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Encapsulation of protein extract of phytoplankton and its application in sago starch from North Maluku

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Abstract- Encapsulation of protein extract of phytoplankton was conducted. The research aims at testing the feasibility of phytoplankton extracts to be used in encapsulated sago food with maltodekstrin. The analysis method was *Lowry* and scanning electron microscopy (SEM). The results indicated that protein extracts of *Dunaliella salina* had a high rendament content after encapsulating process, respectively 1.4 % and 0.407 % while the application of maltodekstrin was 5 percent. The highest protein content after the application of 30 % of protein extract of *Dunaliella salina* to sago starch products was 9.19 mg/g.

Keywords- Encapsulation, phytoplankton, maltodextrin, sago starch, North Maluku.

3. Introduction

Indonesia is an agricultural country that is growing and developing from agricultural sector. The main problem of agriculture is the availability of food for the population. An attempt to homogenization of rice consumption has caused some regions which are not potential for rice to grow to be dependent on rice supply from outside, this happens in North Maluku.

Sago are plant that grows massively in North Maluku. Although this region is potential to be a sago barn as the basis of food self-reliance, the government's manifestation and modernization make the people consume rice rather than sago. All stakeholders need to take part to sustain the sago as a staple food so food self-sufficiency can be realized. In order to produce qualified food, sago should contain high nutritional value. For sago loses many nutrients during the process into sago flour, it is considered necessary to give safe and natural substances or food additives.

One of the efforts to improve the nutritional value of sago is adding the protein extracts, vitamins, amino acids from phytoplankton extract. Phytoplankton contains potential chemical compounds such as proteins, pigments, chlorophylls and carotenoids), carbohydrates, amino acids, lipids, and hydro carbons. Phytoplankton has been widely used for the benefit of mankind, such as food ingredients, animal feed, medicines, fertilizer compound and fuel source. The quality of phytoplankton can be sustained through encapsulation method.

Encapsulation is a process or technique to overlay the core of the active compounds in the form of a solid, liquid, gas, or cells with a particular protective material that can reduce the damage of the active compounds. Encapsulation helps separate the core material with its environment until the material is released into the environment. Protected core material is called *the core* and the structure formed by the protective material covering the nucleus called the *wall*, membrane, or capsule [2]. Capsule is a semi-permeable material, thin, round, and robust whose diameters varying from few micrometers to millimeters [1,2,8]. Encapsulation process also allows the conversion of a compound form of liquid into a spray drying. Spray drying is the drying of materials using high temperature. Principle of drying with a spray drying method is to spray the material in the form of droplets into a hot drying medium. Water in droplets evaporates and leaves the dry material [5,9].

2. Methods

2.1 Cultivation and Production of Phytoplankton Biomass;

Phytoplankton cultivation was processed with the *fed-batch* culture system by periodically or randomly adding the media in which cultures were routinely harvested [3,6]. The process of harvesting was to filter phytoplankton biomass when the density of phytoplankton cell was high enough (cultural optical density optical >1) at day10^{th} and 18^{th} .

2.2 Extraction and analysis of phytoplankton biomass protein

Protein extraction can be processed by *Lorenz* method. Protein was extracted from phytoplankton using 100mM of phosphate buffer solution pH7. Extraction procedure was committed by adding a phosphate buffer solution into a dry sample of phytoplankton to be extracted. The compounds of phosphate buffer and phytoplankton were to be blended. The samples were stored in a refrigerator at 10 degree Celsius for 24 hours. The compounds were blended and centrifuged to separate the protein from phytoplankton biomass. Determination of protein content was done with *Lowry* and *Kjehdal*.

2.3 Selection of biopolymer and characterization of the encapsulated protein extract of products

The main purpose of this stage was to determine the composition of the appropriate encapsulation material (biopolymer) in order to encapsulate extracted protein. Bio polymer to be used was maltodextrin. Characterization was done by scanning electron microscopy (SEM) to determine of product morphology.

2.4 The application of encapsulated protein extracts as additive material for sago starch products

A certain amount of encapsulated dry protein extracts was directly induced into sago starch. The mixture was done at room temperature for 24 – 48hours until the texture looked compact (encapsulated extracts were all mixed).

3. Result and Discussion

3.1 Cultivation and Biomass Harvesting.

Growing patterns of *D. Salina*, *P. cruentum* and *T. chuii* were observed every 24hours during growing periods. Figure 1 shows the growing period of each phytoplankton

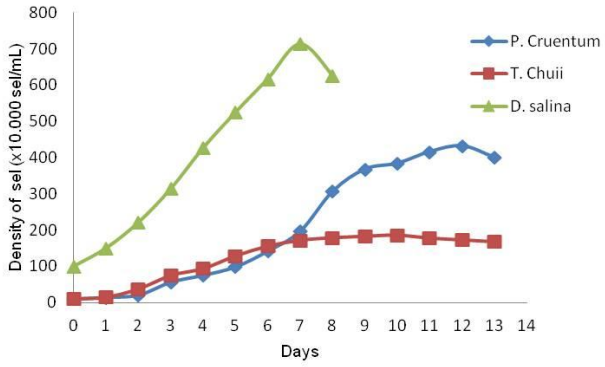


Fig 1. Growth of phytoplankton cells during the cultivation and biomass production

The observation on the growth of *D. Salina*, *P. cruentum* and *T. Chuii* in medium *Conwy* was done every 24 hours for 14 days. Figure 2, generally shows a growing pattern composing of 4 phases; adaptation phase, exponential phase, stationary phase, and mortality phase. As seen in figure 1, the optimum growing period of *D. Salina*, *P. Cruentum*, and *T. Chuii* was on day8, 12, and 9. *D. Salina* with the highest protein content of 58% was selected as raw material based on cultivating time and the quantity of biomass. Furthermore, a semi-mass cultivation was conducted in a 100 liters water tank and so was the biomass harvesting.

3.2 Extraction and encapsulation of phytoplankton extracts

The protein extraction of 2 grams of phytoplankton biomass was conducted using phosphate buffer pH7, 50mL was shaken by using a vortex, and then was stored in the refrigerator for 24hours. After 24hours, the compounds ware blended using a vortex and centrifugation by which protein solution (supernatant) was separated from biomass residues. Supernatant was stored in a refrigerator for further encapsulation process.

Bio polymers used for encapsulation was maltodextrin. Variation of the concentration ratio of protein extracts with 50 mL maltodextrin solution was5 % b/v, 10% b/v, 15% b/v and 20% b/v. Encapsulation of protein extracts was processed at inlet temperature 120^{o}Candoutlet temperature 70^{o}C with a flow rate/pump2. Rendament and encapsulated protein content is presented in table1 and figure 2.

As seen in table 1, the weight of extracted rendament protein on *maltodextrin* percentage is 1.4 (5%), 4.54 (10%), 10.74 (20%) and 15.1 (30%). The highest coating-*maltodextrin* percentage for D. Salina protein extract is 30% with rendament percentage of 15.1%.

Table 1. Rendament and encapsulated protein content

phytoplankton	MD (%)	Rendament (%)	Protein (%)
Dunaliella saline	5	1.4	0.407
	10	4.54	0.219
	20	10.74	0.183
	30	15.1	0.024

Figure 2 shows the content of *maltodextrin*-encapsulated *D. Salina*. The analysis of protein indicated that the highest protein was found in 5 percent-*maltodextrin*-encapsulated protein extract which later decreased while the percentage of *maltodextrin* in solution extract increased. *D. Salina*-capsulated protein content was 0.407 percent (5%), 0.219 percent(10%), 0183 percent (20%), 0.024 percent (30%).

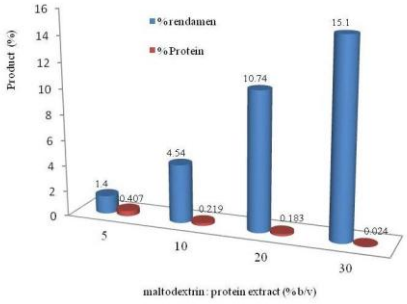


Fig 2. Encapsulated extract rendament and protein content

3.3 Application of capsulized protein in sago starch products

The measurement of protein in fortified phytoplankton extracts is presented in table 2 and figure 3.

Table 2 Protein content in fortified sago starch products

Protein : Sago (%b/b)	Protein (mg/g)
5	0.98
10	1.6
20	3.87
30	9.19

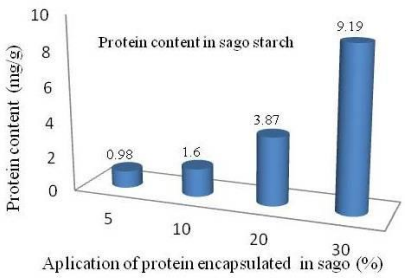
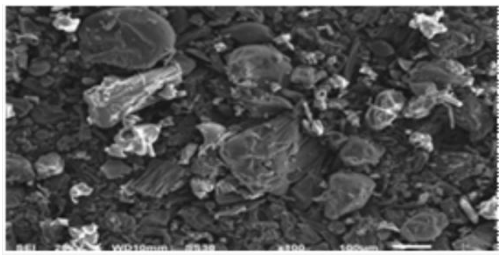


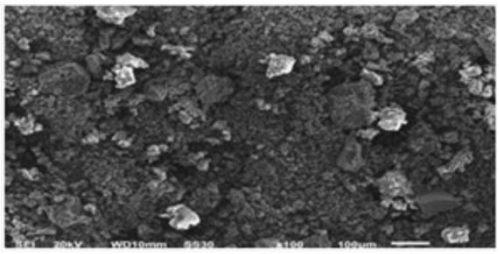
Fig 3 Protein content in fortified sago starch products

The results of protein measurement in fortified sago starch products (Table 2 and Figure 3) illustrates that the higher/more *maltodextrin*-capsulized-protein extract of phytoplankton is applied to sago starch caused to the higher protein. The highest protein content in sago starch added with capsulized protein extract was 30%, and the value of the protein content was 9.19mg/g

Figure 4a and 4b illustrate the measurement of *maltodextrin* samples by scanning electron microscope (SEM) (a) and sample of capsulized protein (b). Picture 4a, *maltodextrin* before capsulized seemed to have large-sized particles, less solid, and shapeless compared with figure b. This indicates that the protein extract of phytoplankton was coated/encapsulated perfectly by *biopolymers maltodextrin*.



(a) SEM *maltodextrin* before capsulized



(b) SEM capsulized protein extract

Fig 4. SEM analysis of a)*Maltodextrin* before encapsulized,(b) Protein extract after capsulized

4. Conclusion

From this research, it can be concluded that protein extract of *D. Salina* can be encapsulated by *maltodextrin*. The highest content of protein extract after encapsulation was 0.407 percent in rendament 1.4 percent. The highest protein content of sago starch after fortified with 30% phytoplankton protein was encapsulated 9.19 mg /g.

5. Acknowledgement

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