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The Potential Secondary Metabolites of Macroalgae *Sargassum polycystum* C. Agardh (1824) from the Coast of West Aceh as Raw Material of Body Scrub

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ABSTRACT Sargassum polycystum is one brown seaweed with a rich alginate source. The previous study showed that *S. polycystum* could be used as a cosmeceutical raw material because of its natural attribute and safe. *S. polycystum* always grows in many coastal of Indonesia. This study aims to characterise brown seaweed (*S. polycystum*) as the raw material of the body scrub. The research method includes the extraction, phytochemical assay, antioxidant assay, and total phenolic content-the phytochemical screening-detected alkaloid and steroid compounds in *S. polycystum* extract. The antioxidant activity by using the CUPRAC method showed the ethanol extract was 53.55±1.07 µM/g and FRAP was 201.95±6.33 µM/g with total phenolic content was 177.647±21.39 Mg GAE/g. We compared the antioxidant capacity of the body scrub by adding brown seaweed of *S. polycystum* 7% (S7) used the CUPRAC method was 34.23±0.33 µM/g, and FRAP was 124.05±1.87 µM/g with total phenolic content was 416.31±78.44 Mg GAE/g. Kruskal Wallis analysis showed that adding brown seaweed *S. polycystum* with different formulas influenced the panellist's preference for smearing ability, odor, texture, colour, and consistency. According to the Mean rank obtained, the level of preferences of the panellists was gained from product S7 namely body scrub with the addition of brown seaweed *S. polycystum* as much as 7%. It is indicated that the brown seaweed *S. polycystum* possesses body scrub raw material that is prospective in the cosmeceutical industry.

Keywords: Body scrub; brown seaweed; raw material; *S. polycystum*

INTRODUCTION

Indonesia The marine environment consists of various organisms, such as algae, molluscs, sponges, corals, and tunicates. Oceans are called the "Lung of the Earth" due to Cyanobacteria and other algae living there, contributing up to 80% of the atmospheric oxygen we use to breathe. Algae are almost ubiquitous among microscopic and macroscopic species, found in every wet environment on land, freshwater, or oceans (Lewin & Andersen, 2019). Fucoxanthin, chlorophylls a and c, carotenoid pigments, reserve substances, oils, and polysaccharides (such as laminarin) are discovered in the brown algae (Vidotti & Rollemberg, 2004; Barsanti & Gualtieri, 2014). Today, cosmeceuticals attract the attention of industries and consumers. It is not yet officially legal, but the industry uses this term involving a product with cosmetics and pharmaceuticals benefits (Vermeer *et al*., 1996; Brandt *et al*., 2011). Natural cosmetics are continuously in demand for their benefit. They offer to replace the dangerous chemicals in traditional cosmetics products. Thus, the cosmetic industry is rapidly growing to satisfy the demands.

Some of the primary natural ingredients in cosmetics are seaweeds, one of the wealthiest marine sources of vitamins, minerals, amino acids, antioxidants, and essential fatty acids. Seaweeds are unique with their bioavailable ingredients. Its active, nutrient-rich compounds can be absorbed easily by the skin and body. Due to their bioavailable nature, including reducing redness and blemishes, brightening, hydrating, re-mineralising, reducing sun damage and firming skin (Thomas & Kim, 2013; Pereira, 2018; Osea Malibu, 2020).

One of the promising seaweed species for the cosmeceutical industry is Sargassum. The genus Sargassum, a type of brown algae, is tropical and subtropical brown seaweed in subtidal and intertidal areas, with 150 species (Olabarria *et al*., 2009). Seawater current and substrate type (i.e., rocky shores) contribute to the distribution and population structure of the Sargassum (Ang, 1986; Ateweberhan *et al*., 2005). Various types of substrate in Aceh coasts, Indonesia, especially West Aceh coasts, have abundant resources of Sargassum (Gazali & Nurdin, 2017). Studies have revealed the seaweed diversity in Aceh, distributed along the coastlines (Gazali *et al*., 2019; Gazali *et al*., 2019; Gazali *et al*., 2020; Gazali *et al*., 2021). However, the exploration for cosmetic prospects like body scrubs remains limited.

Studies related to the Sargassum genus have shown the high antioxidant potential in vitro (Lim *et al*., 2002; Santoso *et al*., 2004; Kim *et al*., 2005; Park *et al*., 2005; Cho *et al*., 2007; Zubia *et al*., 2007; Zubia *et al*., 2008; Budhiyanti *et al*., 2011; Gazali *et al*., 2018) that was utilised in body scrub products by the cosmeceutical industry. Antioxidant compounds are very fascinated in the pharmaceutical industry. Antioxidants can be added in preparing cosmetic ingredients because they possess compound activities against free radicals (Chermahini *et al*., 2011). Recently, the increasing application of natural antioxidants from terrestrial plants in cosmetic raw materials consists of polyphenols and terpenes compounds. Polyphenols have -OH groups attached to the benzene ring. The antioxidant activity is determined by the number and the position of -OH groups on the benzene ring. Phenolic groups also inhibit lipid peroxidation against free radicals. Flavonoids and stilbenes are the largest groups of polyphenols, and the terpene groups are carotenoids that serve as singlet oxygen quenchers (Pouillot *et al*., 2011). Latifah *et al*. (2021) reported that the *Sargassum* sp with the addition of turmeric rhizome powder in the body scrub raw material possesses intense antioxidant activity. The antioxidant compound that has an important role is the phenolic group in the Sargassum sp plant that enhances the functional value of body scrub, such as antioxidant activity.

The body scrub consists of rough material to remove dead skin cells (Alam, 2009). Its primary ingredients are equal to those used in cleansing creams with extra ingredients, i.e., abrasive, coarse grains to remove dead skin cells (Ulfa *et al*., 2016). Body scrub ingredients may originate from synthetic and natural ingredients. Natural ingredients include apricot seeds, walnuts, and almonds, while synthetic ones are polyethene and oxidised polyethene (Ertel, 2006). People have recently preferred cleansing products with natural ingredients because they are safer and rarely irritate. One of the potential brown seaweed from seawater is *S. polycystum*. This study aimed to characterise brown seaweed *S. polycystum* in the raw material of body scrub.

MATERIALS AND METHODS

Samples collection and formulation

Samples of brown seaweed *S. polycystum*, dried algae, were gathered from the coast of Lhok Geulumpang, Aceh Jaya, Indonesia. Fresh *S. polycystum* was washed, chopped and crushed using a blender. The dried *S. polycystum* was prepared using the same fresh *S. polycystum.*

Chemicals and instruments

The chemicals used were 4,6-tri (2-pyridyl)-s-triazine (TPTZ), Dragendorff's reagent, mercuric chloride, ascorbic acid, potassium iodide bought from Sigma–Aldrich. The ethanol pa (Merck), methanol pa (Merck), ethyl acetate pa (Merck), n-hexane pa (Merck), hydrochloric acid (HCl), sulfuric acid (H_2SO_4), chloroform, ammonia, glacial acetic acid, sodium hydroxide(NaOH), $CuCl_2$,$2H_2O$ (Merck), $FeCl_3.6H_2O$ (Merck), Follin-Ciocalteu, 2- deoxyribose and H_2O_2(30%, v/v) were from Merck and potassium peroxodisulfate. This study used the ultraviolet-visible spectrophotometer of Shimadzu, Pharmaspec-1700, as the instrument.

The proximate analysis

The chemical compositions were examined by proximate analysis using the AOAC. They included the water, ash, carbohydrate, protein, and fatty acid content (AOAC, 2005).

Extraction of S. polycystum

The simplicity of *S. polycystum* (300 g) was extracted using three solvents (ethanol, ethyl acetate, and n-hexane). The maceration was done with a ratio of 1:3, with three solvents soaked and filtered by filter paper. A vacuum rotary evaporator was used to evaporate the solvents. The extracts determined antioxidant activity.

Phytochemical analysis

The qualitative analysis of the phytochemical compound from brown seaweed *S. polycystum* extract can be identified by observing the extract's colour changes added with several chemical compounds. The initial phytochemical analysis of different extracts was undertaken based on Khandelwal, Wallis, and Harborne (Harborne, 1999; Wallis, 2005; Khandelwal, 2007). The phytochemical compounds include phenolic, flavonoid, tannin, saponin, alkaloid, and terpene.

Antioxidant activity of FRAP (ferric reducing antioxidant power)

The FRAP antioxidant activity of *S. polycystum* extract refers to Kumar *et al*. (2012) with little modification. The reagent preparations of FRAP consisted of acetate buffer 300 mM (8 mL CH_3COONa and 92 mL CHCOOH) pH 3,6 10 mM TPTZ solution (2,4,6-tripyridyl-striazine) in 40 mM HCl and $FeCl_3.6H_2O$ 20 mM. The freshly prepared solution was mixed with 3.5 mL acetate buffer, 3.5 mL TPTZ dan 3.5 mL of $FeCl_3.6H_2O$. Absorbance measurement used samples of 50 µL, 600 µL aquadest, and 3000 µL of FRAP reagent. The sample mix and FRAP reagent were homogenised using vortex before being incubated using a water bath for 30 minutes (37 °C). Absorbance was measured in wavelength with Trolox solution with various concentrations.

Antioxidant activity of CUPRAC (cupric reducing antioxidant capacity)

Antioxidant activity with CUPRAC Assay according to Apak *et al*. (2008) with modification. *S. polycystum* crude extract (0.3 mL) were diluted with ethanol 99.9% with with 1 mL $CuCl_22H_2O$ 0.01 M, 1 mL neucoproine 0.0075 M, 1 mL of ammonium acetate buffer pH 7 1 M and 0.8 mL aquadest. The sample mix and this reagent were homogenised using a vortex, followed by incubation at the temperature room (30 minutes). Absorbance was measured with a wavelength of 450 nm. The calibration curve was made using a Trolox solution with various concentrations.

Determination of total phenolic content

The Follin-Ciocalteau method refers to Chandini *et al*. (2008) to examine the total phenolic content (TPC). Firstly, 2 mL of 2% sodium carbonate was put into the solution 100 µL aliquot, adding 100 µL of 50% Folin-Ciocalteau's phenol reagents after 2 min. The mixtures were put for 30 min at dark ambient temperature, and the absorbances were measured at 720 nm. The total of phenolic compounds was generated following a phloroglucinol standard curve by plotting concentration (mg m^{-1}) and absorbance (nm), with regression equation of y= 3.910x+0.002, R2= 0.99, where x= concentration and y= absorbance. The phenolic content was expressed as g of Gallic Acid Equivalent (GAE) per 100 g of the dry extract. This analysis was made in three replications for each extract.

Formulation of body scrub

The body scrub was made in three formulas, 1, 2, and 3, using dried *S. polycystum*. In the preparation stage, dried *S. polycystum* was chopped and crushed to a pulp using a blender. The seaweed pulp was then dried using a freeze dryer. The body scrub was formulated by mixing water bases 4, 5, and 6 using dried *S. polycystum*. The body scrub was formulated by mixing water-base (propylene glycol, glycerine, aquadest) and oil base (cetyl alcohol, stearic acid, DEA, perfume) at 70°C and 80°C, then the water base and oil base were mixed to form a cream. Afterwards, the mixture was added with 3% of *S. polycystum* konjac flour and a preservative (methyl-paraben or chitosan). The body scrub was then analysed.

Body scrub characteristic

Body scrub characteristic containing *S. polycystum* and konjac flour includes mineral content, pH, and hedonic test. A hedonic test was carried out on 30 panellists. Parameters of the hedonic test include colour, aroma, consistency, texture and appearance.

Statistical analysis

The three replicates' mean and standard deviation (SD) presented the experimental results. Linear regression analysis was also performed. Hedonic test by Kruskal Wallis Test. Analysis was conducted using SPSS. The result that showed the differences are continued with the Duncan Test.

RESULTS AND DISCUSSION

Chemical composition

Seaweed extract has a high nutritional value, benefiting human nutrients, such as a protein with all essential amino acids, minerals, and vitamins. Also, they comprise bioactive secondary metabolites and many other compounds beneficial for health (Wong *et al*., 2000; Zvyagintseva *et al*., 2005; Alves de Sousa *et al*., 2007; Cardozo *et al*., 2007; Artan *et al*., 2008; Choi *et al*., 2009; Cho *et al*., 2009). The chemical composition of brown algae *S. polycystum* is in Table 1.

Table 1. The chemical composition of dried *S. polycystum*.

The components	Content (%)
Water content	32.70
Ash content	23.13
Protein	6.72
Fatty acid	2.00

The chemical composition of *S. polycystum* can be seen in Table 1. The result showed that the water content of *S. polycystum* was obtained at 32.70%. The water content in seaweed is always influenced by drying processing. Osman *et al*. (2011) revealed that the brown seaweed's water content from the red sea, namely *S. subrepandum*, was 13.02%, and *P. tetrasromatica* was 13.37%. Ash content of *S. polycystum* was 23.13%. This value indicated that the *S. polycystum* has high ash content. The variation of ash content can be related to the amount of an organic compound and salts. Vijay *et al*. (2017) reported that brown seaweed contained high ashes content (45.04%), followed by red seaweed (28.79%) and green seaweed (14.10%). The fatty acid of *S. polycystum* has a low value, namely 2.00%. Garcia *et al*. (2016) stated that seaweed species that grow in tropical areas possess lower fatty acids than those from subtropics areas. The protein content from *S. polycystum* was 6.72%. The protein of brown seaweed is lower (5-15%) than in red seaweed and green seaweed. The analysis of crude fibre from the sample of *S. polycystum* was 10.48%. The value is still lower than the crude fibre of other seaweed. Generally, crude fibre was 30-40% dried weight (Ate *et al*., 2017). Crude fibre is a carbohydrate component that can be hydrolysed using intestine enzymes.

Phytochemical result

The phytochemical analysis result of *S. polycystum* extract is presented in Table 2. The *S. polycystum* extract possesses alkaloid and steroids compounds, according to the results. Alkaloids are a chemical compound group diluted in organic solvents and primarily found in the extract that used polar solvents. Alkaloid possesses the potential as an antioxidant source because it is a polar compound and is also extracted in polar solvents (Sa'adah & Nurhasnawati, 2015). Mooradian (1993) reported that steroid compounds are an index of antioxidant properties of these compounds.

Table 2. The bioactive compound of dried *S. polycystum*.

Phytochemical properties	*S. polycystum*	Information
Alkaloid		
-Dragendroff	+	Orange/yellow
-Wagner	+	Orange/yellow
-Mayer	-	-
Tannin	-	-
Flavonoids	-	-
Saponin	-	-
Phenol Hydroquinone	-	-
Triterpenoid	-	-
Steroids	+	Blue-green

Note: Detected (+) ; Not Detected (-).

Seaweed is rich in secondary metabolites, including alkaloids, phenols, flavonoids, saponins, steroids, and related active compounds, with high medicinal values and is widely used by pharmaceutical industries. Some latest global studies have revealed the phytochemistry of seaweed (Selvin & Lipton, 2004; Fayaz *et al*., 2005; Somepalli *et al*., 2007; Adaikalaraj *et al*., 2011).

Antioxidant capacity and total phenolic content

According to the FRAP method, the antioxidant activity value is 201.95±6.33 μM/g. This result showed that the

S. polycystum extract has the potential as an antioxidant agent for body scrub products. Diachanty *et al*. (2017) reported that the *S. polycystum* extract from Seribu Island has 105.357 μmol trolox/g extracts. The value of FRAP antioxidant capacity is higher than *S. polycystum* from Seribu Island, Jakarta. The FRAP is a determination method of antioxidant activity to determine the antioxidant ability for decreasing Fe3+ in Fe3+-TPTZ complex to be Fe2-TPTZ with donor their electron. The previous study shows that *S. tenerrimum* possesses 4.076,54 μmol trolox/g (Guru *et al*., 2015) and *P. tetrastomatica* 1,168 mg ascorbic acid/g (Megha & Anjali, 2013).

Table 3. Antioxidant capacity and total phenolic content of *S. polycystum*.

Sample	Total phenolic content mg GAE/g	CUPRAC (μM/g)	FRAP (μM/g)
S. polycystum	177.647±21.39	53.55±1.07	201.95±6.33

The CUPRAC antioxidant activities of *S. Polycystum* were 53.55±1.07 μM/g showing that *S. Polycystum* extract has more phenolic compounds than other crude extracts. Fadhilah (2018) reported that the content of ethanol extract from brown seaweed, *Sargassum* sp showed relatively antioxidant solid activity with IC_{50} of 56.60 ppm. Subsequently, the best herbal body scrub formula is with the addition of 1% carrageenan. Body scrub produced had a pH value, viscosity, and scatter following the standard.

Apak *et al*. (2008) argued that the CUPRAC method is more common for measuring the antioxidant capacity of the phenolic compound. Therefore, this *S. Polycystum* crude extract was predicted to have more phenolic compounds. The CUPRAC method was based on Cu (II) – Cu (I) reduction by antioxidants due to neocuproine. The antioxidant activity was investigated using a CUPRAC assay with a routine compound. It was created from several concentration ((10μg/mL, 15 μg/mL, 20 μg/mL, 25 μg/mL dan 30 μg/mL) before adding $CuCl_2.2H_2O$ 0,01 M solution, ethanol neocuproine 0.0075 and acetate ammonium buffer pH 7 1M. Antioxidant activity, the capacity of CUPRAC reduction, was based on sample absorbance decreasing to control absorbance (Apake., 2008). Nevertheless, the FRAP method showed the potential antioxidant capacity (201.95±6.33 μM/g) to be the raw material of body scrub.

Characteristic of body scrub

The body scrub was made into three different formulas that are formula 1 (S3) (body scrub with added dried *S. polycystum* 3%), formula 2 (S5) (body scrub with added *S. polycystum* 5%) and formula 3 (S7) (body scrub with added *S. polycystum* 7%). To identify the sensory of body scrub product of brown seaweed *S. polycystum*, we have involved panellists in giving appraisals on body scrub products. The panellists conducted the appraisal of body scrub with the addition of brown seaweed *S. polycystum* 3% (S3), 5% (S5), and 7% (S7). The organoleptic test, including the smearing ability, aroma, texture, colour, and consistency parameters, is displayed in Table 4.

The Kruskal Wallis analysis showed that differences in body scrub formula significantly affected panellist acceptance of body scrub smearing ability (p>0.05) see Table 4. The average value of the panellists' preference for smearing ability has ranged from 2.70 to 3.32 (neutral-prefer). Duncan's other test results show that formula 1 (S3) was not significantly different from formula 2 (S5) except for formula 3 (S7). Panellists prefer more than the smearing ability of body scrub with dried *S. polycystum* in formula 3, adding *S. polycystum* 7%. The average value of the panellists' preference for aroma ranged from 2.67 to 3.70 (instead prefer). This showed that the panellists liked the aroma. The result of Kruskal Wallis analysis showed that differences in body scrub formula did not have a significant effect on panellist acceptance of the aroma of body scrub (p>0.05) except the formula 3 (S7) see Table 4. The aroma of that panellist was caused by the addition of perfume to the body scrub.

The results of Kruskal Wallis analysis show that differences in body scrub formulas significantly affect panellist acceptance of the texture of body scrub (p> 0.05) see Table 4. The average value of panelists' preferences for body scrub textures ranges from 2.77-to 3.53 (neutral-prefer). Duncan's further analysis showed that formula 1 was not significantly different from formula 2 but significantly different from formula 3. Formula 3 (S7) found the most preferred texture, with a value of 3.53. panellist's assessment showed that most panellists liked the texture of body scrub with dried *S. polycystum*. The colour test showed that differences in body scrub formula significantly affected panellist acceptance of body scrub colour (p>0.05). Duncan's test results showed that the panellist's preference for the colour of formula 1 was not significantly different except for formula 3 (S7). The most preferred colour was formula 3 (S7), with a value of 3.87. The colour of the body scrub is affected by *S. polycystum* seaweed, which has brown. Inconsistency parameter showed that panellist preferences value of all formulas ranges from 3.37-3.60 (instead prefer). Duncan's further test showed that all formula inconsistencies were not significantly different. Several body scrubs have additional ingredients like konjac flour, which contains

Table 4. Hedonic value of body scrub of *S. polycystum*.

Formulas	Smearing ability	Aroma	Texture	Color	Consistency
S3 (Formula 1)	2.70^{ab}	2.67^{a}	2.77^{a}	2.50^{a}	$3.40a^{bc}$
S5 (Formula 2)	2.53^{a}	2.73^{a}	2.73^{a}	2.77^{ab}	3.37^{ab}
S7 (Formula 3)	3.32^{bc}	3.70^{cd}	3.53^{b}	3.87^{d}	3.60^{bc}

Note: different superscript letters indicate significant differences (P < 0.05).

high glucomannan. Wigoeno *et al*. (2013) reported that adding konjac flour to the formula results in a buttercream consistency. Body scrub becomes thicker after adding konjac flour. Besides adding konjac flour, chitosan added to the formula can provide a thick cream consistency of body scrub.

The hedonic value showed the highest value. With the addition of brown seaweed *S. polycystum* with different formulas, Kruskal Wallis influenced the panellist's level of preference for smearing ability, aroma, texture, colour, and consistency parameters. According to the Mean rank obtained, the level of preferences of the panellists was gained from product S7 namely body scrub with the addition of brown seaweed *S. polycystum* as much as 7%. The pH value of body scrub with the addition of *S. polycystum* 7% (S7) is 6.56±0.02. Body scrub with the addition of *S. polycystum* 7% (S7) has a stable emulsion that has not occurred during the separation of the oil and water phase in the product, emulsion stability of body scrub (Figure 1). The results were emphasised antioxidant activity that explained previously.

Figure 1. The emulsion stability of body scrub with the addition of *S. polycystum* 7%.

Sampebarra (2016) believed that the higher the consistency and the better the product's texture, the higher the smearing ability. The consistency and thickness of the body scrub in this study were promising, making it convenient and easy to put evenly on the skin's surface.

CONCLUSIONS

We concluded that the extract of brown seaweed *S. polycystum* has a potential antioxidant agent used as the raw material of body scrub products with relatively strong antioxidant activity. The difference in body scrub formula significantly affected its smearing ability, colour, consistency, and texture. Based on the hedonic assessment result, the best body scrub formula was a body scrub using 7% of dried *S. polycystum.*

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AUTHORS' CONTRIBUTIONS

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REFERENCES

Adaikalaraj, G., M. Johnson M, D.P. Raja & N. Janakiraman. 2011. Pharmacognostical and phytochemical evaluation of selected seaweeds of Rhodophyceae. Natural Products: An Indian Journal. 7 (6):1-9

Alam, M. 2009. Cosmetic Dermatology for Skin of Color. McGraw-Hill Companies. New York

Alves de Sousa, A.P., MR. Torres, C. Pessoa, M.O. de Moraes, F.D.R. Filho, A.P.N.N. Alves & L.V. Costa-Lotufo. 2007. In vivo growth-inhibition of Sarcoma 180 tumour by alginates from brown seaweed *Sargassum vulgare*. Carbohydr. Polym. 69 (1): 7-13. http://dx.doi.org/10.1016%2Fj.carbpol.2006.08.018

Ang, P.O. 1986. Analysis of the vegetation structure of a Sargassum community in the Philippines. Mar. Ecol. Prog. Ser. 28: 9-19. https://doi.org/10.3354/MEPS0 28009

Apak, R., K. Guclu, M. Ozyurek & S.E. Celik. 2008. Mechanism of antioxidant capacity assays and the CUPRAC (cupric ion reducing antioxidant capacity) assay. Microchimica Acta. 160: 413-419. https://doi.org/10.1007/s00604-007-0777-0

Artan, M., Y. Li, F. Karadeniz, S.H. Lee, M.M. Kim & S.K. Kim. 2008. Anti-HIV-1 activity of phloroglucinol derivate, 6,6'–bieckol, from Ecklonia cava. Bioorg. Med. 16 (17): 7921-7926. https://doi.org/10.1016/j.bmc.2008.07.078

Association of Official Analytical Chemists (AOAC). 2005. The Association of Official Analytical Chemists, Inc.

Ate, J.N.B., J.F. da Costa & T.P. Elingsetyo. 2017. Analisis kandungan nutrisi *Gracilaria edule* (S.G. Gmelin) PC Silva dan *Gracilaria coronopifolia* J. Agardh. Jurnal Ilmu Kesehatan. 5 (2): 94-103. https://doi.org/10.30650/jik.v5i2.57

Ateweberhan, M., J.H. Bruggemann & A.M. Breeman. 2005. Seasonal dynamics of *Sargassum ilicifolium* (Phaeophyta) on a shallow reef flat in the Southern Red Sea (Eritrea). Mar. Ecol. Prog. Ser. 292: 159-171. https://dx.doi.org/10.3354/meps292159

Barsanti, L & P. Gualtieri. 2014. Algae Anatomy, Biochemistry, and Biotechnology. CRC Press: Boca Raton, FL, USA.

Brandt, F.S., A. Cazzaniga & M. Hann. 2011. Cosmeceuticals: Current trends and market analysis. Semin. Cutan. Med. Surg. 30 (30): 141-143. https://doi.org/10.1016/j.sder.2011.05.006

Budhiyanti, S.A., S. Raharjo, D.W. Marseno & I.Y.B. Lelana. 2011. Free radical scavenging, metal chelating, and singlet oxygen quenching activity of fractionated brown seaweed *Sargassum hystrix* extract. J. Biol. Sci. 11 (4): 288-298. https://dx.doi.org/10.3923/jbs.2011.288.298

Cardozo, K.H.M., T. Guaratini, M.P. Barros, V.R. Falcao, A.P. Tonon, N.P. Lopes, S. Compos, M.A. Torres, A.O. Souza, P. Colepicolo & E. Pinto. 2007. Metabolites from algae with economical impact. Comp. Biochem. Physiol. 146 (1-2): 60-78. https://doi.org/10.1016/j.cbpc.2006.05.007

Chandini, S.K., P. Ganesan & N. Bhaskar. 2008. In vitro antioxidant activities of three selected brown seaweeds of India. Food Chem. 107 (2): 707-713. https://doi.org/10.1016/j.foodchem.2007.08.081

Chermahini, S.H., F.A.A. Majid & M.R. Sarmidi. 2011.

Cosmeceutical value of herbal extracts as natural ingredients and novel technologies in anti-ageing. J. Med. Plant. Res. 5 (14): 3074-3077. https://doi.org/10.5897/JMPR.9000414

Choi, E.Y., H.J. Hwang, I.H. Kim & T.J. Nam. 2009. Protective effects of a polysaccharide from *Hizikia fusiformis* against ethanol toxicity in rats. Food Chem. Toxicol. 47 (1): 134-139. https://doi.org/10.1016/j.fct.2008.10.026

Diachanty, S., N. Nurjanah & A. Abdullah. 2017. Aktivitas antioksidan berbagai jenis rumput laut coklat dari Perairan Kepulauan Seribu. JPHPI. 20 (2): 305-318. https://doi.org/10.17844/jphpi.v20i2.18013

Ertel, K. 2006. Personal Cleansing Products: Properties and Use Cosmetic Formulation of Skin Care Products. CRC Press. New York

Fadhilah, R.N. 2018. Formula Krim Lulur dari Ekstrak Rumput Laut Coklat *Sargassum* sp. dan Karagenan. Undergraduate Theses. IPB University. Unpublished.

Fayaz, M., KK. Namitha, K.N.C. Murthy, M.M. Swamy, R. Sarada, S. Khanam, P.V. Subbarao & G.A. Ravishankar. 2005. Chemical composition, iron bioavailability and antioxidant activity of *Kappaphycus alvarezzi* (Doty). J. Agr Food Chem. 53 (3): 792-797. https://doi.org/10.1021/jf0493627

Gazali, M & M. Nurdin. 2017. Biodiversity of Marine Macroalgae in The Intertidal Zone of Lhok Bubon Beach, West Aceh, Aceh Province. Proceeding The 4th International Marine and Fisheries Symposium 2017 Fakultas Ilmu Kelautan dan Perikanan Universitas Hasanuddin. Makassar.

Gazali, M., N. Nurjanah & N.P. Zamani. 2018. Eksplorasi senyawa bioaktif alga cokelat *Sargassum* sp. Agardh sebagai antioksidan dari pesisir barat Aceh. JPHPI. 21 (1): 167-178. https://doi.org/10.17844/jphpi.v21i1.21543

Gazali, M., N. Nurjanah & N.P. Zamani. 2019. Skreening alga hijau *Halimeda opuntia* (Linnaeus) sebagai antioksidan dari Pesisir Aceh Barat. JIPI. 24 (3): 267-272. https://doi.org/10.18343/jipi.24.3.267

Gazali, M., N. Nurjanah, N.P. Zamani, M.A. Nasution, Z. Zuriat & R. Syafitri. 2021. Screening for Antioxidant Activity in Extracts of the Marine Macroalgae *Enteromorpha flexuosa* (Wulfen) J. Agardh from South Aceh. IOP Conf. Ser: Earth Environ. Sci. 763 012027. 10.1088/1755-1315/763/1/012027

Gazali, M., N. Nurjanah, N.P. Zamani, Z. Zuriat & M.A. Nasution. 2020. A study on a potential bioactive compound in green seaweed *Chaetomorpha antennina* Kützing (1847) extract as antioxidant from the Gosong Telaga Coast, Aceh Singkil. IOP Conf. Ser: Earth Environ. Sci. 564 012058. https://doi.org/10.1088/1755-1315/564/1/012058

Gazali, M., N.P Zamani & N. Nurjanah. 2019. The potency of green algae *Chaetomorpha crassa* Agardh as an antioxidant agent from the coastal of Lhok Bubon, West Aceh. IOP Conf Ser: Earth Environ Sci 278 012029. https://doi.org/10.1088/1755-1315/278/1/012029

Gilchrest, B.A & S.L. Friedel. 1996. A proposal for rational definition, evaluation, and regulation. Arch. Dermatol. 132: 337-340.

Guru, M.M.S., M. Vasanthi & A. Achary A. 2015. Antioxidant and free radical scavenging potential of crude sulfated polysaccharides from *Turbinaria ornate*. Biologia. 70 (1): 27-33. https://doi.org/10.1515/biolog-2015-0004

Harborne, JB 1999. Phytochemical methods. Chapman & Hall. London

Khandelwal, KR 2007. Practical pharmacognosy techniques and experiments. 17th ed. Pune: Nirali prakashan.

Kim, S.J., S. Woo, H. Yun, S. Yum, E. Choi, J.R. Do, J.H. Jo, D. Kim. S. Lee & TK. Lee. 2005 Total phenolic contents and biological activities of Korean seaweed extracts. Food. Sci. Biotechnol. 14 (6): 798-802. https://www.koreascience.or.kr/publisher/ksfst1.page

Kumar, A., S. Kumari & D. Bhargavan D. 2012. Evaluation of in vitro antioxidant potential of ethanolic extract from the leaves of Achyranthes aspera. Asian J. Pharm. Clin. Res 5 (3): 146-148.

Lim, S.N., PCK. Cheung, V.E.C. Ooi & P.O. Ang. 2002. Evaluation of the antioxidative activity of extracts from brown seaweed, *Sargassum siliquastrum*. J. Agr. Food Chem. 50 (13): 3862-3866. https://doi.org/10.1021/jf020096b

MacFaddin, J.F. 1980. Biochemical Test for Identification of Medical Bacteria. Second Edition. Williams & Wilkins. Baltimore. London. 370-389.

Megha, MN & Anjali BS 2013. Antioxidant potential of seaweeds from Kunakeshwar along the West Coast of Maharashtra. Asian J. Biomed. Pharm. Scie. 3 (22): 45-50. https://doi.org/10.15272/AJBPS.V3I22.322

Mooradian, A.D. 1993. Antioxidant properties of steroids. J. Steroid Biochem. Molec. Biol. 45 (6): 509- 511. https://doi.org/10.1016/0960-0760(93)90166-T

Olabarria, C., I.F. Rodil, M. Incera & J.S. Troncoso. 2009. Limited impact of *Sargassum muticum* on native algal assemblages from rocky intertidal shores. Mar. Environ. Res. 67 (3): 153-158. https://doi.org/10.1016/j.marenvres.2008.12.007

Osea, M. 2020. Non-Toxic Seaweed Skin Care. Available online:https://oseamalibu.com/ (accessed on 14 December 2020).

Osman, N.A., I.M. El-Manawy & A.Sh. Amin. 2011. Nutritional composition and mineral content of five macroalgae from read sea. Egypt. J. Phys. 12 (1): 89-102. https://dx.doi.org/10.21608/egyjs.2011.114940

Park, P.J., S.J. Heo, E.J. Park, S.K. Kim & H.G. Byun. 2005. Reactive oxygen scavenging effect of enzymatic extracts from *Sargassum thunbergii*. J. Agric. Food Chem. 53 (17): 6666-6672. https://doi.org/10.1021/jf050582+

Pereira L. 2018. seaweeds as source of bioactive substances and skincare therapy cosmeceuticals, algotheraphy and thalassotherapy. Cosmetics. 5 (4): 68. https://doi.org/10.3390/cosmetics5040068

Pouillot, A., L.L. Polla, P. Tacchini, A. Neequaye, A. Polla & B. Polla. 2011. Formulating, Packaging and Marketing of Natural Cosmetic Products, John Wiley & Sons, Inc., Hoboken, New Jersey.

Sa'adah, H & H. Nurhasnawati H. 2015. Perbandingan pelarut etanol dan air pada pembuatan ekstrak umbi bawang putih tiwai (*Eleutherina americana* Merr) menggunakan metode maserasi. Jurnal Ilmiah Manuntung. 1 (2): 149-153. https://doi.org/10.51352/jim.v1i2.27

Sampebarra, A.L. 2016. Mempelajari kestabilan dan efek iritasi sediaan lipstick yang diformulasi dengan lemak kakao. Jurnal Industri Hasil Perkebunan. 11 (2): 97-103. http://dx.doi.org/10.33104/jihp.v11i2.3420

Santoso, J., Y. Yoshie-Stark & T. Suzuki. 2004. Antioxidant activity of methanol extracts from Indonesian seaweeds in an oil emulsion model. Fisheries Sci. 70 (1): 183-188. https://doi.org/10.1111/j.1444-2906.2003.00787.x

Selvin, J & A.P. Lipton. 2004. Biopotentials of *Ulva fasciata* and *Hypnea musciformis* collected from the peninsular coast of India. J. Mar. Sci. Technol. 12 (1): 1-6. https://jmstt.ntou.edu.tw/journal/vol12/iss1/1/

Thomas, N.V & SK. Kim. 2013. Beneficial of marine algal compounds in cosmeceuticals. Mar. Drugs. 11 (1): 146-164. https://doi.org/10.3390/md11010146

Ulfa, M., N. Khairi & F. Maryam. 2016. Formulasi dan evaluasi fisik krim body scrub dari ekstrak teh hitam (*Camellia sinensis*), variasi konsentrasi emulgator span-tween 60. Farmasi Fakultas Kedokteran dan Ilmu Kesehatan UIN Alauddin. 4 (4): 179-185. https://doi.org/10.24252/jurfar.v4i4.2257

Vidotti, E.C & M.do.C.E. Rollemberg. 2004. Da economia nos ambientes aquáticos à biorremediação e à química analítica. Quim. Nova. 27 (1): 139-145. https://doi.org/10.1590/S0100-40422004000100024

Vijay, K., S. Balasundari, R. Jeyashakila, P. Velayathum, K. Masilan & R. Reshma. 2017. Proximate and mineral composition of brown seaweed from Gulf of Mannar. Int. J. Fish. Aquat. Stud. 5 (5): 106-112. https://www.fisheriesjournal.com/archives/2017/vol5issue5/PartB/5-4-88-968.pdf

Wallis, T.E. 2005. Textbook of pharmacognosy. New Delhi: CBS. Publishers and Distributors.

Wigoeno, Y.A., R. Azrianingsih & A. Roosdiana. 2013. Analisis kadar glukomanan pada umbi porang (*Amorphophallus muelleri* Blume) menggunakan refluks kondensor. Biotropika. 1(5): 231-235. https://biotropika.ub.ac.id/index.php/biotropika/article/view/195/288

Wong, C.K., V.E.C. Ooi & P.O. Ang. 2000. Protective effects of seaweeds against liver injury caused by carbon tetrachloride in rats. Chemosphere. 41 (1-2): 173-176. https://doi.org/10.1016/S0045-6535(99)00407-5

Zubia, M., C. Payri & E. Deslandes. 2008. Alginate, mannitol, phenolic compounds and biological activities of two range-extending brown algae, *Sargassum mangarevense* and *Turbinaria ornate* (Phaeophyta: Fucales), from Tahiti (French Polynesia). J. Applied. Phycol. 20 (6): 1033-1043. http://dx.doi.org/10.1007%2Fs10811-007-9303-3

Zubia, M., D. Robledo & Y. Freile-Pelegrin. 2007. Antioxidant activities in tropical marine macroalgae from the *Yucatan peninsula*, Mexico. J. Applied Phycol. 19: 449-458. https://doi.org/10.1007/s10811-006-9152-5

Zvyagintseva, T.N., NM. Shevchenko, E.L. Nazarenko, V.I. Gorbach, A.M. Urvantseva, M.I. Kiseleva & V.V. Isakov. 2005. Water-soluble polysaccharides of some brown algae of the Russian Far-East. Structure and biological action of low-molecular-mass polyuronans. J. Exp. Mar. Biol. Ecol. 320 (2): 123-131. http://dx.doi.org/10.1016%2Fj.jembe.2004.12.027

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