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Potential of L-fucose isolated from Brown Seaweeds as Promising Natural Emulsifier compare to Carboxymethyl Cellulose (CMC)

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Abstract. L-fucose has been understood as sulfated polysaccharides and it could be extracted and fractionated from brown algae. These polysaccharides contains carbohydrate, sulfate, and protein that may be used as emulsifier. This research was aimed to study the emulsification properties of L-fucose through the determination of total dissolved solids (TDS), color CIE L*a*b* and stability of oil-in-water emulsion. As much as 0.5% of high concentrated L-fucose and 0.5% of carboxymethyl cellulose (CMC) were used as emulsifier in a 10% (v/v) oil-in-water (O/W) emulsion. The emulsifier was added to O/W emulsions and then heated at 72°C. Result of stability emulsion and TDS showed that L-fucose was comparable to the CMC but remarkable changed the color of O/W emulsion. Heating process significantly reduced the stability O/W emulsion when L-fucose was applied. As conclusion, L-fucose might be used as natural emulsifier in O/W emulsion but in the low heat treatment of food processing. This study may provide valuable information for utilizing natural emulsifier from abundant resources from nature.

Keywords: L-fucose, CMC, O/W emulsion, natural emulsifier, total dissolved solid.

1. Introduction

Fucoidans, the family of sulfated heteropolysaccharides, built up essentially of α -1,3-L-fucose. Its constituted more than 40% of the component monosaccharaides and classified as sugars that present abundantly in brown algae [14]. From the previous study, brown seaweeds possess great potential in biomedical issued due to their bioactive component which generally composed of mannose, glucuronic acid and ¹⁴actose residues [6]. Recently reports have shown that these bioactive component use for multiple pharmacological activities such as anticancer, antitumor, antioxidant, anti-inflammatory,

anticoagulant and immune system boosting properties [15]. Considering to the benefits that is mostly exposed the functional properties, it will be interesting if this component was exposed base on their physical properties.

Oil-in-water (O/W) emulsions system are basically containing two immiscible liquids, one dispersed as droplet (oil) throughout the other (water). These defined by the volume ratio and the composition of oil and aqueous phase and the nature or synthetic emulsifiers. Its usually used in food industry to increase the retention and stability of active compounds. Generally, emulsions are prepared with surface active agents or amphiphilic polymers which decrease interfacial tension when absorbing at the O/W interface [10]. L-fucose which extracted from brown seaweed cell wall are potential sourced of soluble and insoluble dietary fibres. These compounds exhibits potential as water holding capacity and demonstrate the ability to increase viscosity, gels forming and act as emulsifier [7]. As the current demand of consumers prefer to healthy and natural food product, L-fucose has led as great potential of natural food additive. L-fucose are potentially used as natural emulsifier compare to carboxymethyl cellulose (CMC). These polysaccharides contains carbohydrate, sulfate, fats, fibres and protein that might be reacted easily with oil and other aqueous substance [13].

CMC is formed from cellulose after heating with alkali, and the mixture will react with monochloroacetic acid leading to an alteration of the glycopyranose by esterification the hydroxyl groups with methylcarboxyl groups [8]. Nowadays, CMC has widespread application due to its good properties in binding, thickening and stabilizing properties. These emulsifier is often chosen as active agent instead of other gum or other synthetic emulsifier such as Tween 80. In general, CMC has a linear structure composed of a backbone of β -1-4-glucopyranose that will holds insoluble microcrystalline cellulose in a network with other hydrocolloid component [2].

This study was examined the potential of using L-fucose as natural emulsifier in O/W emulsions. This was aimed to determine the emulsification properties of L-fucose through the determination of total dissolved solids (TDS), color CIE L*a*b* and stability of oil-in-water emulsion comparing with a synthetic (CMC) emulsifier to establish the influence of physical properties during heating and non-heating treatment.

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2. Materials and Methods

2.1. Chemicals and reagents

L-fucose was extracted from brown seaweed and harvested from Jepara beach, Central Java, Indonesia. Palm oil "Bimoli" was purchased from modern store in Semarang, Indonesia. Acetone (99%) was ordered from Jedang, Co. Ltd., Indonesia. Aquadest and Sodium Chloride powder was obtained from UPT Integrated Laboratory, Diponegoro University, Semarang, Indonesia.

11. Extraction of Brown Seaweed

The isolation and separation of water-soluble polysaccharides were carried out using the method from previous researcher [14] with some modifications. The brown seaweeds were stored in laboratory and dried at 50°C under slow air circulation in oven, ground using a grinder and incubated with acetone to eliminate lipids and pigments. About 50 g of powdered algae was suspended with five volumes of 0.25 M NaCl and pH was adjusted to 8.0 with 1 M NaOH. Acetone enzyme was added as much as 1 g and let them for 24 h. After incubation for 24 h at 60°C, the mixture was filtered through Whatman No.1 and precipitated with increasing amounts of ice-cold acetone (600 ml) under gentle agitation. Precipitates formed were collected by centrifugation at 10,000 rpm for 10 min and dried under freeze condition.

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2.3. Preparation of Oil-in-Water Emulsions

The sample was prepared in tube using 0.5% L-fucose and 0.5% carboxymethyl cellulose (CMC) into different formulas using a ratio of 1:10 (v/v) for emulsifiers and palm oil. Water-soluble (O/W) liquid emulsion was prepared with 5% palm oil and 0.5% natural emulsifier of L-fucose or a synthetic emulsifier of CMC. The mixture then was added with aquadest into the maximum volume of 15 ml. The emulsion was heated at 72°C and unheated. The final mixture then was shaken using vortex that was set to 1000rpm for 1 min. The sample mixture were labelled as fucan+water+oil and CMC+water+oil for the mixture with the addition of L-fucose and CMC, respectively. The mark "H" was used to determine the heating treatment.

2.4. TDS (Total Dissolved Solids) measurement

The total dissolved solids was examined with 8200 (Ezdo, Indonesia) instrument. Firstly, calibrations the instrument was done using standard solution 1413 $\mu\text{S}/\text{cm}$. The solution was stirred gently and let them until the display showed stable then press call for 3 sec. and flashing with 1413 $\mu\text{S}/\text{cm}$. The instrument was ready to use by dipping the cell into the sample solution and data were taken for 3 times then was calculated the average \pm SD.

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2.5. Colour analysis measurement

The appearance of solution colour was measured using a Digital Color Meter that was done previously [12]. The instrument was calibrated on the CIE LAB color space system using a white tile (Dc: $L=97.79$, $a=-0.11$, $b=2.69$). The L^* value represents lightness and a^* and b^* values represents redness and yellowness, respectively. Colour measurements of O/W emulsions using CMC and L-fucose were recorded base on heating treatment.

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2.6. Stability of Oil-in-Water Emulsions.

Stability of oil-in-water emulsions was measured with micrometre screw. After centrifugation, the precipitation of emulsion sample was measured to obtain the thickness of separated upper part of emulsion.

3. Result and Discussion

3.1. Total Dissolved Solids

Total dissolved solids analysis using 8200 (Ezdo, Indonesia) was measured 3 times and the average calculation used as the data. The result indicates that TDS in O/W emulsion with CMC without heating treatment was less than L-fucose (Fig. 1). Those might be influenced by the characteristic of CMC to improve water solubility and it will maximumly be happened by heating the cellulose with alkali [8]. This statement was in agreement with the study of other researcher [5] that the solids of matrix from CMC would dissolve in hot water resulting a good heat barrier even at low concentration. The best result of heating treatment was emulsion with CMC as emulsifier as shown in Figure 1 that CMC resulted TDS higher than L-fucose when heating was applied. This indicated that CMC was work well in hot water rather than fucose. It might be explained because hydrocolloids from brown seaweed were generally acted as physical functions in stabilizing emulsions, viscose behaviour, gelation, suspension and foams, and control of crystal growth and all characteristics would give adverse effects during heating [4].

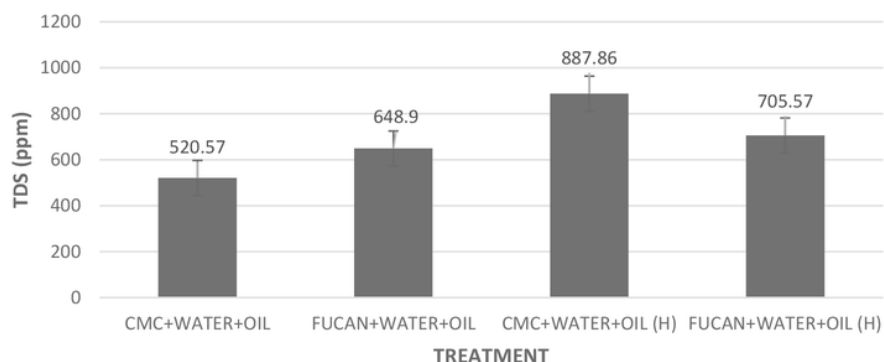


Figure 1. Total dissolved solution of O/W emulsions with 0.5% L-fucose or 0.5% of CMC that was prepared with heating and non-heating treatment. The label “H” at the sample means heated sample.

3.2. Colour Analysis

The Lab color model consists of three components (lightness or L*) starting from 0 (black) to 100 (white) and component **a*** represents the red-green level with the level (+60 red, -60 green) and component b* represents blue to yellow that are two chromatic components with a range of values from -120 to +120 [11]. The emulsion with heat treatment was applied at 72°C. The heated and non-heated sample were done to determine the effect of heating on the Lab color model. The results show remarkable changes in L-fucose color before and after heating. This resulted that by heating treatment, the color of L-fucose was more clear and closed to CMC (Fig. 2). Heat treatment would naturally degrade colour of L-fucose by destroying the glycosidic bonds. While some previous study reported that the extraction of brown seaweeds usually happened in low temperature to keep their bioactive component and the colour turned up into dark resulting the problem during the application of L-fucose. But after heating treatment, lightness of L-fucose was almost same value as CMC. This suggests that L-fucose was potentially used as additive in food as a natural emulsifier without changing colour. This is in line with statements other researcher [3] which suggest that the lightness was important factor in oil-in-water emulsions to show better results when high temperatures was applied, suggesting the possible application in pasteurization process.

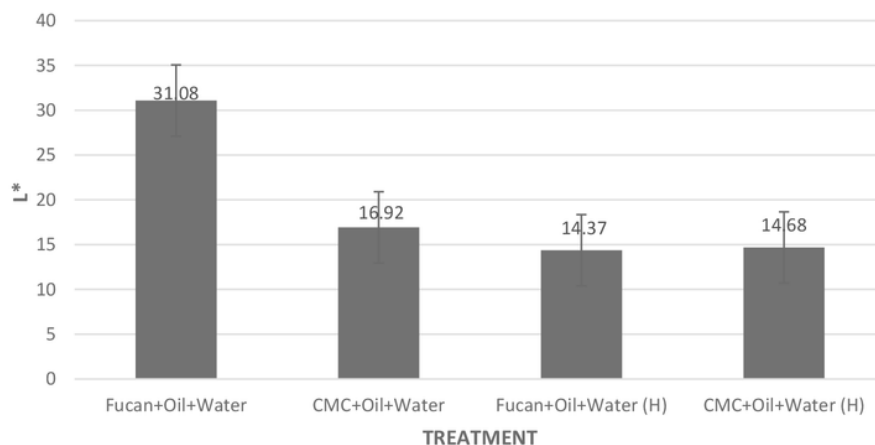


Figure 2. Lightness of O/W emulsions with 0.5% L-fucose or 0.5% of CMC prepared with heating and non-heating treatment. The label “H” at the sample means heated sample.

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3.3. Stability of Oil-in-Water Emulsions

In the emulsion, the separation of emulsion may appear as a time of storage. Figure 3 showed the separation in upper part of emulsion. In the sample with unheated treatment, CMC remained 0.2 mm while L-fucose remained 0.23 mm in upper part. In the heated treatment, CMC remained 0.089 mm while L-fucose remained 0.114 mm. The separation of emulsion may be explained by the natural appearance of oil in a water. The stability of emulsion with CMC and L-fucose were comparable indicating the potent use as emulsifier of L-fucose. The speed of stirring may also affect the stability of emulsion. The increase in stability of emulsion might be achieved with higher stirring speed since the stirring was able to decrease particle size leading to an increase in the interfacial surface. Hence, utilization of high stirring intensity could stabilize the system [9]. The increasing of temperature often accelerates emulsion breaking [1] resulting the high stability of emulsion.

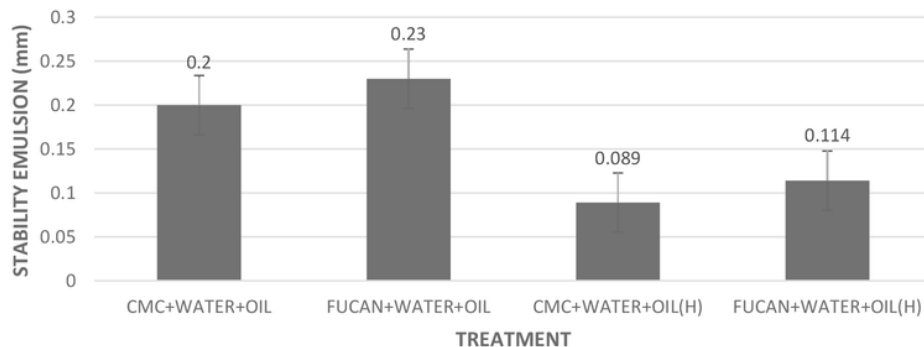


Figure 3. Stability of O/W emulsions with 0.5% L-fucose or 0.5% of CMC prepared with heating and non-heating treatment. The label “H” at the sample means heated sample.

4. Conclusion

The result of stability emulsion, TDS, and lightness showed that L-fucose was comparable to the CMC. Heating process might reduce the stability O/W emulsion with L-fucose. Thus, L-fucose might be used as natural emulsifier in O/W emulsion. This study may provide valuable information for utilizing natural emulsifier from abundant resources from nature.

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