DOI: https://doi.org/10.37905/jfpj.v4i2.14085

Jambura Fish Processing Journal
Vol. 4 No. 2 Tahun 2022
P-ISSN: 2655-3465 E-ISSN: 2720-8826

SCREENING OF PHYTOCHEMICALS IDENTIFIED AND ANTIOXIDANT ACTIVITY OF *Aegiceras corniculatum* EXTRACT THAT CULTIVATES FROM THE MANGROVE AREA OF TARAKAN CITY

Imra[1]*, Mohammad Fadnan Akhmadi[1], Diana Maulianawati[2], Fitri Awalia Nur[1], Sari Afriani[3]

[1]Department of Fisheries Products Technology, Faculty of Fisheries and Marine Sciences, Universitas Borneo Tarakan, Jl. Amal Lama No.01, Tarakan, North Borneo 77123, Indonesia

[2]Department of Aquaculture, Faculty of Fisheries and Marine Sciences, Universitas Borneo Tarakan, Jl. Amal Lama No.01, Tarakan, North Borneo 77123, Indonesia

[3]Department of Aquaculture, Faculty of Marine and Fisheries, Universitas Syiah Kuala, Jl. Teuku Nyak Arief No.441, Banda Aceh, Aceh 23111, Indonesia

*Korespodensi: imranmomo@gmail.com

(Diterima 18-04-2022; Direvisi 22-06-2022; Dipublikasi 31-07-2022)

ABSTRACT

Aegiceras corniculatum is mangrove vegetation that is widely spread in the mangrove area in Karang Rejo, Tarakan City and it has the potential for the development of drugs from natural ingredients from tropical sea coasts. The purpose of this study was to determine the water content, bioactive compounds, and antioxidant activity of A. corniculatum. The methods used were the analysis of water content, analysis of bioactive compounds using the phytochemical method, and analysis of antioxidant activity using the DPPH method. This study showed the percentage of moisture or water content in the leaf and fruit extracts of A. corniculatum were 1.83% and 1.95%, respectively. The bioactive compounds detected in the leaf and fruit extracts came from flavonoids, alkaloids, tannins, phenol hydroquinone, and saponins. The antioxidant analysis showed that the fruit and leaf crude extracts had an antioxidant activity with IC_{50} values were 129.7 ppm and 365.8 ppm, respectively.

***Keywords:* antioxidants; bioactive compounds; free radical; IC_{50}**

INTRODUCTION

A mangrove forest is a coastal forest ecosystem consisting of groups of vegetation that can live and adapt to an environment of fluctuating salinity. The city of Tarakan is a small island with an area of 657.33 km^2 located in the north of Borneo Island and has an area of mangrove forest resources of 1,224.8 ha (Rachmawani *et al*., 2010). Mangrove Forest of Karang Rejo is a mangrove conservation forest area in Tarakan City. The extent of the Karang Rejo mangrove area is 22 hectares. This forest provides productive natural resources, including fish resources (fish, shrimp, crabs, gastropods, shellfish), various animals, snakes, monkeys, proboci's monkeys, multiple types of birds, and others, as well as multiple types of mangrove vegetation, including; Bruguiera sp., *Avicennia* sp., *Coneratia* sp, *Nypa fructicans*, *Aegiceras* sp., and others. The most common mangrove vegetation found at the edge of the coastal mangrove forest

in Tarakan City is *Aegiceras corniculatum*.

Aegiceras corniculatum is a type of mangrove vegetation that grows in the mainland part of the tidal forest, in the form of a shrub or small tree that is always green and grows straight with a tree height of up to 6 meters. The outer bark is gray to reddish-brown, fissured, and has many lenticels. The leaves are light-skinned, shiny green on top and pale green on the bottom, with an inverted oval to the elliptical shape. The crescent-shaped fruit is green or yellowish. *A. corniculatum* has also been investigated regarding the potential of drugs such as the anticoagulant (Tangkery *et al*., 2013). Trianto *et al* . (2004) found the antibacterial activity of *A. corniculatum* extract against *Vibrio harveyi* and *Vibrio parahemolyticus*.

Mangrove vegetation is also known to have medicinal potential, such as antioxidant activity. Previous research has established that fruit and bark extract of *Bruguiera gymnorrhiza* had an IC_{50} of 13.46 and 56.93 ppm, respectively (Sudirman *et al* . 2014); Nurjanah *et al* . 2015). Recent work by Haq *et al* . (2014) reported that the bark extract of *Sonneratia alba* had an IC_{50} of 38 ppm. Imra *et al.* (2017) showed that methanol extract of *Nypa fruticans* has a very strong antioxidant activity with an IC_{50} value of 22.06 ppm. The active compounds that generally play a role in antioxidant activity are tannins, flavonoids, phenolics, saponins, and terpenoids. Margaretta *et al*. (2011) stated that phenolic compounds have a hydroxyl group that captures free radical activity in their molecular structure. Considering all of this evidence, it seems that *A. corniculatum* also contains components that have antioxidant activity. Seeing its benefits, this plant should be able to trace the content of antioxidant activities compounds and be used as a natural source of antioxidants, considering that its utilization is still around the coast and is used traditionally.

Screening of phytochemicals is a crucial way to explore the ability of the natural product. Several studies about phytochemicals in natural products have led to the development of the use of natural products for various purposes. *Saoropus androgynus*, *Apium graveolens* (Awaludin *et al*., 2019), *Nephlorepis biserrata* (Maulianawati *et al*. 2018; 2020), *Centella asiatica* (Rukisah *et al*. 2019) have been testing for phytochemical and used as antibacterial, molting stimulant, sex-reversal, and accelerate gonadal maturation. *Geloina coaxans* from the mangrove area showed antibacterial activity against *Vibrio parahaemolyticus* (Weliyadi *et al*., 2018). Currently, there are no data on the phytochemicals of *A. corniculatum* from Tarakan. For the first time, the present research explores the active compounds and antioxidant activity of *A. corniculatum*.

RESEARCH METHOD

Materials

The fruit and leaves of *A corniculatum*. Other materials used include chemicals for extraction of active compounds (Ethanol 97% Merck), chemical analysis (moisture content and ash content), antioxidant (DPPH SIGMA) and phytochemical testing. The main equipment used in this research is, *shaker*, *vacuum rotary evaporator* RV IKA 05 .

Corniculatum extract preparation

The leaves and fruits of *A. corniculatum* were washed with running water, then cut into small pieces, and dried for two days. Drying was continued using an oven at 50^{o}C for 24 hours. Dried fruit and leaves were mashed using a blender.

Extraction of A. corniculatum (Harbone 1987)

The powder of leaves and fruit was extracted by the maceration method using 96% ethanol solvent for 48 hours, then filtered (Repeated thrice). The collected filtrate was concentrated using a vacuum rotary evaporator at 40-50^{o}C to obtain a crude extract. The extract was weighed to get the extract yield. The extract was then analyzed for phytochemicals to determine the components of the active compounds. The antioxidant activity test used the 1,1-diphenyl-2-picrylhydrazil (DPPH) method.

Moisture Analysis (AOAC 2005)

Moisture content or water content was determined by using the oven drying method (AOAC 2005). The homogeneous sample was weighed at approximately 1 g (W_1) and placed in an empty cup (W_o). The cup was then closed and placed in an oven at 105^{o}C for 4 hours or until the weight was constant (W_2).

$$\text{Moisture } (\%) = \frac{W_1 - W_2}{W_1} \times 100$$

Where W_1 = Sample weighed before dried, W_2 = Sample weighed after dried

Determination of Active Compounds (Harbone 1987)

Active compound testing was carried out to know whether or not bioactive components were contained in the leaf and fruit extract of A. *corniculatum*. The test for alkaloids, steroids/triterpenoids, tannins, saponins, and phenol hydroquinone were described below.

Alkaloids

A 0.01 g of extract was dissolved in a few drops of 2N sulfuric acid. The test used three reagents, namely Dragendorff's, Meyer's, and Wagner's reagent. The test results are declared positive if with Dragendorff's reagent, a red to orange precipitate was formed, a yellowish-white precipitate with Meyer's reagent, and a brown precipitate revealed with Wagner's reagent.

Steroids/Triterpenoids

A total of 0.01 g of extract was dissolved in 2 mL of chloroform in a dry test tube, followed by adding ten drops of acetic anhydride and three drops of concentrated sulfuric acid. A positive reaction is shown with the formation of red color, and then it turns blue and green.

Saponins

Saponins can be detected by foam test in hot water. The foam is stable for 30 minutes and does not disappear after the addition of 1 drop of 2N HCl, indicating the presence of saponins.

Phenol Hydroquinone

A 0.01 g of extract was diluted with 20 mL of 70% ethanol. 1 mL of the solution was taken, and two drops of 5% $FeCl_3$ solution were added. The formation of the green or bluish-black color showed the presence of phenolic compounds.

Determination of Antioxidant Activity

Antioxidant activity of crude extract of leaves and fruit of A. *corniculatum was* determined using the *1,1-diphenyl-2-picrylhydrazil* (DPPH) method based on the Blois method (1958), which concentration has been modified. The DPPH test method is based on the ability of these antioxidant substances to neutralize free radicals. The free radicals used is *1,1-diphenyl* -2- *picrylhydrazil* (DPPH). The free radical DPPH is a synthetic radical which is stable at room temperature and soluble in polar solvents such as methanol and ethanol (Molyneux 2004).

The extract was dissolved in ethanol and prepared with 250, 500, 750, and 1000 ppm diluted concentrations. Ascorbic acid was used as a positive control with a concentration of 2, 4, 6, 8, and 10 ppm. The DPPH reagent solution is made by dissolving DPPH in ethanol with a concentration of 1 mM, kept at a low temperature, and protected from light. 4.5 mL of the extract solution or positive control solution was put in a test tube and then reacted with 0.5 mL of DPPH solution. The test tube was covered with aluminum foil and incubated at a temperature of 37^{o} C for 1 hour. After incubation, the absorbance was measured using a UV-Vis spectrophotometer at a wavelength of 517 nm.

A compound can be said to have antioxidant activity if it can donate its hydrogen atom, which is characterized by a purple to yellow color change (Molyneux 2004). The percentage of free radical inhibition expresses the antioxidant activity. Absorbance from solution blank was also measured to calculate the percent inhibition. The antioxidant activity (%) of the extract was calculated according to the following equation:

$$\%\ Scavenging\ Activity = \frac{A_{control} - A_{sample}}{A_{control}} \times 100$$

The concentration and inhibition values of the extract were plotted on the x and y axes, respectively. The equation of the line obtained in the form of y=b Ln(x) + a is used to find the IC (*Inhibitory Concentration*) value by stating the "y" value as 50 and the "x" value as IC_{50}. The IC_{50} value represents the concentration of the sample solution required to reduce DPPH by 50%. The smaller the IC_{50} value, the higher the antioxidant activity. A compound is said to be a very strong antioxidant if the IC_{50} value is less than 50 ppm, strong if the IC_{50} value is between 50-100 ppm, mild if the IC_{50} value ranges from 100-150 ppm, and weak if the IC_{50} value range between 150-200 ppm (Blois 1958).

RESULTS AND DISCUSSION

Extract of A. corniculatum

Aegiceras corniculatum is vegetation that is scattered in the mangrove swamp forest. This vegetation has oval leaves with small white flowers. The fruit size is about 5 cm, thick pencil-shaped curved, and pointed (Figure 3. a), spread in Asia and Australia. The vegetation of *A. corniculatum* used in this study was the leaves and fruit. Leaf and fruit powders that have gone through the preparation process are tested for moisture content. The principle of determining the moisture or water content was to evaporate the water in the material by heating. Heating is carried out at a temperature of 110 ◦ C. The material is then weighed to a constant weight, which means all the water has been evaporated. The results showed that the moisture content of leaf and fruit extracts of A. *corniculatum* were 1.83% and 1.95%, respectively. The moisture content of the fruits is higher than the leaves. The water content of the leaves and, nipah fruit was much lower than that obtained on the *Rhizopora mucronata* fruit, namely 52.38% (Mile *et al*, 2021).

Figure 3. (a) *A. corniculatum*, (b) maceration processed, (c) fruits preparation, and (d) leaves preparation

Powder of leaves and fruits maceration were carried out using ethanol solvent in a ratio of 1:5 (w/v) for 48 hours. This process was resulting green color for leaves extract and a brownish-yellow for fruit extract. The crude extract was then tested for the content of active compounds and antioxidants.

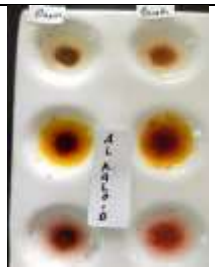
Active Compounds of A. corniculatum Extracts

The active compounds of the leaf and fruit extract of *A. cornicaltum* were tested using the phytochemicals method. It aims to preliminary investigate the extract's bioactive compound, including flavonoids, tannins, saponins, phenol hydroquinone, alkaloids, and steroids. The test results for active compounds can be seen in Table 1.

The phytochemical test showed that the leaf extract and fruit contain flavonoids, tannins, phenol hydroquinone, saponins, and alkaloids. Active compounds that generally play a role in antioxidants are tannins, flavonoids, and saponins (Harbone 1987). Margaretta *et al.* (2011) reported that antioxidants naturally derived from plants, such as phenolic compounds having a hydroxyl group at the structure of the molecule, which has free radical scavenging activity. If the hydroxyl group is more than one, the antioxidant activity is robust. Supriatna *et al* . (2019) get total phenol content and potential flavonoids antioxidant on skin stem mangroves. Phenolic compounds are soluble compounds in polar and slightly polar compounds.

Phenols include compounds of plant origin and have the same characteristics, namely an aromatic ring containing one or two hydroxyl groups: Monocyclic phenol, phenol propanoic, and phenolic quinones. Quinones are colored compounds and have a basic chromophore, namely the chromophores of benzoquinones (Harborne 1987).

Table 1. The active compound of leaf and fruit extract of *A. corniculatum*

Compound active	Extract		Result	Picture
	Leaf	Fruit		
Alkaloids				
- Wagner	+	+	brown precipitate	
- Meyer	+	+	red-orange precipitate	
- Dragendrof	+	+	White-yellowish precipitate	
Steroids	-	-	Blue and green	
Flavonoids	+	+	Red, yellow, or orange on coating amyl alcohol	
Tannin	+	+	Dark-gree precipitate or dark blue	
Phenol hydroquinone	+	+	Green-blue	
Saponins	+	+	Stable foam after 30 seconds	

Information : (+) detected (-) not detected

Leaf and fruit extracts were identified as positive for flavonoids. Flavonoids are the largest group of phenols. Malik *et al* . (2017) get potential flavonoid compounds antioxidant on mangroves. Compounds classified as tannins are polyphenolic compounds that contain hydroxyl groups and other groups to form hydroxyl groups complex strongly with proteins. Tannins are identified positive on the leaf and the fruit extract of A. corniculatum. Tannins spread wide throughout part of the plant and are potentially found in mangroves (Das *et al*, 2020). Leaf and fruit extracts contain saponins, the main triterpenoids group. Saponins are triterpenoid glycosides which It is also commonly found in plants. Amrati *et al* . (2020) get activity antiproliferative with antioxidants on compound saponins.

Activity Antioxidant Extract *A. corniculatum*

The antioxidant activity test was carried out using the *1,1-diphenyl* -2 *picrylhydrazil* (DPPH) method. DPPH is a free radical compound that is the most stable compared to other types of free radicals. If stored in dry storage, this compound will be permanently stable over the years. Ascorbic acid antioxidant was used as a comparison and positive control—the IC_{50} value was commonly used to interpret the results. The smaller the IC_{50} value, the higher the antioxidant activity (Molyneux 2004). The antioxidant activity of ascorbic acid, leaf, and fruit extracts of *A. corniculatum* can be seen in Table 2.

Table 2. The IC_{50} value of leaf and fruit extracts of *A. corniculatum* and ascorbic acid standards using the DPPH method.

Sample	Percent inhibition (%)				IC_{50}
	250 ppm	500 ppm	750 ppm	1000 ppm	
Ascorbic acid (0.1 M)	-	-	-	-	78.9
Leaf extract	44.4	60.0	66.7	96.7	365.8
Fruit extract	56.7	68.9	73.3	94.4	129.7

Molyneux (2004) states the IC_{50} value is the concentration of the sample solution needed to reduce DPPH by 50%. Blois (1958) stated that a compound is said to be a very strong antioxidant if the IC_{50} value is less than from 50 ppm, strong if the IC_{50} value is between 50-100 ppm, moderate if the IC_{50} value is around 100-150 ppm, and weak if the IC 50 value is between 150-200 ppm. Table 2 shows that the fruit extract has moderate antioxidant activity with an IC_{50} value of 129.7 ppm, while the leaf extract has a weak antioxidant activity with an IC50 value of 365.8 ppm.

The fruit extract of *A. corniculatum* has high antioxidant activity. According to the research conducted by Imra *et al*. (2016), it obtained an antioxidant activity in Nypa leaf extract using methanol as a solvent with an IC_{50} value of 22.5 ppm. Ascorbic acid is vitamin C which can inhibit free radicals and have

robust antioxidant activity. Molyneux (2004) stated that ascorbic acid could reduce free radicals from DPPH compounds. Some mangrove vegetation is also known to have antioxidant activity. Percent inhibition on Free radical reduction is the ability of a material to inhibit free radicals associated with the concentration of the material being tested. The highest percentage of inhibition was produced by a solution with a high concentration of crude extract (1000 ppm). The lowest percentage of inhibition was produced with the smallest crude extract concentration (250 ppm). The result indicates that the higher the concentration of fruit and leaf extracts, the higher the percentage of inhibition.

CONCLUSION

This study showed the percentage of moisture or water content in the fruit and leaf extracts of A. corniculatum were 1.83% and 1.95%, respectively. The bioactive compounds detected in the leaf and fruit extracts came from flavonoids, alkaloids, tannins, phenol hydroquinone, and saponins. The antioxidant analysis showed that the fruit and leaf crude extracts had an antioxidant activity with IC_{50} values were 129.7 ppm and 365.8 ppm, respectively. Overall, this study strengthens the idea that leaf and fruit extracts of *A corniculatum* from the mangrove area of Tarakan City have bioactive compounds and antioxidant activity. This research was expected to be used as basic research for future research on A. *corniculatum*.

ACKNOWLEDGMENT

The author would like to thank the grant funds from DIPA of the University of Borneo Tarakan fiscal year 2021, which has supported this research.

REFERENCES

Amrati, F. E. Z., Mohammed, B., Meryem, S., Samir, I., Ahmed, B., Riaz, U., Amal, A., Francesca, D. C., Mohammed, E. M., Anna, C., Laila, B., & Dalila, B. (2020). Phytocemical study on antioxidant and antiproliverative activities of Moroccan *Caralluma europaea* extract and its bioactive compound classes. *Hindawi Journal*, 1 – 9.

Awaludin, A., Maulianawati, D., & Adriansyah, M. (2019). Potensi Ekstrak Etanol Seledri (*Apium graveolens*) untuk Maskulinisasi Ikan Cupang (*Betta* sp). *Jurnal Sumberdaya Akuatik Indopasifik*, *3*(2), 101-114.

Awaludin, A., Kartina, K., Maulianawati, D., Manalu, W., Andriyanto, A., Septiana, R., & Lalang, Y. (2020). Phytochemical screening and toxicity of ethanol extract of *Sauropus androgynus*. *Biodiversitas Journal of Biological Diversity*, *21*(7).

Association of Official Analytical Chemist [AOAC]. 2005. *Official Method of The Association Official Agriculture Chemist*. Washington DC: AOAC.

Bandarnayake, W. M. (2002). Bioactivities, Bioactive compounds and chemical constituents of mangrove plants*. Wetlands Ecol Manage*, 10, 421- 452.

Blois. (1958). Antioxidant determinations by the use of a stable free radical. *Nature Journal.* 181: 1199-1200.

DAS, A. K., Nazrul, I., Omar, F., Ashaduzzaman, Rudi, D. (2020). Review on tannins, Extraction processes, aplications and possibilities. *South African Journal of Botany*, 135: 58 – 70.

Haq, I., Hosain A. B. M. S., Khandaker, M. M., Merican, A. F., Faruq, G., Boyce, N., & Azirun, M. S. (2014). Antioxidant and antibacterial activities of different extracts and fractions of mangrove plant *Sonneratia alba*. *Journal International of Agriculture and Biology, 16*(4), 707-714.

Harborne, J. B. (1987). *Metode Fitokimia*. Edisi kedua. Padmawinata, K., & Soediro I, penerjemah. Bandung (ID): ITB. Terjemahan dari : *Phytochemical Methods*.

Imra, Kustiariyah, T., & Desniar. (2016). Aktivitas antioksidan dan antibakteri ekstrak nipah (*Nypa fruticans*) terhadap *Vibrio* sp. Isolat kepiting bakau (*Scylla* sp.). *Jurnal Pengolahan Hasil Perikanan Indonesia, 19*(3), 241 – 250

Indriyanto. (2006). *Ekologi Hutan*. Bumi Aksara Jakarta.

Malik, N. H., Zamzahaila, M. Z., Shamsul, B. A. R., Kasawani, I., & Mohamad, K. Z. (2017). Antioxidative activities and flavonoids contents in leaves of selected mangrove species in Setiu Wetlands extracted using different solvents. *Journal of Sustainability Science and Management*, *3*, 14 -22.

Maulianawati, D., Awaludin, A., Rukisah, R., & Iswan, M. (2018). Uji toksisitas dan Analisis Kandungan Fitokimia Ekstrak Methanol dan Kloroform Daun Paku Uban (*Nephlorepis bisserata*). *Jurnal Harpodon Borneo*, *11*(2).

Maulianawati, D., Rukisah, R., Awaludin, A., & Guntur, M. I. (2020). Utilization of Paku Uban (*Nephrolepis biserrata*) Extract as a Molting Stimulant of Mud Crabs (*Scylla* spp.) in Traditional Ponds. *Jurnal Ilmiah Perikanan dan Kelautan*, *12*(1), 113-121.

Margaretta, S., & Handayan, S. D. (2011). Ekstraksi senyawa phenolik *Pandanus amaryllifolius* ROXB sebagai antioksidan alami. *Journal Widya Teknik, 10*, 21-30.

Mile, L., Happy, N., Dwi, S., & Titik, D. S. (2021). Studi fitokimia buah mangrove (*Rhizophora mucronata*) di Desa Langge Kabupaten Gorontalo Utara. *Jambura Fish Processing Journal*, *3*(1), 1 – 8

Molyneux, P. (2004). The use of stable free radical diphenylpicrylhydrazil (DPPH) for estimating antioxidant activity. *Songklanakarin Journal Science Technol*ogy, *26*(2), 211-219.

Nurjanah, N., Jacoeb A. M., Hidayat, T., & Shylina, A. (2015). Bioactive compuonds and antioxidant activities of Lindur Stem Bark (*Bruguiera gymnorrhiza). Journal International of Plant Science and Ecology,* 1(5), 182-189.

Rachmawani, D., Yulianda, F., & Yulianto, G. (2010). Kajian pengelolaan ekosistem mangrove secara berkelanjutan Kota Tarakan Kalimantan Timur (Studi Kasus Desa Binalatung Kecamatan Tarakan Timur). *Publikasi Jurnal Aquarine*, *1*(2), 2085-9449

Rukisah, R., Maulianawati, D., & Cahyadi, J. (2019). In vitro antibacterial efficacy of leaves extract of *Centela asiatica* against *Vibrio harveyi* and *Aeromonas hydrophila*. *Indonesian Aquaculture Journal*, *14*(2), 69-74.

Sawitri, R.,, Bismark, M, & Karlina, E. (2013). Ekosistem Mangrove sebagai objek isata Aalam di Kawasan Konservasi Mangrove dan Bekantan di Kota Tarakan. *Jurnal Penelitian Hutan dan Konservasi Alam, 10*(3), 297-314.

Spalding, M., Kainuma, M., & Collins, l. (2010). World atlas of Mangroves in Indonesia. Bogor: PKA/WI_IPB.

Sudirman, S., Nurjanah, & Jacoeb, A. M. (2014). Proximate compositions, bioactive compounds and antioxidant activity from large-leafed mangrove (*Bruguiera gymnorrhiza*) fruit. *Journal International Food Research,* 21(6), 2387-2391.

Supriatna, D., Yeni, M., Iis, R. & Mochamad, U. K. A. (2019). Aktivitas antioksidan, kadar total flavonoid dan fenol ekstrak metanol kulit batang mangrove berdasarkan stadia pertumbuhannya. *Jurnal Perikanan dan Kelautan*, *10*(2), 35 – 42.

Tangkery, R. A. B., Darus, S. P., & Antonius, R. (2013). Uji aktivitas antikoagulan ekstrak mangrove *Aegiceras corniculatum*. *Jurnal Pesisir dan laut Tropis,* 1(1).

Trianto, A., Edi, W., Suryono., & Rahayu, S. S. (2004). Ekstrak Daun Mangrove *Aegiceras corniculatum* sebagai antibakteri *Vibrio harveyi* dan *Vibrio parahaemolyticus*. *Jurnal Ilmu Kelautan,* 9(4), 186–189.

Weliyadi, E., Awaludin, A., Imra, I., & Maulianawati, D. (2018). Aktivitas antibakteri ekstrak daging kerang bakau (*Geloina coaxans*) dari kawasan mangrove Tarakan terhadap *Vibrio parahaemolyticus*. *Jurnal Pengolahan Hasil Perikanan Indonesia*, *21*(1), 35-41.