The physical characteristics of analog cincau from different proportions of the cottonii organic powder

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Abstract. Black grass jelly often called black jelly, also known as black cincau (“cincau” in Indonesian), was produced by boiling the black grass jelly to extract the jelly. It has a high soluble fiber content. This study investigated the analog cincau formulation using organic powder cottonii (OPC) ingredients as the gelling agent. The OPC was obtained from Seaweed Eucheuma cottonii (Lampung) without an alkali treatment. The analog cincau formulation consists of OPC, konjac, KCl, tapioca flour, cincau flavor. A commercial cincau was used as a reference. The physical quality characterization of analog cincau in this study includes gel strength, elasticity, and syneresis. Based on the physical analysis results, the best formula of analog cincau was the cincau using the following formula: OPC 65%, konjac 15%, tapioca flour 10%, and KCl 10%. Its physical characteristics were almost similar to the commercial cincau. The characteristics of the cincau with the best formula were the gel strength of 532 g/cm², elasticity 246 (g/sec), and syneresis 2.70%.

1. Introduction

Indonesia’s oceans’ high biodiversity consists of various types of marine products. Seaweed is one of the leading commodities spread in almost all Indonesian waters and is potential for an export commodity. The current total national seaweed production has experienced a significant increase [1]. In 2019, Indonesia was the second-largest seaweed producer globally after China, with a total output of 27.86% of the actual world seaweed production [2].

Indonesia has varied seaweed types, such as red seaweed (Eucheuma cottonii and Gracilaria). The secondary metabolite is carrageenan, agar, and pigments (consisting of phycocerythrin and phycocyanin). The utilization of seaweed can be maximized by diversification of processed seaweed products which is one of the efforts to increase the usability, nutritional value, and economic value of seaweed [3].

Carrageenan is one of the economically valuable seaweed processed products. Carrageenan is sourced from red seaweed (Rhodophyceae) in the form of sulfated polysaccharides. It has hydrocolloid properties, so it is widely used in food and industrial products. In addition to being used as a stabilizer, other functional properties in food products are crystallization preventer, gelling emulsifiers, thickener, protective colloid, and coagulant. Some genera of carrageenan-producing red seaweed include Chondrus, Eucheuma, and Gigartina, but generally for the tropics, many are produced by the genus Eucheuma [4].
Seaweed flour with a concentration of 30% of carrageenan is a food ingredient rich in iodine (3.86 (ug/g)). It was obtained from *Eucheuma cottonii* [5]. Other research reports that seaweed flour from *E. cottonii* contains a total dietary fibre of 91.3% from total carbohydrate and iodine of 19.4 (ug/g) [6].

The carrageenan can form gels and gelatin, but the properties of carrageenan gel are brittle and less elastic. One of the other vegetable ingredients that have elastic properties but cannot form a gel is konjac. Konjac or konjac *manna* or *konyaku* are hydrocolloid polysaccharides from the Amorphophallus plant. The main compound of konjac is a glucomannan consisting of mannose and glucose by 1.4 glycosidic bonds. Konjac dissolves in hot or cold water, its thickness is high with a pH between 4.0 to 7.0, functioning as a gelling agent, thickener, emulsifier, and stabilizer. Based on the properties above, konjac can be used as a mixer to increase the elasticity of carrageenan as an ingredient in making *cincau* or grass jelly [7, 8].

The applications of carrageenan and konjac in the food industry include as suspension in yoghurt, stabilizers in ice cream, and gelling agents in jelly and candy, or known as jelly candy. Konjac has synergism with carrageenan in terms of gel strength and elasticity [9].

Black grass jelly, often called as black jelly (*“cincau”* in Indonesian), was produced by boiling the black grass jelly to extract the black jelly. Black cincau (*Mesona palustris* BL) is a traditional beverage ingredient that is believed to be efficacious for health. Its use is generally as a mixture of fresh drinks with pieces of fruit or canned in syrup. This product is obtained from *cincau* extract, which contains a hydrocolloid component as a gel. The formation of black gel is a unique phenomenon, the gelling agent of the *cincau* cannot stand alone to form gels; starch and minerals must be added, such as soda ash [10,11]. General hydrocolloids can be used as thickeners, but not all hydrocolloids can form gels. The disadvantage of black cincau is that the manufacturing process is less hygienic, seasonal plant, short shelf life, and has high syneresis [12]. The alternative for analog *cincau* production is using *Organic Powdered Cottonii* (OPC), which can make gels and formulate with other ingredients (konjac and tapioca powder) to higher its elasticity and organic ingredient. OPC is diversification from hydrocolloids that can be gelled to improve the quality of processed products that work on gelling, defense coatings, encapsulation, edible films, and others [13]. This study investigated making the analog *cincau* formulation using OPC ingredients as the gelling agent and characterization physical properties of its product.

2. **Material and methods**

2.1. **Materials**

*Organic Powdered Cottonii* (OPC) was obtained from *Eucheuma cottonii* from Lampung. The other ingredients were konjac flour, flavour 138.4_15, tapioca flour, *cincau* flavour, food coloring Edicol Ponceau 4R purchased from the local market.

2.2. **Methods**

2.2.1. **The procedure of making organic powder cottonii.** The first step to making OPC was by chopping (0.5 cm) fresh seaweed E. cottonii, separating seaweed chips from the liquid using a spinner. The resulting chip is then immersed in KOH solution 1.5% (concentration follows) for 15 minutes, washed until neutral, dried and shifted into seaweed flour size 60 mesh [14]. Furthermore, OPC quality analysis is carried out, namely (moisture content, ash content) [15], syneresis, water gel, and gel strength (in concentration 1.5%) [10].

2.2.2. **Making of analog cincau.** The cincau formulation was carried out, as shown in Table 1. The materials used for making cincau consisted of OPC, tapioca flour, KCl, and Konjac. At the same time, cincau flavor and cincau coloring (black) are constant. As much as 197 g of water is weighed in a beaker glass. The total sample used was 3 g, of which 3 g was obtained from 1.5% of 197 g water. First, the OPC varied, konjac varied, and tapioca flour varied were weighed according to the formulation in Table 1. Then, as much as 0.6 g of KCl was added. The order to enter the sample was
KCl first, konjac, OPC, and then tapioca flour. It is then heated to a constant temperature at 80°C while being stirred and maintained for 10-15 minutes. After that, the flavor was added, then was mixed until homogeneous and poured the sample into the container that has been provided, filled until complete, and covered using a lid then left until the liquid is thick at room temperature. The samples were then placed in the refrigerator at 10°C for 12-15 hours [14].

| Table 1. Variations of OPC in the formulation of analog cincau. |
|---------------------------------------------------------------|
| **Formula** | **OPC (%)** | **Konjac (%)** | **Tapioca flour (%)** | **KCl (%)** |
| F1       | 45         | 15           | 20            | 20         |
| F2       | 55         | 15           | 15            | 20         |
| F3       | 65         | 15           | 10            | 10         |
| F4       | 55         | 20           | 5             | 20         |
| F5       | 45         | 20           | 10            | 25         |
| F6       | 40         | 25           | 10            | 25         |
| F7       | 35         | 20           | 15            | 30         |

Notes:
F1: OPC:Konjac:Tapioca:KCl =45:15:15:20
F2: OPC:Konjac:Tapioca:KCl =55:15:15:20
F3: OPC:Konjac:Tapioca:KCl =65:15:10:10
F4: OPC:Konjac:Tapioca:KCl =55:20:5:20
F5: OPC:Konjac:Tapioca:KCl =45:20:5:20
F6: OPC:Konjac:Tapioca:KCl =40:25:10:25
F7: OPC:Konjac:Tapioca:KCl =35:20:15:30

2.2.3. **Characterization of analog cincau**

2.2.3.1 **Testing of gel strength.** The testing of gel strength was conducted according to the following steps. The first step is weighing 197 g of distilled water into a beaker glass. A 0.6 g of Potassium Chloride (KCl) was then added to the solution using a multiple heating stirrer until it dissolved. Three g of the sample to be analyzed was added to the solution. It is then heated until 80°C and maintained for 15 minutes. The liquid was poured into the sample container until it was full and carefully closed it using aluminum foil. After thickening the solution, the sample container was turned over and placed in the refrigerator at 10°C for 12-15 hours. The sample was removed from the container and put at the midpoint of the gel analog cincau. The gel strength (gr/cm²) was then measured and elasticity (g/sec) were evaluated using a TA-XT plus texture analyzer (Stable Micro Systems, England) using a 12.5 mm diameter probe at a constant speed of 1 mm/s until the gel breaks with 14 mm depth or distance penetration. The value that appears is the strength of the gel in units of grams per square centimeter (g/cm²). Each treatment was replicated three times [7].

2.2.3.2 **The procedure of gel syneresis.** Syneresis measurement of gel cincau was conducted using a modified method proposed by Lin and Chang (2016). The container that still contains the sample was weighed using a digital scale, it is noted as the initial weight. Next, the gel analog cincau was removed from the container and placed on absorbent tissue, then waited for ± 60 minutes. The container was cleaned from the remaining water using a tissue. The sample was re-entered into a dry container and weighed using a digital scale. It was recorded as the final result. Each treatment was triplicated [16]. The syneresis value was then calculated by the following formula:

\[
\text{Syneresis} = \frac{\text{initial weigh} - \text{final weigh}}{\text{initial weigh}} \times 100\% \quad (1)
\]
3. Results and discussion

3.1. Organic powder cottonii (OPC)

The characteristics of analysis OPC were as follow: water content 9.34%, ash content 23.77%, protein content 4.02%, syneresis 2.2 %, water gel 103 (g/cm²), and KCl gel strength 205 g/cm².

3.2. Gel strength and elasticity

The gel strength of cincau products from OPC variations is presented in Figure 1. Figure 1 shows that the OPC concentration affected the value of gel strength. As an example, F1, which contained lower OPC (45%), achieved lower gel strength (619 g/cm²) compared to F4 (OPC 55%), which had higher gel strength of 681 g/cm². This condition is caused by the aggregate amount formed in the nets form that has powerful bonds resulting in the texture of the gel being brittle and rigid. The functional OPC in the analogue cincau formula is a gelling agent to substituted cincau extract. However, at the same concentration (1.5%), the ability of OPC gelling agents is still lower than other carrageenan types such as semi-refined carrageenan (SRC) [17].

Figure 1. Gel strength from variations of OPC in the formulation of analog cincau.

Similarly, KCl also increases gel strength, such as on formulas F2 and F4, higher addition of KCl resulted in higher gel strength. Whereas, konjac and OPC have a synergistic effect for gel enhancement in analog cincau. It can be seen from the comparison of F1 gel strength with F4, there is an increase in gel strength from 619 gr/cm² of F1 (45% OPC + 15% konjac) to 681 gr/cm² (55% OPC + 20% konjac). Another example was in formulas F3 and F4, where the increase of konjac increases the gel strength.

When it is compared to commercial cincau, the F7 formula has the closest gel strength. In addition to adding gel strength, konjac also plays a role in increasing elasticity [9]. It is also found in research formulations of jelly powder that the increase in the concentration of carrageenan and konjac increases the elasticity value of jelly obtained [18].

The elasticity values of analog cincau studies ranged from 187-249 (g/sec) (Figure 2). Its elasticity value is still below the elasticity of commercial cincau. The ingredients that play a role in the analog cincau formula are OPC and konjac. As shown in F2 (OPC 55%) and F3 (OPC 65%), the elasticity increases with the increase of OPC. In addition, F1 and F5 which has the same amount of OPC result in different elasticity. F5 (20% konjac) has more elasticity than F1 (15% konjac). Figure 2 shows that OPC and konjac materials can enhance the elasticity of analog cincau. On the contrary, KCl lowers the elasticity value [9].
3.3. Syneresis

Besides the gel strength, the properties of syneresis are also crucial in the quality of the cincau characteristics. It is expected that the syneresis of cincau is lower than commercial cincau. High syneresis ability accelerates the growth of microbes; this matter accelerates the damage of cincau. Normally, food additives are added to achieve a longer shelf-life. The addition of KCl in analog cincau can increase synereses, such as in F3 and F4. The formula with less KCl (F3;2.7%) has lower syneresis than that with higher KCl (F4;3.38%).

One of the disadvantages of the black cincau in the soft gel is the two stages of cooking with a relatively long time and high syneresis. High syneresis will be easier to be contaminated by microbes [12]. Syneresis is the spontaneous discharge of liquid from the cincau [19]. Some of the results of syneresis research from instant cincau range from 0.1% - 3.4%. Generally, black cincau using tapioca flour can affect additional syneresis. Syneresis black cincau is higher than analog cincau [11, 18].

Figure 2. Elasticity from variations of OPC in the formulation of analog cincau.

The formulas which have a close similarity to the commercial cincau were F3 and F7. If it is determined from the lowest value of syneresis, F3 is selected. To complete the results of the physical properties of the analog cincau, the future research of the physical properties of the analog cincau requires to be supported by sensory testing and a shelf-life analysis product. The advantages of analog...
cincau compared to black cincau are that making analog cincau is more practical, result in a lower syneresis, and the raw material is available in all of the seasons. Another research making grass jelly using 20% agar powder the total weight has syneresis of 2.1% [20].

4. Conclusions
The formulation materials used for making analog cincau consisted of OPC, tapioca flour, KCl and konjac, and Flavor 138.4_15. The best formula from the analog cincau was using OPC 65%; konjac 15%, tapioca flour 10%, and KCl 10%. These results are based on the similarity of physical tests by characteristic gel strength of 532 g/cm² and syneresis 2.70% as reference using cincau commercial (black cincau). OPC and konjac can increase the gel strength and elasticity of analog cincau. The OPC can substitute extract original cincau as a gelling agent in grass jelly.

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Author Contributions
Conceived and designed the experiments ES as the main contributor; collected the data ES, JB, NH; wrote manuscript ES. All authors reviewed the manuscript.

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