WWW.IJRPR.COM

**International Journal of Research Publication and Reviews**

Journal homepage: www.ijrpr.com ISSN 2582-7421

# The Addition of Seaweed (Ulva Lactuca) on Physicochemical Characteristics of Flakes

***Husna Haya Abidah*** [a], ***Sumardianto*** [a], ***Lukita Purnamayati*** [a], ***Muhammad Hauzan Arifin*** [a]*, ***Siti Oftafia Wijayanti*** [b]

[a] *Department of Fisheries Product Technology, Faculty of Fisheries and Marine Sciences, Universitas Diponegoro, Semarang, Indonesia*

[b] *Department of Capture Fisheries, Faculty of Fisheries and Marine Sciences, Universitas Diponegoro, Semarang, Indonesia*

DOI : https://doi.org/10.55248/gengpi.6.0425.1305

**A B S T R A C T**

Flakes are fast food cereal foods in the form of thin sheets and brownish yellow in color which are usually consumed with the addition of milk. The purpose of this study was to determine the effect of adding Ulva lactuca seaweed on the physicochemical characteristics and quality of flakes and to determine the concentration of seaweed (Ulva lactuca) addition that is appropriate and most preferred by panelists in flakes. The study was conducted in a laboratory with a completely randomized design (CRD). The research treatment was the addition of seaweed (Ulva lactuca) of 0%, 10%, 20%, and 30%. Hedonic, proximate, dietary fiber, and color were processed using SPSS. The concentration of seaweed (Ulva lactuca) addition that is appropriate and most preferred by panelists in flakes is with an addition of 30%. The addition of Ulva lactuca seaweed has a significant effect on the physicochemical characteristics such as proximate value, color, and hedonic. The treatment of adding 30% seaweed (Ulva lactuca) is most preferred by panelists because it has a fragrant and specific aroma of roasted Ulva lactuca seaweed, the taste of seaweed flakes (Ulva lactuca) is sweet with a little savory, the texture of seaweed flakes (Ulva lactuca) is crispy, and the appearance of seaweed flakes (Ulva lactuca) has an attractive green color. The results of the physicochemical characteristics test with the addition of seaweed (Ulva lactuca) include water content of 5.80%, ash content of 1.26%, fat content of 6.16%, protein content of 4.44%, carbohydrates of 65.57%, insoluble dietary fiber of 6.01%, soluble dietary fiber of 0.55%, total dietary fiber of 6.57%, and color analysis of 44.97 (L); 1.53 (a*); 5.22 (b*). and the average hedonic value of 7.2 >µ>7.87.

Keywords: Dietary fiber, Flakes, Hedonic, Physicochemical properties, Proximate, Ulva lactuca

## 1. Introduction

As the world's largest archipelagic nation, Indonesia possesses immense marine biodiversity, with seaweed representing a largely untapped resource for food security and economic development. Among various seaweed species, Ulva lactuca (commonly known as sea lettuce) stands out due to its widespread distribution in Indonesian waters, particularly in nutrient-rich regions like Gunungkidul, Yogyakarta. This green macroalgae has attracted scientific interest due to its exceptional nutritional profile, containing substantial amounts of dietary fiber (2-5%), high-quality protein (15-26%), complex carbohydrates (46-51%), and essential micronutrients including vitamins B1, B2, B12, and C (Sanjaya et al., 2023). Notably, its bioactive compounds such as chlorophyll (13.15%), tocopherols, and phenolic substances demonstrate potent antioxidant capacity, as evidenced by its DPPH radical scavenging activity (Costa et al., 2018). Despite these advantages, current utilization of Ulva lactuca in Indonesia remains limited to traditional uses, failing to capitalize on its full potential as a functional food ingredient.

The development of Ulva lactuca-fortified corn flakes presents an innovative approach to enhance the nutritional value of conventional breakfast cereals while addressing modern consumers' demand for convenient yet healthy food options. Current commercial flakes predominantly made from corn or wheat flour are nutritionally imbalanced, being high in simple carbohydrates but deficient in dietary fiber, plant-based proteins, and bioactive compounds. Incorporating Ulva lactuca could significantly improve the nutritional profile of these products while simultaneously introducing natural pigmentation through chlorophyll, eliminating the need for synthetic food colorants. This aligns with the growing global trend toward clean-label products and natural food additives (Nisa et al., 2023). However, the inclusion of seaweed biomass may influence critical product attributes including texture stability, flavor profile, and color retention during processing and storage, requiring careful formulation optimization. These technical challenges highlight the need for systematic research to determine the optimal incorporation levels that balance nutritional enhancement with consumer acceptability.

This study addresses a significant research gap by being the first comprehensive investigation into the development and characterization of Ulva lactuca-enriched corn flakes. The research has dual objectives: first, to rigorously evaluate the physicochemical properties (including proximate composition, water activity, texture profile, and color stability) of the fortified flakes; and second, to assess consumer acceptance through standardized sensory evaluation protocols. The findings will provide crucial data for food technologists and industry stakeholders seeking to develop innovative seaweed-based products. From a broader perspective, successful implementation of this research could stimulate the blue economy by creating value-added products from underutilized marine resources, while simultaneously addressing nutritional deficiencies in conventional processed foods. Furthermore, it supports sustainable food systems by promoting the use of local, renewable marine ingredients, contributing to both environmental conservation and rural economic development in coastal communities where seaweed cultivation is prevalent.

## 2. Methodology

### *2.1 Materials*

The production of Ulva lactuca-enriched flakes involves specific equipment and ingredients to ensure optimal processing. Key tools include a baking pan (for drying raw materials in the oven), an oven (Kirin brand, for baking the flakes), parchment paper (600 cm², as a base for the dough), a bowl (20 cm, for holding raw materials), a blender (1.50, to homogenize Ulva lactuca seaweed), a hand roller (for flattening the dough), and a precision scale (1 g, for weighing samples and ingredients). The primary ingredients consist of Ulva lactuca seaweed (main component), corn flour, sago flour, powdered sugar (additive), vanilla (flavor enhancer), honey (additive), salt (flavor balancer), water, margarine, and coconut oil (essential base ingredients). This method integrates seaweed into a functional food product while maintaining structural and sensory quality.

### *2.2 Flakes Productions*

The production of flakes incorporating Ulva lactuca seaweed was adapted from the method described by Hulu et al. (2022), with modifications to include Ulva lactuca. The process was conducted as follows: First, Ulva lactuca seaweed was blended with water to form a homogenized seaweed slurry. The dough was then prepared by mixing corn flour, sago flour, powdered sugar, vanilla, honey, salt, margarine, and water in predetermined proportions. The mixture was homogenized until a uniform consistency was achieved. Subsequently, the dough was flattened and molded into the desired shape. Finally, the shaped dough was baked in an oven at 140°C for 60 minutes.

### *2.3 Fiber Content*

The dietary fiber content was determined following the AOAC (1995) method with modifications. Briefly, 0.5 g of sample was placed in an Erlenmeyer flask, mixed with 50 mL phosphate buffer and 0.1 mL α-amylase, then heated at 100°C for 30 min with intermittent stirring. After cooling, 20 mL distilled water, 5 mL 1N HCl, and 1 mL 1% pepsin were added, and the mixture was reheated to 100°C for 30 min. Subsequently, 5 mL 1N NaOH and 0.1 mL β-amylase were added, and the flask was incubated at 100°C for 1 h. The digested sample was filtered through pre-weighed filter paper, and the residue was washed sequentially with ethanol and acetone (10 mL each, twice), then oven-dried at 105°C overnight to determine insoluble dietary fiber (IDF). The filtrate was adjusted to 100 mL, mixed with 400 mL 95% ethanol, and allowed to precipitate for 1 h before filtration. The precipitate underwent similar washing and drying steps to quantify soluble dietary fiber (SDF). Total dietary fiber (TDF) was calculated as the sum of IDF and SDF (TDF = IDF + SDF).

### *2.4 Proximate Analysis*

The proximate analysis was conducted according to AOAC (1995) to determine water, protein, ash, fat and carbohydrate content of flakes.

### *2.5 Hedonic Analysis*

The hedonic test was conducted to evaluate consumer acceptance of the product using a 9-point hedonic scale ranging from 1 ("dislike extremely") to 9 ("like extremely"). The sensory attributes assessed included aroma, taste, texture, and appearance. In this study, 30 untrained panelists participated in the evaluation. Each panelist rated their level of liking for each attribute by selecting the appropriate numerical score on the evaluation sheet. The collected data were then analyzed to draw conclusions regarding product acceptability. This method follows standard hedonic testing procedures where numerical responses are used to quantify subjective preferences for sensory characteristics.

### *2.6 Color Analysis*

The color analysis was performed following the method described by Gaurav (2003) using a HunterLab ColorFlex EZ spectrophotometer. Measurements were conducted in the Hunter color system, which evaluates three parameters: L* (lightness/white), a* (red-green spectrum), and b* (yellow-blue spectrum). Prior to analysis, the chromameter was calibrated using the built-in white standard reference tile. Color measurements were expressed in terms of L*, a*, and b* values, with the total color degree being calculated using white as the reference standard.

### *2.7 Data Analysis*

This study employed a laboratory experimental design to investigate the effect of Ulva lactuca seaweed paste addition (0%, 10%, 20%, and 30%) on flake properties using a completely randomized design (CRD) with three replications. The evaluated parameters included hedonic acceptance, crispiness in milk, color characteristics (L*, a*, b*), dietary fiber content, proximate composition (protein, moisture, ash, carbohydrate, and fat content). All analytical measurements followed standard methods with appropriate calibration procedures prior to analysis. For parametric data, one-way ANOVA was performed when the normality test showed $P>0.05$ to examine treatment effects. When ANOVA revealed significant differences ($P<0.05$), post-hoc analysis using Honest Significant Difference (HSD) test was conducted to determine specific treatment differences. Non-parametric data were analyzed using the Kruskal-Wallis test (P>0.05 in normality test), followed by Mann-Whitney U test for pairwise comparisons when significant differences were detected (P<0.05). All statistical analyses were performed at α=0.05 significance level using SPSS 21.

## 3. Results And Discussions

### *3.1 Fiber Content*

Table 3.1. Dietary Fiber Content of Flakes with Different Ulva Concentration

| Ulva concentration | Insoluble dietary fiber (%) | Soluble dietary fiber (%) | Total dietary fiber (%) |
|---|---|---|---|
| 0% | 2.82±0.11$^{a}$ | 0.25±0.01$^{a}$ | 3.06±0.13$^{a}$ |
| 10% | 3.44±0.22$^{b}$ | 0.31±0.02$^{b}$ | 3.77±0.24$^{b}$ |
| 20% | 4.69±0.22$^{c}$ | 0.47±0.03$^{c}$ | 5.14±0.24$^{c}$ |
| 30% | 6.01±0.19$^{d}$ | 0.55±0.08$^{d}$ | 6.57±0.28$^{d}$ |

Information:

Data ± standard deviation

Data followed by different lowercase letters in the same column are significantly different (P<0.05)

The dietary fiber in Ulva lactuca-enriched flakes comprised insoluble (IDF), soluble (SDF), and total (TDF) fractions, showing concentration-dependent increases (2.82-6.01% IDF, 0.25-0.55% SDF, 3.06-6.57% TDF). Statistical analysis revealed significant treatment effects (ANOVA, p<0.001) for all fiber types, with HSD tests showing: (1) control (0%) differed significantly from 20% treatment in SDF, (2) 10% differed from 30% in SDF, and (3) all concentrations differed in TDF. Normality tests confirmed parametric distribution for IDF (p=0.822) and TDF (p=0.699), while SDF showed heterogeneity (p=0.027). Independent t-tests (Fadhoil et al., 2024) confirmed formulation differences (p<0.05), demonstrating that higher Ulva lactuca concentrations significantly increased all fiber fractions.

### *3.2 Proximate Analysis*

Table 3.2. Proximate Analysis of Flakes with Different Ulva Concentration

| Ulva concentration (%) | Water content (%) | Protein content (%) | Ash content (%) | Fat content (%) | Carbohydrate content (%) |
|---|---|---|---|---|---|
| 0% | 4.83±0.05$^{a}$ | 3.34±0.056$^{a}$ | 1.08±1.01$^{a}$ | 9.65±0.21$^{d}$ | 71.53±0.76$^{a}$ |
| 10% | 5.20±0.10$^{b}$ | 3.52±0.098$^{a}$ | 1.08±1.01$^{a}$ | 8.63±0.01$^{c}$ | 71.46±0.27$^{a}$ |
| 20% | 5.86±0.01$^{c}$ | 3.87±0.03$^{b}$ | 1.26±1.23$^{a}$ | 7.34±0.03$^{b}$ | 67.37±0.28$^{b}$ |
| 30% | 5.80±0.02$^{c}$ | 4.44±0.07$^{c}$ | 1.26±1.23$^{a}$ | 6.16±1.38$^{a}$ | 65.57±1.14$^{b}$ |

Information:

Data ± standard deviation

Data followed by different lowercase letters in the same column are significantly different (P<0.05)

The moisture content of flakes supplemented with *Ulva lactuca* ranged from 4.83% to 5.86%, complying with the Indonesian National Standard (SNI) 4270-2021 (maximum 8%) and the recommendation by Winarno (2008) that a moisture content below 14% is safe for storage. Statistical analysis (SPSS) confirmed data homogeneity (Sig. 0.172 > 0.05) and a significant effect of seaweed addition on moisture content (Sig. 0.000 < 0.05). This increase is attributed to the hydrophilic nature of *Ulva lactuca* and the inclusion of liquid ingredients such as milk and honey. The low moisture content in flakes, achieved through baking, is critical for product stability and microbial growth inhibition (Ekafitri & Isworo, 2014). Safitri et al. (2023) further noted that flake thickness influences moisture retention, with thicker flakes exhibiting higher water content. The ash content of the flakes increased from 1.08% (control) to 1.26% at 20–30% seaweed concentration, indicating elevated mineral levels, including calcium, phosphorus, and potassium derived from Ulva lactuca. Statistical tests confirmed normal distribution (Sig. 0.989 > 0.05), though ANOVA (Sig. 0.994 > 0.05) indicated no significant effect of seaweed addition on ash content. These values meet SNI 01-4270-1996 standards (maximum 4%). According to Winarno (2002), ash content reflects the inorganic residue from organic material combustion. Ginting & Husni (2020) emphasized that higher ash content correlates with the mineral composition of seaweed and its concentration in the formulation.

Fat content decreased from 9.65% (control) to 6.15% at 30% seaweed concentration, still adhering to SNI 01-4270-1996 (minimum 7%). Statistical analysis revealed a significant effect (Sig. 0.000 < 0.05). The low-fat content is attributed to the inherently low lipid levels in *Ulva lactuca* (0.36% in dried form, Zakaria et al., 2017) and thermal processing, which promotes fat extraction and volatilization. Costa et al. (2018) reported a total fat content of 5.17% in *Ulva lactuca*, but processing further reduced this value. Although fat contributes to texture and flavor, its reduction does not compromise product quality due to the high fiber and carbohydrate content of seaweed (Adi & Loaloka et al., 2024). Protein levels ranged from 3.34% to 4.44%, conforming to SNI 01-4270-1996 (maximum 5%). ANOVA (Sig. 0.000 < 0.05) confirmed a significant effect of seaweed incorporation. Proteins in Ulva lactuca contain C, H, O, and N, along with minerals such as S and P. Despite a slight decline in protein content with increasing moisture (Adi et al., 2024), nutritional adequacy was maintained. AOAC (2005) underscores the importance of protein analysis in evaluating food quality, and in this context, seaweed flakes meet the criteria for a viable protein source. Carbohydrates constituted the dominant component (65.57–71.53%), with a significant effect from seaweed addition (Sig. 0.000 < 0.05). Carbohydrates influence sensory attributes such as taste, color, and texture. Fitri et al. (2020) highlighted their role in preventing ketosis, supporting fat/protein metabolism, and minimizing mineral loss. The high carbohydrate content stems from the cornmeal base and seaweed-derived fiber, positioning these flakes as a stable energy source compliant with cereal quality standards.

### *3.3 Hedonic Analysis*

Table 3.3. Hedonic Analysis of Flakes with Different Ulva Concentration

| Parameter | Ulva concentrations | | | |
|---|---|---|---|---|
| | 0 (%) | 10 (%) | 20 (%) | 30% (%) |
| Appearance | $7.53 \pm 0.86^{a}$ | $7.16 \pm 1.05^{a}$ | $7.47 \pm 7.27^{a}$ | $7.20 \pm 1.06^{a}$ |
| Aroma | $7.46 \pm 1.16^{b}$ | $6.97 \pm 1.19^{b}$ | $7.27 \pm 0.83^{b}$ | $7.23 \pm 0.82^{b}$ |
| Taste | $7.03 \pm 0.85^{c}$ | $7.17 \pm 0.91^{c}$ | $7.73 \pm 0.98^{c}$ | $7.73 \pm 1.01^{c}$ |
| Texture | $6.96 \pm 1.15^{d}$ | $6.90 \pm 1.09^{d}$ | $7.70 \pm 0.99^{d}$ | $7.87 \pm 0.90^{d}$ |
| Hedonic interval | $7.03<\mu<7.47$ | $6.84<\mu< 7.26$ | $7.33<\mu< 7.75$ | $7.27< \mu< 7.75$ |

Information:

Data ± standard deviation

Data followed by different lowercase letters in the same column are significantly different ($P<0.05$)

The investigation was conducted through hedonic evaluation encompassing appearance, aroma, taste, and texture characteristics. Experimental treatments involved incorporating Ulva lactuca seaweed slurry into flakes at concentrations of 0%, 10%, 20%, and 30%. Subsequent hedonic testing aimed to determine the optimal seaweed concentration that maintained acceptable physical properties while maximizing panelist preference. As shown in Table 4.1, sensory acceptance testing utilizing a 9-point hedonic scale was performed with approximately 30 panelists. The resulting confidence intervals for each treatment were: 0% Ulva lactuca ($7.03<\mu<7.47$), 10% ($6.84<\mu<7.26$), 20% ($7.33<\mu<7.75$), and 30% ($7.27<\mu<7.75$). Non-parametric Kruskal-Wallis analysis revealed significant treatment effects (Asymp. Sig. <0.05) across all sensory parameters, prompting subsequent Mann-Whitney testing which confirmed statistically distinct differences between treatments. The calculated Chi-Square values for appearance (51.917), aroma (44.417), taste (64.333), and texture (25.750) substantially exceeded the critical value of 9.48 at $\alpha=0.05$ ($X^2$ critical), leading to rejection of the null hypothesis. These results conclusively demonstrate that Ulva lactuca incorporation significantly influences flake characteristics across all evaluated parameters. Appearance evaluation proved particularly significant as it forms the initial sensory impression. All concentrations (0-30%) received favorable ratings (scale: 1-9), with manually processed flakes exhibiting irregular rectangular dimensions (1.5 cm × 1.5 cm) due to the use of basic cutting implements. Mean appearance scores ranged 7.2-7.53, corresponding to "like" on the descriptive scale. The progressive darkening from yellowish-brown (0%) to dark green (30%) resulted from both chlorophyll content (Zakaria et al., 2017) and thermal-induced browning reactions. Panelists showed greatest preference for the 20% concentration. According to Nelwida et al. (2019) and Agustini et al. (2015), the observed color changes during heating can be attributed to non-enzymatic browning processes including Maillard reactions and caramelization, where prolonged high-temperature exposure promotes interactions between amino acids and reducing sugars.

Aroma characteristics significantly impacted product acceptance, with all treatments scoring 6.97-7.46 ("like"). The control (0%) exhibited pronounced vanilla fragrance, while 10-30% concentrations developed characteristic roasted seaweed notes. Vanilla powder (Vanilla planifolia) was selected for its durable fragrance and practical handling (Kusumastuti and Adriani, 2017), with Yamin et al. (2022) further noting its advantages in shelf stability and space efficiency. The distinctive seaweed aroma in treated samples originated from thermal processing of Ulva lactuca slurry components. Taste profiling revealed concentration-dependent transitions from sweet (0%) to sweet-umami (10-30%), with mean scores of 7.03-7.73. This shift reflects both the biochemical composition of Ulva lactuca and supplementary ingredients (milk, margarine, salt). The sweetness perception mechanism involves gustducin-mediated activation of adenylate cyclase, subsequent cAMP production, and calcium-dependent neurotransmitter release (Nisa et al., 2023). Texture analysis showed increasing crispiness with seaweed concentration (scores: 6.9-7.87), peaking at 30% addition. Ramadhani et al. (2012) attribute such textural properties to controlled moisture content (5 mL water addition during processing), which optimizes structural integrity during thermal treatment.

### *3.4 Color Analysis*

Table 3.4. Color Analysis of Flakes with Different Ulva Concentration

| Ulva Concentration | L | a* | b* |
|---|---|---|---|
| 0% | 62.16±0.69[a] | 12.86±0.19[a] | 15.02±0.01[a] |
| 10% | 51.70±0.51[b] | 5.71±0.98[b] | 9.41±0.08[b] |
| 20% | 47.01±0.25[c] | 2.30±0.30[c] | 7.93±0.00[c] |
| 30% | 44.97±0.34[d] | 1.53±0.22[c] | 5.22±0.63[d] |

Information:

Data ± standard deviation

Data followed by different lowercase letters in the same column are significantly different (P<0.05)

The results demonstrate that the incorporation of Ulva lactuca seaweed significantly influences the color characteristics of flakes, as evidenced by changes in the L*, a*, and b* values measured using a chromameter. Statistical analysis confirmed that the color data were normally distributed and homogeneous, with significant differences ($p < 0.000$) observed across all treatments for each color parameter (L*, a*, and b*). This indicates that variations in Ulva lactuca concentration produce distinct and measurable effects on flake color properties. The lightness (L*) values, which indicate the degree of brightness, ranged from 44.97 to 62.16 across the different treatments. The highest L* value (62.16) was observed in the control sample (0% Ulva lactuca), while the lowest (44.97) was recorded in the 30% Ulva lactuca treatment. This progressive decrease in L* values reflect a darkening effect, which can be attributed to Maillard reactions occurring during processing. According to Safitri et al. (2023), the reduction in L* values is associated with the presence of carbohydrates and proteins, which intensify Maillard browning. Sailah and Miladulhaq (2021) further support this observation, noting that prolonged heating and reduced moisture content enhance non-enzymatic browning reactions, leading to darker coloration in food products.

For the a* values, which represent the red-green chromaticity axis, the control flakes exhibited the highest a* value (12.86), indicating a reddish hue, while the 30% Ulva lactuca flakes had the lowest a* value (1.53), reflecting a shift toward green. The positive a* values in the control sample are consistent with findings by Safitri et al. (2021), who reported that fish flakes containing tilapia flour tended to exhibit reddish-brown tones due to Maillard reactions. In contrast, the greenish tint in Ulva lactuca-supplemented flakes arises from chlorophyll pigments present in the seaweed, as noted by Soeprijadi et al. (2023).

The b* values, which measure the yellow-blue chromaticity, decreased from 15.02 in the control to 5.22 in the 30% Ulva lactuca treatment. This trend suggests a shift from yellow to greenish-brown hues, influenced by roasting-induced Maillard reactions (Hapsari et al., 2022). The observed color changes underscore the role of thermal processing in modulating flake appearance, with higher Ulva lactuca concentrations intensifying green and brown tones due to combined chlorophyll and Maillard effects. Color is a critical determinant of food quality, and the CIELAB system (L*, a*, b*) provides a standardized method for quantifying these attributes. As explained by Sinaga (2019), the L* parameter defines lightness, while a* and b* represent the green-red and blue-yellow color dimensions, respectively. The human eye perceives color within the 380-780 nm wavelength range, and digital color segmentation helps objectively assess food product appearance.

## 4. Conclusions

This study found that adding Ulva lactuca seaweed (up to 30%) significantly improved the nutritional value and sensory quality of flakes. The 30% formulation was most preferred, offering better taste, texture, and color while increasing protein (4.44%), fiber (6.57%), and carbohydrate (65.57%) content. These results suggest Ulva lactuca can effectively enhance both the health benefits and consumer appeal of snack products. Further research could explore large-scale production methods.

**References**

Adi, A. A. A. M., Loaloka, M. S., Sin, J. G. L., & Nur, A. 2024. Modification of Ubiriga Flakes as Supplementary Food for Pregnant Women with Chronic Energy Deficiency in Kupang City. Innovative: Journal Of Social Science Research, 4(1), 5808-5816.

Agustini, S., Priyanto, G., Hamzah, B., Santoso, B., & Pambayun, R. 2015. The Effect of Process Modification on the Sensory Quality of Eight-Hour Cake. Jurnal Dinamika Penelitian Industri, 26(2), 107-115.

Association of Official Analytical Chemistry (AOAC). 1995. Official Methods of Analysis. Determination of Dietary Fiber Content.

Costa, D.J.F., Merdekawati, W., & Otu, F.R. 2018. Proximate Analysis, Antioxidant Activity, and Pigment Composition of Ulva Lactuca L. from Kukup Coastal Waters. Jurnal Teknologi Pangan dan Gizi, 17(1), 1-17.

Ekafitri, R., & Isworo, R. 2014. Utilization of Legumes as Protein Source Raw Materials for Emergency Food. Jurnal Pangan, 23(2), 134-144.

Fadhoil, H. F., Kurniati, W. D., & Hayati, N. 2024. Proximate and Dietary Fiber Analysis of Snack Bar with Addition of Persimmon (Diospyros kaki L.) and Sword Bean (Canavalia ensiformis [L.] DC). Jurnal Media Gizi Ilmiah Indonesia, 2(2), 86-95.

Gaurav, S. 2003. Digital Color Imaging Handbook. CRC Press, 12-16.

Ginting, F.R.B., & Husni, A. 2020. Characteristics of Flakes Fortified with Sargassum hystrix Flour as Functional Food. Jurnal Teknologi dan Manajemen Agroindustri, 9(3), 241-251.

Hapsari, D. R., Maulani, A. R., & Aminah, S. 2022. Physical, Chemical, and Sensory Characteristics of Purple Yam (Dioscorea alata L.) Based Flakes with Soybean Flour (Glycine max L.) Addition. Jurnal Agroindustri Halal, 8(2), 201-212.

Kusumastuti, S., & Adriani, M. 2017. Effect of Soy Milk and Mocaf (Modified Cassava Flour) Substitution on Acceptability, Fiber Content and Economic Value of Red Dragon Fruit Ice Cream. Jurnal Amerta Nutr, 1(3), 252-260.

Nelwida, N., Berliana, B., & Nurhayati, N. 2019. Nutritional Content of Black Garlic Heated at Different Times. Jurnal Ilmiah Ilmu-Ilmu Peternakan, 22(1), 53-64.

Nisa, R.C., Mariani, M., & Ngurah, I.G.A. 2023. Effect of Katuk Leaf (Sauropus Androgynus (L.) Puree Addition on the Physical Quality and Consumer Acceptability of Taro Flakes. Jurnal Sosial dan Sains, 3(8), 873-892.

Ramadhani, G. A., Izzati, M., & Parman, S. 2012. Proximate Analysis, Antioxidants and Preference of Cereal Food from Corn Flour (Zea mays L.) and Pumpkin Flour (Cucurbita moschata Durch). ANATOMI dan FISIOLOGI, 20(2), 32-39.

Safitri, E., Anggo, A. D., & Rianingsih, L. 2023. Effect of Nile Tilapia (Oreochromis niloticus) Flour Addition on Quality and Acceptability of Fish Flakes. Jurnal Ilmu dan Teknologi Perikanan, 5(1), 52-61.

Sailah, I. and Miladulhaq, M., 2021. Physicochemical Properties Changes During the Processing of Single-Bulb Garlic into Black Garlic Using a Rice Cooker. *Jurnal Teknologi Industri Pertanian*, *31*(1), pp.88-97.

Sanjaya, S., & Rabasari, S. 2023. Utilization of Seaweed in Shredded Meat Production as Tourist Souvenir. Jurnal Inovasi Penelitian, 3(10), 7895-7910.

Sinaga, A. S. 2019. Lab* Color Space Segmentation. Jurnal Mantik, 3(1), 43-46.

Soeprijadi, L., Panjaitan, T. F. C., & Prabhita, T. S. A. 2023. Sensory Evaluation of Nori Made from Ulva lactuca and Gracilaria sp. Seaweeds. Jurnal Marinade, 6(02), 124-134.

Yamin, L. O. M., Rizal, & BD, A. I. 2022. Innovation of Moringa Leaf Tea Processing as Functional Beverage to Increase Income in Ghonsume Village, Duruka District, Muna Regency. Jurnal Online Program Studi Pendidikan Ekonomi, 7(4), 102-114.

Zakaria, F. R., Priosoeryanto, B. P., Erniati, E., & Sajida, S. 2017. Characteristics of Nori from Ulva lactuca and Eucheuma cottonii Seaweed Mixture. Jurnal Pascapanen dan Bioteknologi Kelautan dan Perikanan, 12(1), 23-30