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EFFECT OF WASHING AND STORAGE METHODS ON THE QUALITY OF SEAWEED *POWDER Ulva Sp.* IN CV. LARS

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Abstract

Ulva sp. is a type of seaweed that has high potential as a sea vegetable with sufficient protein and economic value. This study aims to determine the effect of washing and storage methods on the quality of *Ulva sp.* powder in CV. Lars. The research was conducted using two washing methods (seawater and fresh water), two types of packaging (black plastic and aluminum foil), and storage time of 0, 15, and 30 days at room temperature. The parameters analyzed included moisture content, impurity content, color (CIELab model), and organoleptic test. The results show that washing with fresh water packaged in aluminum foil gives the best results in keeping moisture content low, maintaining its natural green color, and providing an acceptable taste and aroma. The average impurity level is below 1%, indicating that both washing methods are equally effective. The discoloration towards yellow occurs more often in washing using seawater. In conclusion, the combination of washing with fresh water and storage using aluminum foil packaging is the best treatment in maintaining the quality of *Ulva sp.* powder. during storage.

Keywords: methods; powder quality; storage; *Ulva Sp.;* washing

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INTRODUCTION

Seaweed is a sustainable alternative as a food ingredient and a source of other valuable substances. Sustainable food production will come from lower trophic levels, mainly through the marine cultivation of extractive species, such as seaweed (Krause *et al.*, 2022). This development can happen by building innovative and cost-effective production technologies, ensuring food security, and reducing the nutrition and carbon footprint of global food production through carbon sequestration, (Buck & Shpigel, 2023).

Ulva spp. is a genus of green macroalgae with a large surface diameter (*Chlorophyta*). This type of algae belongs to the genus that grows quickly and has a short life cycle. *Ulva* spp. is commonly found in polluted areas that are impacted by high human activities and can survive a wide variety of salinity, temperature, light intensity, high concentrations of pollutants, and other abiotic factors. *Ulva* spp. belongs to the genus with the most productive photosynthetics. One of the benefits of the high photosynthesis capacity of *Ulva* spp. as a nutrient absorption medium, (Amaral *et al.*, 2018).

This seaweed is glanced at mainly because it has a rich nutritional profile. *Ulva fenestrata* cultivated in offshore marine ponds has recently been reported to achieve a protein content of between 16.6 and 20.75% dry weight (dw), while the total fatty acid content varies between 3.2 and 3.5% dw, and polysaccharide levels between 25 and 29% dw (Mar Vall-llosera *et al* 2024). However, the quality of *Ulva sp.* powder is greatly

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influenced by the processing process, particularly its washing, drying and storage methods. The proper washing method is very important because it can affect the chemical and organoleptic composition *of Ulva* sp. powder, such as color, taste, aroma, and texture. Furthermore, the aroma and color *of Ulva sp.* (Uribe *et al.*, 2018)

The storage process must consider factors such as temperature, humidity, and light exposure to maintain nutrient stability and prevent microbiological damage or oxidation, (StÈvant, *et al.*, 2017). Storage conditions of dried *Ulva* sp. powder are carried out at room temperature (RT) 25°C – 30°C to mimic the storage conditions used by suppliers in supermarkets or by consumers after purchase. The effect of light on the quality of seaweed during *storage*, will increase lipid oxidation and degradation of ascorbic acid, (Hanna Harryson, 2019)

Seaweed *Ulva* sp. or also known as "sea lettuce" is a type of green seaweed that grows abundantly in the tropical waters of Indonesia. Its rich nutritional content of dietary fiber, minerals, and antioxidants makes it a potential food ingredient that supports healthy and environmentally friendly consumption trends. However, in its fresh form, *Ulva* sp. It is easy to experience deterioration if it is not handled properly after harvest. One of the solutions that is now being developed is to process it into a dry powder that is practical and durable. This research was conducted at CV. Lars where *Ulva* spp. powder has been developed, but research is needed to improve the quality of existing *Ulva* spp. powder and as part of efforts to develop quality various *sea vegetable* products with an efficient and cost-effective scientific approach.

METHOD

This research was carried out from February to June 2025. Samples of *Ulva lactuca seaweed* were obtained from the waters of Takalar Regency, South Sulawesi. Moisture content testing was carried out at the Fisheries Product Biochemistry Laboratory of the Pangkajene and Islands State Agricultural Polytechnic using the oven method, while the impurity level testing was carried out manually through visual separation, and color analysis was carried out using the CIELab system (L*, a*, b*) based on the Aspose online application, which is widely used for the evaluation of dry food colors (AOAC, 2016; Pathare et al., 2013). This study used a complete random design (RAL) with two main factors, namely the washing method and the type of storage packaging. The leaching factor consists of two treatments, namely leaching using seawater (S1) and fresh water (S2), which are known to affect the stability of bioactive compounds and the physical characteristics of seaweed, (McHugh, 2003; Yaich et al., 2011). After washing, the sample is dried using a *dehydrator* machine for 5 hours at a temperature of 65°C, then powdered using *a disk mill machine*, filtered until a homogeneous powder is obtained, and stored in two types of packaging, namely black plastic coated with clear plastic and aluminum foil, which is commonly used to suppress quality degradation during storage, (Ratti, 2001; Robertson, 2013). Storage is carried out at room temperature (25–30 °C) for 0, 15, and 30 days. The observed parameters included moisture content, impurity content, and color characteristics. The observation data is analyzed descriptively and presented in the form of tables and graphs for easy interpretation, with each test being carried out three times to improve the reliability and consistency of the data, (Gomez & Gomez, 2007).

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RESULT AND DISCUSSION

Ulva lactuca Water Content Test

Ulva sp. washing treatment using fresh water produced a higher moisture content, with an average of 13.22%, compared to washing using seawater which had an average of 9.67%. At the beginning of storage (H.0), the moisture content of *Ulva* sp. powder from washing with fresh water (S2) was higher than that of seawater (S1). This is likely due to the osmosis process during washing as fresh water enters the seaweed tissue, thereby increasing the initial moisture content. *Ulva lactuca* washed with fresh water has increased moisture content due to the entry of water into the cells, but it also loses moisture more easily when stored in dry conditions, (Poeloengasih *et al.*, 2019).

This is reinforced by the tests carried out by Satmalee, *et al.*, (2023) that after 4 months of storage *of dry Ulva rigida*, its hardness increases significantly, the initial moisture content is high, but it experiences a steady decrease in moisture content during storage due to moisture release. This decrease is influenced by the characteristics of seaweed raw materials, drying methods, and types of packaging.

On the 30th day, the moisture content of S2 decreased significantly from 14.15% to 11.77%. This indicates the gradual release of moisture during storage. On the other hand, the moisture content in S1 increased from 9.38% to 10.21%. This increase is likely due to the hygroscopic nature of the powder particles of Ulva sp. and moisture absorption from the surrounding air. Ulva sp. powder that are dried and packaged in non-airtight packaging tend to fluctuate in moisture content, depending on the relative humidity of the environment, (Pinheiro *et al.*, 2019). This is in line with the increase in the moisture content in the seawater sample (S1) on day 30.

Freshwater washing significantly lowers the mineral content and makes the thallus more fragile, while seawater washing retains its original structure and color. (Poeloengasih et al., 2019). Additionally, vapor-resistant packaging such as aluminum foil helps keep moisture content at a stable level during long storage periods, (Pinheiro *et al.*, 2019). Higher moisture content in Ulva sp. Freshwater washes is likely caused by the difference in osmotic pressure between the freshwater and the seaweed tissue. When immersed in fresh water, water enters the cell through the process of osmosis, causing the tissue to absorb more water. In contrast, washing with seawater (hypotonic against *Ulva sp.)* tissue does not trigger significant water absorption, and may even lead to slight cellular dehydration. (Wirenfeldt, 2023)

Impurity Rate Test

The dirtiness test of *Ulva* sp. powder was carried out only on day 0 (H.0) after going through the washing process with seawater (S1) and with freshwater/tap water (S2), then conventional drying was carried out using a dehydrate machine with a temperature of 65'C for 5 hours to maintain the green color of *the Ulva* sp. seaweed. (Satmalee, *et al.*, 2023), and to maintain 70% of the karatenoid content is better than drying in the sun which only retains 50% (Uribe, *et al*., 2019). By using the Formula for Calculating the Impurity Rate (%):

$$\%\ Level\ of\ impurity = \frac{Weight\ of\ feces\ (g)}{Initial\ weight\ of\ sample\ (g)}\ X\ 100\%$$

The results of the analysis showed that the impurity level *of Ulva lactuca* powder from 2 different washing methods showed results that were not much different with 3 repetitions for each S1 and S2 samples, namely the result of washing using seawater (S1) was 1.4% and washing using freshwater/tap water (S2) was 1.8%. This provides two important illustrations, that washing using seawater and freshwater/tap can reduce the level of impurity effectively, because the average impurity is far below the maximum limit of 3% according to the provisions of SNI 2690:2015 which is a reference for the quality of dried seaweed products.

And although there are very small differences, the distribution of the data shows that the success of the washing is largely determined by other technical factors such as the time or duration of the wash, the intensity of stirring and also the condition of the initial raw material (the presence or absence of sand or debris attached) because the effectiveness of seaweed cleaning depends on the technique and length of the washing time, not only on the water medium, (Poeloengasih, *et al*., 2019)

The washing method affects the degree of impurity and the initial color characteristics of the powder. Washing using fresh water gives a brighter green color and a more neutral taste compared to seawater. Both washing methods are equally effective in lowering impurity levels to below safe limits (<3%).

***Ulva sp.* Color**

Color is one of the important parameters in assessing the visual quality and attractiveness of seaweed-based processed food products. Therefore the loss of the initial color leads to a decrease in quality. The characteristics of green and luminous color in *Ulva* sp. evolved during storage, (Sánchez-García, *et al*., 2021. The effect of oven drying on the surface color of *the Ulva lactuca* evaluated, compared to fresh samples, using color coordinates defined by the *Commission Internationale de l'Eclairage* naming the coordinates as L*, a*, b*, a color scale based on the Opposing Color Theory that assumes that receptors in the human eye perceive colors as opposite color pairs, such as: 1) L scale: Light *vs*. dark, where a low number (0-50) indicates dark, and a high number (51-100) indicates light; 2) Scale a: Red *vs*. green, where a positive number indicates red, and a negative number indicates green; 3) Scale b: Yellow *vs*. blue, where a positive number indicates yellow, and a negative number indicates blue, (Blog.Hunter.com).

A perfect color scale will be uniform across the color space, which means that a one-unit difference between two colors will appear visually different by the same amount, whether red, purple, orange, or blue. In this study, colors were analyzed using RGB (*Red, Green, Blue*), CMYK (*Cyan, Magenta, Yellow, Key/Black*), and L*a*b* color models, and were visually classified into two dominant categories: *Dark Slate Gray* (dark gray) and

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Dark Green (dark green) on days 0 and 30. Analysis Based on the CIELab Model (L*, a*, b*), namely:

The average L* value (Brightness) of the L* value increases from H.0 to H.30 → the color becomes brighter and slightly faded, which means that during the storage period of *the Ulva* sp. seaweed there is a slight discoloration due to mild oxidation. Changes in the L* value (brightness) of *Ulva sp*. between day 0 and day 30 for each washing and packaging treatment. The L* value in S1 (seawater) has increased, for example S1-Foil from 21.33 to 34.33, indicating that the color of *Ulva lactuca* powder has become brighter or faded. On the other hand, in S2-Plastic, there was a drastic increase from 12.67 to 27.67, which indicated a partial fading of the green pigment. However, S2-Foil only underwent a slight increase in L*, from 15.00 to 18.00, which suggests that the combination of freshwater washing and aluminum foil packaging more effectively maintains the original dark green color. A high L* value leads to a lighter or yellowish color, while a lower L* value indicates a more intense or darker color. An increase in the L* value over time is an indication of the oxidation of chlorophyll pigment into pheopitin, especially in the S1 treatment. Thus, this graph confirms that fresh water and tightly sealed packaging such as aluminum foil help maintain the intensity of natural colors, as well as suppress the degradation of visual pigments during storage.

The value of a* (Green – Red) remained negative, but on the 30th day the value of a* was more negative, especially for *Ulva* sp. which was washed using fresh water (S2). This indicates that the green pigment (chlorophyll) in S2 is relatively stable or even increased. Change in the value of a* (green to red color components) during storage. All samples showed a negative a* value, which indicates the predominance of the green color. A more negative a* value indicates a higher intensity of the green color. On day 0, the a* value is in the range of –6.67 to –8.00. However, on day 30, there was a significant decrease to -20.00 in some treatments. This suggests that the green color becomes more intense over time, especially in freshwater washing treatments and using aluminum foil packaging. This change indicates that storage in appropriate packaging is able to maintain the stability of chlorophyll pigments, (Satmalee, 2023) and even strengthens the natural color intensity of *Ulva* sp powder products.

The value of b* (Blue – Yellow), the value of b* is still positive, indicating that the yellow – greenish spectrum remains dominant. However, the value of b* at H.30 was slightly increased in the process of washing Ulva lactuca using seawater (S1) which tended towards pale yellow green. Change in value b* (blue to yellow component). A positive value of b* indicates the dominance of greenish-yellow color. During storage, there was an increase in the value of b* in all treatments, especially in S1 (seawater), from 15 to 22. This indicates a tendency for the color to become more yellowish, which may be caused by the oxidation of chlorophyll into pheopitin. (Pinheiro, *et al*., 2019) In contrast, in S2 with Aluminum Foil, the value of b* increased only slightly, indicating that the aluminum foil packaging was better able to maintain the stability of the green color and prevent significant pigment degradation.

Storage for 30 days at room temperature causes physical changes in *Ulva sp. powder.*, especially on moisture content and color. The S2 (freshwater) treatment, especially those packaged in aluminum foil, shows the best stability in maintaining low moisture content and a sharper green color. The significantly decreased moisture content indicates the effectiveness of the packaging in maintaining moisture stability. Supports instrumental results, where powders washed with fresh water and stored in aluminum foil retain better color, flavor and aroma than other treatments. Overall, washing using fresh water combined with storage in aluminum foil packaging is the best treatment to maintain the quality of *Ulva* sp. *powder.* during storage at room temperature.

CONCLUSION

Based on the results of the study on the effect of washing and storage methods on the quality of *Ulva* sp. powder in CV. Lars, it can be concluded that washing using fresh water is more effective in maintaining the natural green color *of Ulva* sp. than washing using seawater, which is indicated by a brighter powder color, more neutral taste, and does not cause a significant difference in the level of impurity. The impurity level in all treatments is still within safe limits according to SNI standards (<3%), with an average value of 0.67%, which indicates that both washing methods can effectively reduce raw material impurities. Storage for 30 days at room temperature (25–30 °C) influences increased moisture content and powder discoloration, where the combination of freshwater washing treatment with aluminum foil packaging provides the best results in maintaining moisture stability and maintaining a natural green color. Color analysis using the CIELab model showed an increase in L* value (lighter color) throughout treatments, a more pronounced decrease in a* values in freshwater washing (increased green intensity), and a more significant increase in b* values in seawater washing, indicating a color shift towards yellow due to chlorophyll. The results of organoleptic testing also reinforced the findings, where washing using fresh water resulted in a more neutral taste, a less pungent marine aroma, and a more preferable color appearance. Overall, the washing treatment using fresh water combined with storage in aluminum foil packaging at room temperature is the best treatment because it is able to provide optimal physical and organoleptic quality stability of *Ulva* sp. powder.

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