, JPHPI, **12**, 2 (2009)
40. T. K. Ningrum, U. Nafisah, E. D. Antari, J. Farmasindo, **5**, 1 (2021)
41. I. L. Lestari, S. R. Mita, Farmaka. **14**, 1 (2017)
42. A. Skendi, M. Irakli, P. Chatzopoulou. J.Appl. Res. Med. Aroma. Plants, **6**, (2017)
43. P. Molyneux, Songklanakarin. J. Sci. Technol, **26**, 2 (2004)
44. Badan Standarisasi Nasional. SNI Nomor 16-4399-1996. Sediaan Tabir Surya.
45. B. Iskandar, Z. P. Dian, F. Renovita, Leny. Health Sci. Pharm. J., **5**, 1 (2021)
46. N. S. P. Swastika, A. Mufrod, Purwanto, Tradit. Med. J., **18**, 3 (2013)
47. S. P. J. Ulaen, Y. Banne, R. A. Suatan, J. Ilmiah Farmasi, **3** (2012)
48. D. E. Ermawati, S. Martodihardjo, T. S. Sulaiman, J. Pharm. Sci. Clin. Res, **2**, 2 (2017)
49. Y. Damayanti, A. D. Lesmono, T. Prihandono. J. Pembelajaran Fisika, **7**, 3 (2018)
50. A. C. Erungan, S. Purwaningsih, S. B. Anita, JPHPI, 1**2**, 2 (2009)
51. S. Arita, T. E. Agustina, D. Patrica, L. Rahmawati, J. Teknik Kimia Universitas Sriwijaya. **16**, 4 (2009)
52. Deladeria VP. 2021. karakteristik body scrub dari residu garam Ulva lactuca dengan penambahan bubuk bengkuang (Pachyrhizus erosus) [skripsi]. Bogor: Institut Pertanian Bogor.

53. Okafor LA, Anumata ES, Anyikamba SN, Ofodum NM, Okonkwo SI. Int. J. Sci. Engineer. Res. **9**, 11, (2018)
54. J. Arct, A. Oborska, M. Mojski, M. Chudzicki, Pol J Cosmetol, **19**, 1 (2016)
55. T. S. Julianto TS. Fitokimia Tinjauan Metabolit Sekunder dan Skrining Fitokimia. Yogyakarta (ID): Universitas Islam Indonesia. (2019)
56. A. Abdullah, Nurjanah, A. V. Seulalae, *Antioxidant activity of biopigment fractions from golden apple snail eggs (Pomacea canaliculata)*, in The 4th EMBRIO International Symposium and the 7th International Symposium of East Asia Fisheries and Technologists Association, Bogor, Indonesia, 5-6 August 2019, Bogor, Indonesia (2020)
57. A. Setyowati, C. L. Suryani, AGRITECH, **33**, 4 (2013)
58. A. Andriyanto, M. A. M. Andriani, E. Widowati E, J. Teknosains Pangan, **2**, 2 (2013)
59. Rusdiana, J. Tata Rias, **7**, 2 (2018)
60. E. P. D. Putra, R. R. Pratama, Agrointek, **16**, 1 (2022)