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Replacement of gum arabic by dry *Spirullina* sp. biomass as a food emulsifier in bread making

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Abstract. Bread is one of the most consumed foods worldwide. Bread with a fine texture is desired by the food industry to meet customer's satisfaction. Food emulsifier plays important role in making bread with fine texture, where Gum Arabic is one of natural food emulsifiers used by many in the food industry, although it is limited in availability and triggers some adverse effects on health. This research study aims to replace the use of Gum Arabic by dry *Spirullina* sp. biomass. The emulsifier was incorporated at a proportion of 2% (w/w) of the total used wheat flour, with the inclusion containing both gum Arabic and dry *Spirullina* sp. biomass. The ratios of (gum Arabic: dry *Spirullina* sp. biomass) of 2:0; 1.5:0.5; 1:1; 1.5:0.5; 0:2 were coded as A, B, C, D, E respectively and the study used a completely randomized design. This research revealed that the dry *Spirullina* sp. biomass replacement of Gum Arabic can reduce springiness, moisture content and the customer preference of produced bread where treatment B produced bread which was the most similar to the control (A).

1. Introduction

During the globalization era, food utilization pays attention to the industries and researchers involved in both developed and developing countries. This is because food stock with appropriate functionalities must be stable in sustaining people's lives. People nowadays require food with desirable nutrition content that is safe to consume.

Bread is one of staple food in some countries; Indonesia is one of countries with a high level of bread consumption, as proven by the World Bank's report which demonstrates that the average amount of money used to consume bread per household in Indonesia was IDR. 8.500.000, - (USD. 935) in 2010. This means that bread companies are being challenged to produce desirable bread to compete in the food market. Companies are now developing bread with high palatability, which is determined by the performance, taste and texture. Texture is one of the crucial variables affecting the customer's preferences; it can be profiled by determining the value of hardness and gumminess, where fine texture are obtained from high springiness and low hardness [1].

In order to gain bread with a fine texture, the ingredients are highly determining, where the use of an emulsifier is highly crucial. Gum Arabic is the most used emulsifier. It is a food hydrocolloid, increasing water absorption and emulsifying as well as stabilizing the formed emulsion [1]. Unfortunately, Gum Arabic is imported, pricey and can trigger some side effects such as an unfavorable viscous sensation in the mouth, early morning nausea, mild diarrhea and a bloating abdomen [2]. Therefore, a replacement for Gum Arabic is highly desirable.



Dry *Spirullina* sp. biomass is a freshwater microalgae with a high protein content that has been commercialized by some biotechnology industries because it is fast-growing and it is easy to cultivate and process into dry matter. It was proven by a prior study that the biomass is capable of forming an oil-water emulsion because it contains the phycosianin protein (*pigment protein*) which is able to reduce the interfacial tension of an aqueous/air interface [3]. Therefore, the aim of this study was to determine the effect of replacing Gum Arabic with dry Spirulina biomass and the impact on the physicochemical properties of bread.

2. Materials and methods

2.1 Bread preparation

The bread was prepared according to what was stated by Mojiono [4] with minor modifications. The dough was made by mixing wheat flour (Bogasari, Indonesia) with protein, salt, sugar, baker's yeast and skimmed milk with the respective amounts of 400g, 1g, 20g, 6g and 8g. The emulsifier was then incorporated at a proportion of 2.00% (w/w) of the total amount of wheat flour. Furthermore, 200ml water was added. It was then mixed slowly, kneaded and then 16g of batter (Blueband, Indonesia) was incorporated. The dough was then incubated, shaped and heated at 180°C for 15 minutes.

2.2 Moisture content

The moisture content was determined by the referenced method of AOAC (2007). The analysis was carried out in triplicate.

2.3 Springiness test

Springiness was measured using a Texture Analyzer TA-XT2i with a cylindrical probe with a diameter of 35R. This test was carried out in triplicate.

2.4 Hedonic test

A total of 30 panelists were engaged to evaluate the bread's color, texture, aroma and taste, where each attribute was ranged to 1-5. The bread was coded and randomly served to the panelist.

2.5 Experimental design

The ratio of Gum Arabic to dry *Spirullina* sp biomass with a total of 2% was designed by using a completely randomized design with the following information:

A = Gum Arabic: dry Spirulina biomass = 2:0

B = Gum Arabic: dry Spirulina biomass = 1.5:0.5

C = Gum Arabic: dry Spirulina biomass = 1:1

D = Gum Arabic: dry Spirulina biomass = 0.5:1.5

E = Gum Arabic: dry Spirulina biomass = 0:2

The moisture content and springiness data was analyzed using Analysis of Variance, followed by Duncan's test. The hedonic test data was analyzed using a non-parametric test created by Kruskal-Wallis. All of the statistical analyses were carried out by using statistical software SPSS 16.00.

3. Results and discussion

Table 1 showed that the replacement of Gum Arabic with *Spirullina* sp. biomass tended to reduce the moisture content of the bread and its springiness. In contrast with Gum Arabic, *Spirullina* sp. biomass could not retain the amount of water within the ingredients. Consequently, the bread's hardness increased and the springiness reduced. Springiness is related to aeration and the elasticity of the bread; high values are desired [5]. Indeed, a prior study carried out by Chronakis [6] on food gel demonstrated that the thermodynamic incompatibility happens while cooking within the micro algal protein and other components, causing the gels' rheological parameters to reduce [6]. Figure 1 shows that the replacement of Gum Arabic with the *Spirullina* sp. biomass also reduced the customer's

preference. According to the results of this study, the researcher suggests doing further work on the use of a protein extracted from microalgae. This is because the protein extracted from microalgae is capable of being an emulsifier well [7, 8].

Table 1. Physicochemical properties of the bread incorporated with the *Spirulina* sp. biomass

Treatment	Moisture content (%)	Springiness (gf)
A	34,33 ^a ± 0,10000	0,7473 ^a ± 0,0049695
B	32,74 ^{ab} ± 0,18257	0,6866 ^{ab} ± 0,0118708
C	33,14 ^{ab} ± 0,20000	0,5966 ^c ± 0,0361596
D	33,26 ^{ab} ± 0,17078	0,6810 ^{ab} ± 0,0165048
E	31,91 ^b ± 0,15000	0,6331 ^{bc} ± 0,0331365

A =Gum Arabic: dry *Spirulina* biomass = 2:0; B= Gum Arabic: dry *Spirulina* biomass = 1.5:0.5; C= Gum Arabic: dry *Spirulina* biomass = 1:1; D= Gum Arabic: dry *Spirulina* biomass = 0.5:1.5; E= gum Arabic: dry *Spirulina* biomass = 0:2

Data expressed as the mean (n: 3) ± SD

Different superscripts show differences within the treatment

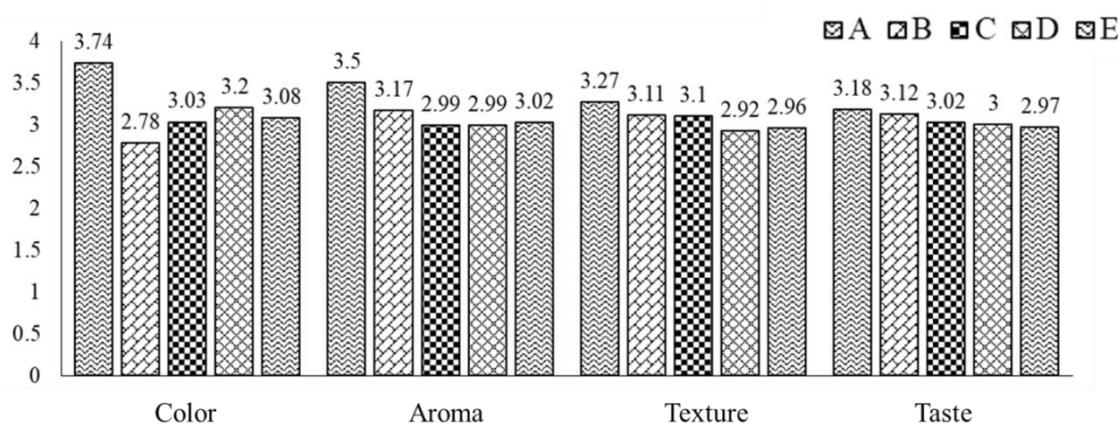


Figure 1. The result of hedonic test

4. Conclusion

The replacement of Gum Arabic with dry *Spirulina* sp. biomass reduced the moisture content and springiness as well as the customer's preference. This study suggests the use of a protein extracted from *Sprullina* sp., instead of the use of the whole cell.

5. References

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