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# Chemical Characteristics of Fishball from Indian Mackerel and Oyster Mushroom with the Addition of Seaweed Porridge

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

Fishball is a processed product made from fish meat, tapioca flour, and spices, which then undergoes grinding, mixing of the dough, molding, and boiling until fully cooked. Indian mackerel can enhance the nutritional value of fish balls because it contains high animal protein, while the addition of oyster mushrooms provides plant-based protein and fibre. Fishball also utilises seaweed as an additional hydrocolloid source, serving as a stabiliser and gelling agent that lends the fishball a chewy texture. The objective of this study was to determine the effect of different proportions of Indian mackerel and oyster mushrooms with the addition of seaweed porridge on the chemical characteristics of fishball. The research employed a Completely Randomized Design (CRD) with a two-factor factorial pattern and three replications, followed by analysis using ANOVA and DMRT at 5%. The first factor was the proportion of Indian mackerel and oyster mushrooms (90:10, 70:30, and 50:50). The second factor was the type of seaweed Eucheuma cottoni, Gracilaria sp., and Ulva lactuca. The best treatment was found in the proportion of Indian mackerel and oyster mushrooms (90:10) with the addition of Eucheuma cottoni seaweed porridge, which resulted in 73.11% moisture, 1.45% ash, 12.44% protein, 2.05% fat, and 10.94% carbohydrate.

**Contribution to Sustainable Development Goals (SDGs):**
**SDG 2:** Zero hunger
**SDG 3**: Good Health and Well-being
**SDG 12:** Responsible Consumption and Production

## 1. INTRODUCTION

### 1.1. Research Background

A meatball is a type of processed meat product (beef, chicken, fish, and others) that is ground, shaped into balls, and then boiled in boiling water until cooked. The meatball is one of the food products favoured by the Indonesian people. According to data from [1], the average annual consumption of meatballs in Indonesia is 2.5 kg per capita. Beef-based meatballs have relatively high levels of saturated fatty acids and cholesterol; therefore, excessive consumption of beef meatballs can increase the risk of stroke, heart attack, and hypertension [2]. The price of beef is relatively high, thus requiring an alternative source of animal protein that is both high in nutritional value and more affordable. One such option is Indian mackerel, which can be used as a substitute for beef in meatball production.

Indian mackerel (Rastrelliger kanagurta) is a small pelagic fish that is widely found throughout Indonesian waters and has high potential. According to statistical data from [3], the production volume of Indian mackerel in 2023 reached 373,499 tons, making it one of the top ten marine fishery commodities in Indonesia. Indian mackerel is highly nutritious, containing 21.3 grams of protein, 71.4 grams of water, 1.7 grams of ash, as well as omega-3 and omega-6 fatty acids, which are beneficial for disease prevention and enhancing brain function [4].

According to data from Ref. [5], the production volume of white oyster mushrooms in Indonesia in 2023 reached 537,866 kg, equivalent to 53,787 tons. Oyster mushrooms are white in color, have a soft and chewy texture, a neutral taste, making them suitable for processing and cooking into various types of food. Oyster mushrooms are a nutritious food source rich in protein and fibre, as well as vitamins and minerals essential for growth, development, and overall health. Their chewy and fibrous texture resembles meat, allowing them to serve as an alternative source of fiber to replace animal-based ingredients. However, oyster mushrooms do not contain connective tissue found in meat, such as collagen fibres, elastin fibres, and reticular fibres, which provide elasticity to meat. Therefore, the use of binding agents (binders) is necessary in the production of meatballs.

Binding agents (binders) play an important role in maintaining the consistency, shape, and emulsion stability of products. They can bind the dough, enhance water-holding capacity, and produce a chewy texture in the product [6]. One of the binding agents that can be used in meatball production is seaweed, as it contains hydrocolloids that are capable of forming gels, increasing viscosity, and acting as stabilizers and emulsifiers. This allows the product to remain stable by binding meat particles together and preventing the emulsion system from breaking. Types of seaweed found in Indonesia include Eucheuma cottoni, Gracilaria sp., and Ulva lactuca. According to statistical data from [7], Indonesia's seaweed production in 2023 reached 15.3 million tons, dominated by Eucheuma cottonii (Kappaphycus alvarezii) with a volume of 7.05 million tons, accounting for 82.7% of global production, and Gracilaria with a volume of 1.91 million tons (32.1% of the global output). The use of Gracilaria sp. and Ulva lactuca in fishball processing has not yet been widely adopted compared to Eucheuma cottoni, which is already commonly used as an additive in meatball production.

## 1.2. Literature Review

Fishball is a processed fishery product made with at least 40% fish meat mixed with flour and other ingredients as needed, followed by forming and cooking until fully cooked [8]. According to [9], fishball products are made from fish meat, flour, and seasonings through a process that includes grinding, dough preparation, moulding, and finally boiling. High-quality fishballs should not only be highly nutritious but also possess the appropriate level of elasticity or texture [10].

Indian mackerel (Rastrelliger kanagurta L.) is a small pelagic fish with high potential and is widely found in tropical and subtropical waters, including the warm waters throughout Indonesia. In the study by [11], the nutritional composition of fresh Indian mackerel (%) was reported as 74.20% moisture, 1.66% ash, 20.91% protein, and 1.38% fat. Indian mackerel is rich in essential unsaturated fatty acids, specifically omega-3 and omega-6, which are essential for the body to enhance brain function, prevent diseases, and strengthen cardiac muscle endurance [12]. Fish proteins are classified into three types: myofibrillar, sarcoplasmic, and stromal proteins. The structure of myofibrils, the degree of cross-linking, and the water-holding capacity of fish muscle proteins play an important role in the elasticity of fishballs [13].

Oyster mushroom (Pleurotus ostreatus) is a type of wood-decaying fungus that is widely cultivated in Indonesia. The cap of the oyster mushroom is curved, rounded, and oval, resembling the shell of an oyster or clam, with wavy edges [14]. Oyster mushrooms are one of the plant-based ingredients that contain a high amount of fibre and serve as an alternative to animal-derived fibre. Its fibrous texture resembles that of meat fibres when cooked. The nutritional content of oyster mushroom per 100 grams consists of 10.5 g protein, 57.6 g carbohydrates, 1.6 g fat, and 7.5 g crude fiber [15].

Seaweed is a type of marine plant belonging to macroalgae that grows attached to the seabed. The types of macroalgae consist of green algae (Chlorophyta), brown algae (Phaeophyta), and red algae (Rhodophyta). Carrageenan, agar, and alginate are hydrocolloid compounds derived from different types of seaweed, namely Eucheuma cottoni as a carrageenan producer, Gracilaria sp. as an agar producer, and Sargassum sp. as an alginate producer [7]. Seaweed contains hydrocolloid components, such as carrageenan, agar, and alginate, which function to improve and provide a compact textural quality in food products, such as fishballs [16]. Carrageenan is a food additive that can thicken and stabilise foods, enhance gel elasticity and viscosity, and can be extracted with hot water due to its ability to form gels, creating a chewy and compact texture [17]. Therefore, the combination of Indian mackerel and oyster mushrooms, along with the addition of seaweed porridge, is expected to produce fishballs with a chewy texture and desirable quality.

## 1.3. Research Objective

This study aimed to determine the effect of different proportions of Indian mackerel and oyster mushrooms, combined with seaweed porridge, on the chemical characteristics of fishballs, as well as to identify the optimal treatment combination for achieving fishballs with the desired quality.

# 2. MATERIALS AND METHODS

## 2.1. Materials

### *2.1.1. Raw Material*

The raw materials used in this study included Indian mackerel and oyster mushrooms obtained from the market; seaweeds Eucheuma cottoni, Gracilaria sp., and Ulva lactuca purchased from an online store; as well as water, Rose Brand tapioca flour, ice cubes, garlic, eggs, salt, and ground pepper obtained from a supermarket.

### *2.1.2. Analytical Material*

The materials used for analysis included distilled water, sulfuric acid ($H_2SO_4$) (Merck), sodium hydroxide (NaOH) (Merck), hydrochloric acid (HCl) (Merck), boric acid ($H_3BO_3$) (Merck), Kjeldahl tablets, bromocresol green indicator, methyl red indicator, 95% alcohol, and petroleum benzene (Merck)..

## 2.2. Methods

### *2.2.1. Experimental Design*

This study employed an experimental method using a Completely Randomized Design (CRD) with a factorial pattern consisting of two factors and three replications. The first factor was the proportion of Indian mackerel and oyster mushrooms (90:10, 70:30, and 50:50), and the second factor was the type of seaweed (Eucheuma cottoni, Gracilaria sp., and Ulva lactuca). The data obtained were analyzed using Analysis of Variance (ANOVA). If a significant interaction was observed between the two treatments, Duncan's Multiple Range Test (DMRT) was performed at a 95% confidence level ($\alpha = 0.05$).

### *2.2.2. Seaweed Porridge*

The procedure for preparing seaweed porridge was carried out in several stages, modified from the method described in [6]. The three types of seaweed were first thoroughly washed, then soaked for 2 hours, and washed again. Subsequently, the seaweed was cut into small pieces and blended until smooth.

### *2.2.3. Fishball*

The procedure for making fish balls was carried out through several stages, modified from the method described in [18]. The preparation of raw materials included filleting Indian mackerel, cutting oyster mushrooms, and blanching them. Indian mackerel, oyster mushrooms, and 6% ice were placed into a blender and ground for 3 minutes. Subsequently, additional ingredients were added, including 10% seaweed porridge (in three types), 2% garlic, 1.5% salt, 0.5% pepper, 15% tapioca flour, and 5% egg white, which were then blended until homogeneous. The dough was shaped into balls using a spoon, and the fish balls were boiled at 100°C for 10 minutes, until they were cooked and floating. The final fishball products obtained were then analyzed based on predetermined parameters.

# 3. RESULT AND DISCUSSION

## 3.1 Moisture Content of Fishballs

The average moisture content of fishballs with different proportions of Indian mackerel and oyster mushrooms combined with the addition of Eucheuma cottoni, Gracilaria sp., and Ulva lactuca seaweed porridge is presented in Table 1. Based on the data, the moisture content of fishballs ranged from 72.62% to 77.59%. The highest moisture content was found in the treatment with a 50:50 ratio of Indian mackerel to oyster mushrooms with the addition of Eucheuma cottoni seaweed, which reached 77.59%. In contrast, the lowest moisture content was observed in the treatment with a 90:10 ratio of Indian mackerel to oyster mushrooms combined with the addition of Gracilaria sp. seaweed, at 72.62%.

**Table 1.** Moisture Content of Fishballs

| Indian Mackerel and Oyster Mushroom | Types of Seaweeds | Moisture Content (% ± SD) |
|---|---|---|
| 90 : 10 | *Eucheuma cottoni* | 73.11 ± 0.12$^{f}$ |
| | *Gracilaria* sp. | 72.62 ± 0.03$^{g}$ |
| | *Ulva lactuca* | 72.77 ± 0.06$^{g}$ |
| 70 : 30 | *Eucheuma cottoni* | 75.18 ± 0.05$^{d}$ |
| | *Gracilaria* sp. | 74.52 ± 0.11$^{e}$ |
| | *Ulva lactuca* | 74.71 ± 0.15$^{e}$ |
| 50 : 50 | *Eucheuma cottoni* | 77.59 ± 0.04$^{a}$ |
| | *Gracilaria* sp. | 76.63 ± 0.09$^{c}$ |
| | *Ulva lactuca* | 77.00 ± 0.20$^{b}$ |

Different superscript letters indicate significant differences ($p \leq 0.05$)

The moisture content of fishballs in this study ranged from 72.62% to 77.59%. The moisture content of the fishballs increased with higher proportions of oyster mushrooms and lower proportions of Indian mackerel, as well as with the addition of Eucheuma cottoni seaweed porridge. This was due to differences in the water content of the raw materials, where Indian mackerel contained less water compared to oyster mushrooms. Based on the raw material analysis, the moisture content of the Indian mackerel used in this study was 72.81%, while that of the white oyster mushrooms was 88.2%. The fibre content also influenced the moisture content of fishballs in oyster mushrooms, as a higher fibre content leads to a greater water absorption capacity, causing more water to be bound within the dough and thereby increasing the moisture content of the fishballs. This is consistent with the statement of [19], who reported that fiber has a high water-holding capacity due to its large polymer size and abundance of hydroxyl groups, which enable it to bind large amounts of water.

The addition of Eucheuma cottoni, Gracilaria sp., and Ulva lactuca seaweed porridge also influenced the moisture content of fishballs. This is due to the moisture content of Eucheuma cottoni (25.74%), Gracilaria sp. (15.39%), and Ulva lactuca (17.76%). Therefore, in this study, fishballs using Eucheuma cottoni seaweed had the highest moisture content. Seaweed has high water absorption and binding ability, which causes fishballs to absorb more water during the boiling process, resulting in higher moisture content. Increasing the hydrocolloid addition enhances the compactness of the gel matrix, resulting in stronger gel formation and greater water retention, thereby increasing the moisture content. This is in line with the statement of [20], who reported that the addition of Kappaphycus alvarezii seaweed porridge increased the moisture content of payus fishballs, as water was trapped within the carrageenan matrix formed during heating, due to the sulfate groups in carrageenan that can bind water.

## 3.2 Ash Content of Fishballs

The average ash content of fishballs with different proportions of Indian mackerel and oyster mushrooms combined with the addition of Eucheuma cottoni, Gracilaria sp., and Ulva lactuca seaweed porridge is presented in Table 2. Based on the data, the ash content of fishballs ranged from 1.11% to 1.69%. The highest ash content was observed in the treatment with a 90:10 ratio of Indian mackerel to oyster mushrooms, combined with the addition of Gracilaria sp. seaweed, at 1.69%. In contrast, the lowest ash content was observed in the treatment with a 50:50 ratio of Indian mackerel to oyster mushrooms combined with the addition of Eucheuma cottoni seaweed, at 1.11%.

**Table 2.** Ash Content of Fishballs

| Indian Mackerel and Oyster Mushroom | Types of Seaweeds | Ash Content (% ± SD) |
|---|---|---|
| 90 : 10 | *Eucheuma cottoni* | 1.45 ± 0.02$^{c}$ |
| | *Gracilaria* sp. | 1.69 ± 0.05$^{a}$ |
| | *Ulva lactuca* | 1.54 ± 0.01$^{b}$ |
| 70 : 30 | *Eucheuma cottoni* | 1.30 ± 0.05$^{e}$ |
| | *Gracilaria* sp. | 1.41 ± 0.01$^{cd}$ |
| | *Ulva lactuca* | 1.37 ± 0.02$^{de}$ |
| 50 : 50 | *Eucheuma cottoni* | 1.11 ± 0.03$^{g}$ |
| | *Gracilaria* sp. | 1.22 ± 0.06$^{f}$ |
| | *Ulva lactuca* | 1.17 ± 0.05$^{fg}$ |

Different superscript letters indicate significant differences ($p \leq 0.05$)

The ash content of fishballs in this study ranged from 1.11% to 1.69%. The ash content of the fishballs increased with higher proportions of Indian mackerel and lower proportions of oyster mushrooms, as well as with the addition of Gracilaria sp. seaweed porridge. This is due to the higher ash content in Indian mackerel compared to oyster mushrooms. Based on the raw material analysis, the ash content of the Indian mackerel used in this study was 1.48%, while that of the white oyster mushrooms was 0.62%. This is consistent with the report of [4], which stated that the ash content of Indian mackerel is 1.66%, while that of fresh oyster mushrooms is 0.60%. The potassium content in Indian mackerel is 64,391.16 mg/100 g, while the calcium content in Indian mackerel is 29,197.66 mg/100 g [21]. Ash is composed of various minerals with diverse compositions depending on the type and source of food materials used. Indian mackerel, oyster mushrooms, and seaweed all contain different mineral components.

The addition of Eucheuma cottoni, Gracilaria sp., and Ulva lactuca seaweed porridge can influence the ash content of fishballs because seaweed contains relatively high mineral levels. According to [22], Eucheuma cottoni seaweed contains minerals such as potassium, calcium, sodium, iron, and iodine. Gracilaria sp. seaweed contains minerals such as nitrogen, potassium, phosphorus, manganese, and zinc. Ulva lactuca seaweed contains minerals such as calcium (Ca) 17.95%, sodium (Na) 22.27%, magnesium (Mg) 22.23%, potassium (K) 12.28%, and iron (Fe) 0.18% [23]. Variations in ash content and mineral composition may occur due to differences in seaweed species, growing habitats, and environmental conditions.

## 3.3 Protein Content of Fishballs

The average protein content of fishballs with different proportions of Indian mackerel and oyster mushrooms combined with the addition of Eucheuma cottoni, Gracilaria and Ulva lactuca seaweed porridge is presented in Table 3. Based on the data, the protein content of fishballs ranged from 8.30% to 14.48%. The highest protein content was observed in the treatment with a 90:10


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ratio of Indian mackerel to oyster mushrooms combined with the addition of Gracilaria sp. seaweed, reaching 14.48%. In contrast, the lowest protein content was found in the treatment with a 50:50 ratio of Indian mackerel to oyster mushrooms combined with the addition of Eucheuma cottoni seaweed, at 8.30%.

**Table 3**. Protein Content of Fishballs

| Indian Mackerel and Oyster Mushroom | Types of Seaweeds | Protein Content (% ± SD) |
|---|---|---|
| 90 : 10 | *Eucheuma cottoni* | $12.44 \pm 0.11^{c}$ |
| | *Gracilaria* sp. | $14.48 \pm 0.08^{a}$ |
| | *Ulva lactuca* | $13.32 \pm 0.10^{b}$ |
| 70 : 30 | *Eucheuma cottoni* | $10.37 \pm 0.06^{f}$ |
| | *Gracilaria* sp. | $11.72 \pm 0.08^{d}$ |
| | *Ulva lactuca* | $10.96 \pm 0.09^{e}$ |
| 50 : 50 | *Eucheuma cottoni* | $8.30 \pm 0.13^{i}$ |
| | *Gracilaria* sp. | $10.06 \pm 0.16^{g}$ |
| | *Ulva lactuca* | $9.44 \pm 0.07^{h}$ |

Different superscript letters indicate significant differences ($p \leq 0.05$)

The protein content of fishballs in this study ranged from 8.30% to 14.48%. The protein content of the fishballs increased with higher proportions of Indian mackerel and lower proportions of oyster mushrooms, along with the addition of Gracilaria sp. seaweed porridge. This was due to the higher protein content in Indian mackerel compared to oyster mushrooms. Based on raw material analysis, the protein content of Indian mackerel used in this study was 20.65%, while that of white oyster mushrooms was 6.34%. This is consistent with [4] and [15], who reported that Indian mackerel contained 21.3% protein and fresh oyster mushrooms contained 10.5% protein. Protein in meat components plays a crucial role in fishball production, serving as a binder that forms a compact structure and acts as an emulsifier.

The addition of Eucheuma cottoni, Gracilaria sp., and Ulva lactuca seaweed porridge can also influence the protein content of fishballs. This is due to the protein content of Eucheuma cottoni (2.49%), Gracilaria sp. (13.23%), and Ulva lactuca (10.51%). Therefore, in this study, fishballs using Gracilaria sp. seaweed had the highest protein content. Seaweed contains hydrocolloids such as carrageenan and agar, which are used to bind free water and retain protein so that it remains in the fishball matrix during cooking. This is in line with the statement of [24], who noted that carrageenan has binding properties and traps water within the gel matrix, thereby minimizing the loss of water-soluble proteins, as these proteins are bound by carrageenan. According to [18], the effect of carrageenan in seaweed on protein is determined by the number of sulfate groups present in carrageenan. Protein serves as an essential nutrient source of amino acids and provides functional properties such as thickening, emulsifying, and gel formation [25].

## 3.4 Fat Content of Fishballs

The treatment of different proportions of Indian mackerel and oyster mushrooms had a significant effect ($p<0.05$) on the fat content of fishballs; however, the addition of Eucheuma cottoni, Gracilaria sp., and Ulva lactuca seaweed porridge had no significant effect ($p>0.05$) on the fat content of fishballs. The average fat content of fishballs with different proportions of Indian mackerel and oyster mushrooms is presented in Table 4.

**Table 4**. Fat content of Fishballs

| Indian Mackerel and Oyster Mushroom | Fat Content (% ± SD) |
|---|---|
| 90 : 10 | $2.04 \pm 0.04^{a}$ |
| 70 : 30 | $1.76 \pm 0.02^{b}$ |
| 50 : 50 | $1.44 \pm 0.06^{c}$ |

Different superscript letters indicate significant differences ($p \leq 0.05$)

Table 12 shows that the average fat content of fishballs with different proportions of Indian mackerel and oyster mushrooms ranged from 1.44% to 2.04%. The highest fat content was observed in the treatment with a 90:10 ratio of Indian mackerel to oyster mushrooms, at 2.04%, while the lowest was found in the treatment with a 50:50 ratio of Indian mackerel to oyster mushrooms, at 1.44%. The fat content of the fishballs decreased with higher proportions of oyster mushrooms and lower proportions of Indian mackerel, since oyster mushrooms contain less fat compared to Indian mackerel. Based on raw material analysis, the fat content of white oyster mushrooms in this study was 0.38% and Indian mackerel was 1.74%. This is consistent with [4], who reported that the fat content of oyster mushrooms was 0.33%, while that of Indian mackerel reached 3.4%.

**Table 5.** Fat Content of Fishballs

| Types of Seaweeds | Fat Content (% ± SD) |
|---|---|
| *Eucheuma cottoni* | $1.76 \pm 0.29^{a}$ |
| *Gracilaria* sp. | $1.75 \pm 0.29^{a}$ |
| *Ulva lactuca* | $1.75 \pm 0.30^{a}$ |

Different superscript letters indicate not non-significant differences ($p \geq 0.05$)

The analysis results showed that the addition of Eucheuma cottoni, Gracilaria sp., and Ulva lactuca seaweed porridge had no significant effect on the fat content of fishballs, as these types of seaweed contain very little fat. Based on raw material analysis, the fat content of seaweed used in this study was Eucheuma cottoni 0.87%, Gracilaria sp. 0.52%, and Ulva lactuca 0.69%.

## 3.5 Carbohydrate Content of Fishballs

The average carbohydrate content of fishballs with different proportions of Indian mackerel and oyster mushrooms combined with the addition of Eucheuma cottoni, Gracilaria sp., and Ulva lactuca seaweed porridge is presented in Table 6. Based on the data, the carbohydrate content of fishballs ranged from 9.16% to 11.52%. The highest carbohydrate content was observed in the treatment with a 50:50 ratio of Indian mackerel to oyster mushrooms combined with the addition of Eucheuma cottoni seaweed, at 11.52%. In contrast, the lowest carbohydrate content was found in the treatment with a 90:10 ratio of Indian mackerel to oyster mushrooms combined with the addition of Gracilaria sp. seaweed, at 9.16%.

The carbohydrate content of the fishballs increased with higher proportions of oyster mushrooms and lower proportions of Indian mackerel, as well as with the addition of Eucheuma cottoni seaweed porridge. This was due to the higher carbohydrate content of oyster mushrooms compared to Indian mackerel. The addition of tapioca flour also influenced the carbohydrate content of fishballs. According to [26], tapioca flour is made from cassava, which contains starch composed of 17% amylose and 83% amylopectin. Tapioca flour has a high carbohydrate content of about 84.2%. Carbohydrate levels may be affected by the amylose and amylopectin composition of the flour.

**Table 6.** Carbohydrate Content of Fishballs

| Indian Mackerel and Oyster Mushrooms | Types of Seaweeds | Carbohydrate Content (% ± SD) |
|---|---|---|
| 90 : 10 | *Eucheuma cottoni* | $10.94 \pm 0.02^{c}$ |
| | *Gracilaria* sp. | $9.16 \pm 0.02^{f}$ |
| | *Ulva lactuca* | $10.31 \pm 0.12^{e}$ |
| 70 : 30 | *Eucheuma cottoni* | $11.36 \pm 0.05^{ab}$ |
| | *Gracilaria* sp. | $10.56 \pm 0.09^{d}$ |
| | *Ulva lactuca* | $11.18 \pm 0.10^{b}$ |
| 50 : 50 | *Eucheuma cottoni* | $11.52 \pm 0.14^{a}$ |
| | *Gracilaria* sp. | $10.63 \pm 0.20^{d}$ |
| | *Ulva lactuca* | $10.93 \pm 0.21^{c}$ |

Different superscript letters indicate significant differences ($p \leq 0.05$)

The addition of Eucheuma cottoni, Gracilaria sp., and Ulva lactuca seaweed porridge also affected the carbohydrate content of fishballs, as the tested seaweeds were found to have high carbohydrate content. The carbohydrate content of seaweed used in this study was Eucheuma cottoni 67.72%, Gracilaria sp. 65.54%, and Ulva lactuca 66.35%. The carbohydrate content of fishballs with the addition of Eucheuma cottoni seaweed porridge was higher compared to those with the addition of Gracilaria sp. seaweed porridge.

## 4 CONCLUSION

Fishballs produced in this study are products made from Indian mackerel and oyster mushrooms with the addition of Eucheuma cottoni, Gracilaria sp., and Ulva lactuca seaweed porridge. The results of this study showed a significant interaction between the proportion of Indian mackerel and oyster mushrooms, and the addition of seaweed porridge, on moisture content, ash content, protein content, and carbohydrate content; however, no significant interaction was observed on the fat content of fishballs. The best formulation was obtained from the treatment with a 90:10 ratio of Indian mackerel to oyster mushrooms combined with the addition of Eucheuma cottoni seaweed porridge, which resulted in 73.11% moisture, 1.45% ash, 12.44% protein, 2.05% fat, and 10.94% carbohydrates.

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