Improvement the Yoghurt Nutritional Value, Organoleptic Properties and Preferences by Spirulina (*Spirulina platensis*) Supplementation

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Abstract Spirulina sp has been identified as potential source food functional such as protein, amino acids and other high added value compounds from microalgae. One of the compounds is phycocyanin as also known for antioxidant use. This research was aimed to increase the nutritional value and organoleptic properties and preferences yoghurt by *Spirulina platensis* supplementation. Completely randomized controlled group design conducted by 31 respondents. Spirulina Research accomplished in Food Technology, Microbiology and Chemistry Laboratory at Bandung Health Polytechnic in Bandung. Samples divided randomly into three groups: (1) yoghurt standard supplemented 50 ml, (2) yoghurt and spirulina 1% supplemented 50 ml, (3) yoghurt and spirulina 1.2% supplemented 50 ml. Spirulina was added concentration by 0, 1, 1.2% calculated by dx trial. Proximate analysis revealed the highest protein in enriched by spirulina 1%. However fat was lower 3.48 – 3.56 compare to control. All products found growing Lactobacillus acidophilus with a pH of 4.0 range. There was no microbial contamination such as E coli, Salmonella sp, Pseudomonas sp. Supplementation of spirulina to yoghurt products can be accepted by organoleptic, chemical and microbiological tests of concentrations of 1 and 1.2%. The material makes the blue colours more attractive and can be accepted by the expert panellist.

Introduction

Nowadays there is a tendency of people consume the foodour beverages, it's not only judged by nutritional content and delicious but also consider the influence of these foods on the health of the body is called functional properties [1].
The development of the current dimension of the disease tends toward degenerative diseases, where the main trigger is free radical involvement and poor eating behaviour. The presence of free radicals can damage the integrity of cells in the body and decrease the body's antioxidant status. Functional utilization becomes an alternative to avoid the substance.

One food that has a functional substance is *Spirulina platensis*. *Spirulina platensis* application is usually for food colouring, because of its phycocyanin content. The study has found the presence of antioxidant and anti-inflammatory properties of phycocyanin\(^2\) the stability of phycocyanin extract \(^2\)\(^-\)\(^4\). *Spirulina platensis* can be used for the production of functional foods because its bioactive compounds increase the nutritional value. However, some of the *Spirulina platensis* bioactive compounds are heat sensitive, so processing techniques need to be considered strictly. Spirulina contains chlorophyll and carotenoids as well as phenolic compounds and flavonoids as natural substances\(^5\). *Spirulina platensis* in powder form contains phenolic compounds and potential flavonoids. Beta-carotene in *Spirulina platensis* is one of the antioxidants neutralize free radical substances in the human body. Beta-carotene is one of the simplest forms of carotenoids with the molecular formula C\(_{40}\) H\(_{56}\)\(^6\)\(^,\)\(^7\). *Spirulina platensis* is one of the microalgae used by people living around water reservoirs, or water with high salt concentrations. Spirulina plants harvested from seawater have a higher mineral content than from freshwater and brackish water areas. Seawater contains high salt such as NaCl, KCl, MgCl. Spirulina processed on salted medium also contains phycocyanin, polysaccharide, inositol higher than fresh water.

Technical fermentation technology can be defined as an anaerobic or partial anaerobic carbohydrate oxidation process that produces alcohol and some acids. The result of fermentation is obtained as a result of metabolism of microbes in a food substance in an anaerobic state. Microbes that perform fermentation require energy generally obtained from glucose \(^9\). Food processing by fermentation process is a preservation method that depends on the production of certain microorganisms, chemical and physical changes that alter the original body shape and flavour of the foodstuff. These changes can improve the nutrients of the product and generally inhibit the growth of microorganisms which is not desirable. One of the fermented products is fermented milk.

Yoghurt is a dairy product that is pasteurized, fermented with bacteria mixture of *Lactobacillus bulgaricus* and *Streptococcus thermophilus*, or *Lactobacillus acidophilus* that can break down the milk sugar (lactose) into lactic acid \(^10\) to obtain the acidity, smell, and taste Which is typical \(^11\). The use of *Streptococcus thermophilus* as starter culture is its ability to ferment lactose and lowers the pH of the product quickly \(^12\), while *L. bulgaricus* is an important characteristic in yoghurt that stimulates the growth of *Streptococcus thermophilus*, also produces exopolysaccaride Which improves the texture and rheology of fermented milk products \(^12\). Some factors that may affect the fermentation process is the influence of nutrients, temperature, water activity, pH, and oxygen.

Yoghurt has the advantage of being proven to lose weight, low cholesterol, and blood sugar levels. Milk has a high enough antioxidant and 10 times ascorbic acid (vitamin C) \(^13\). Previous research Milk fermented into low-symbiotic yoghurt cholesterol \(^14\).

This study aimed to observe the implementation of *Spirulina platensis* powder into different yoghurt products *Spirulina platensis* which the application is at a relatively low temperature to protect the bioactive compounds of Amage. According to Agustini et al., the nutritional value of fresh *Spirulina platensis* has a significant difference compared with that of *Spirulina platensis* dry \(^15\). In addition, here is very different quantitatively for its bioactive compounds. The maximum concentration of *Spirulina platensis* that can be added to the product is determined, thus, will be accepted for consumption. Protein content and fat content were analyzed for both products.\(^16,\)\(^17\) The water content, the Ash content, and the β-carotene analysis are performed gently. Based on this research, this research was aimed to increase the nutritional value and organoleptic properties and preferences yoghurt by *Spirulina platensis* supplementation.
Material and Methods

This study used an experimental design of Completely Randomized Design with three replicates for each treatment\(^{[18]}\). Research subjects 31 panels of organoleptic test experts who are in the Health Polytechnic Bandung, Ministry of Health, Department of Nutrition Bandung. The research was conducted in several stages: (1) first step to get the most appropriate spirulina concentration, this activity was done with the aid of DX Trial software. This tool helps choose the most appropriate concentration of spirulina. In the selection test the concentration of *Spirulina platensis* was 0.5, 0.7, 0.9, 1.0\(^{[23]}\), 1.2.

The experimental results obtained that are organoleptically feasible are concentrations 1.0, 1.2. (2) The test was continued to measure the parameters of organoleptic properties\(^{[19]}\), (3) stage performed to measure parameters of proximate analysis including Protein, Fat, Minerals, and pH. Yoghurt is made from milk fermented with a commercial inoculum of Lactobacillus acidophilus. Samples divided randomly into three groups: (1) yoghurt standard supplemented 50 ml, (2) yoghurt and spirulina 1% supplemented 50 ml, (3) yoghurt and spirulina 1.2% supplemented 50 ml. Creating *Spirulina platensis* yoghurt, prepare milk, pour it into a saucepan and boil at a temperature of about 70°C by letting the pot open. Add spirulina as percentage that has been designed (1.0, 1.2%). Add 8% sugar, spirulina, and boiling lasts 15 minutes while stirring for whole cream milk not burnt. Finish boiling milk juice cooled to 45°C. Prepare a stater in the form of culture of Lactobacillus acidophilus bacteria as much as 5%. Dairy milk with a temperature of 42°C was inoculated with the stater. Stater mixing with milk should be evenly distributed and done cleanly so as not to be contaminated by other bacteria. Store a mixture of milk and stater juice in an incubator at 42°C. Duration of curing is 6 - 8 hours. Incubation is considered sufficient when the presence of thickened coagulation of milk, slowly pH 4 - 4.5 and forming yoghurt. Test data characteristic of yoghurt probiotic microorganism was measured by Total Plate Count (TPC) method, microbial contamination, total amount of probiotics. Statistical analysis presented bivariate (Wilcoxon, Pairs t-test), bivariate (Kruskal Wallis, Anova / Post Hoc Duncan Multi Range Test, multivariate Anacova with significance level <0.05.

Results

1. Organoleptic Test

The organoleptic test of 31 trained panellists consisting The Bandung Health Polytechnics Department of Nutrition to provide hedonic quality assessment of colour, aroma, taste, and consistency. The picture of the level of acceptance is done by organoleptic test which includes colour parameters, taste, aroma, and consistency. The results showed on the table as mentioned below.

| Parameters   | Concentration of *S. platensis* powder (5w/w) | p   |
|--------------|-----------------------------------------------|-----|
|              | 0                                             | 1.0 | 1.2 |       |
| Colour       | 4.80 ± 0.913                                  | 5.96 ± 0.730 | 6.0 ± 0.957 | 0.001 |
| Taste        | 4.40 ± 1.258                                  | 5.0 ± 1.258 | 5.40 ± 1.155 | 0.018 |
| Aroma        | 5.08 ± 1.37                                   | 5.36 ± 0.907 | 5.52 ± 0.770 | 0.275 |
| Consistency  | 3.76 ± 1.615                                  | 5.52 ± 1.005 | 5.40 ± 0.913 | 0.001 |

Significance, p<0.05

The results of organoleptic test showed that there was a significant difference in the colour (p <0.001). Different turning products were white control group (4.80 ± 0.913), while the most preferred product group colour was 1.2% spirulina addition group. However the product formula was 1.0 (5.96 ± 0.730), and 1, 2% (6.0 ± 0.957) did not differ significantly.

The result of organoleptic test showed that there was a significant difference to taste (p <0.018). The differentiated product flavours were 1.2% (5.40 ± 1.155), whereas most preferred was the 1.2% spirulina addition group compared with controls (4.40 ± 1.258) and 1% spirulina (5.0 ± 1.258).
The results of the organoleptic test show that there is no difference between the three formulas; Control group (5.08 ± 1.37), spirulina group 1% (5.36 ± 0.907) and 1.2% spirulina group (5.52 ± 0.770) significantly to the aroma (p > 0.275), so it can be said Panellists favor the fragrance of the product even when spirulina is added.

The results of organoleptic test showed that there was a significant difference to consistency (p < 0.001). Consistency of different turning products was the control group (3.76 ± 1.615), while most preferred was the 1.0% spirulina addition group (5.52 ± 1.005) and the 1.2% (5.40 ± 0.913) group of products Conditions are not significantly different.

2. **Proximate Analysis**
The result of proximate analysis obtained the data as follows; protein content showed results in the range 10.13 - 10.35, the biggest result was group with addition of 1.0% (10.30 gr). Fat content decreased 3.46 - 4.45. The lowest fat content was at a concentration of 1.2% of 3.48, and the highest was 4.45 in the control group. Mineral showed in the range of 2.21 - 2.34, the lowest group of 2.21 in the control group, while the increased spirulina content also affected the mineral content, as evidenced by the 1.2% group. Based on observations pH levels are in acidic conditions (pH 4.0).

![Proximate Analysis Graph](Graph 1)

**Graph 1.** Proximate analysis of Yoghurt with addition of *Spirulina platensis* powder

3. **Microbiological Analysis**
Microbiological analysis was performed on total plate number parameter (TPCN) obtained the result as follows.

| No | Parameters / Groups          | Results     |
|----|------------------------------|-------------|
| 1  | Total Plate Count            |             |
|    | Control                      | > 10<sup>4</sup> |
|    | Spirulina 1,0% Group         | 6.69 X 10<sup>4</sup> |
|    | Spirulina 1,2% Group         | > 10<sup>4</sup> |
| 2  | MPN Coliform                 |             |
|    | Control                      | 0 MPN/100 mL |
|    | Spirulina 1,0% Group         | 0 MPN/100 mL |
|    | Spirulina 1,2% Group         | 0 MPN/100 mL |
| 3  | Microorganism Contamination  |             |
|    | a. *Escherichia coli*        | Negative    |
|    | b. Salmonella sp.            | Negative    |
|    | c. Pseudomonas sp.           | Negative    |
Based on the observation and analysis of types of microbes with the help of ManRogosa Agar (MRSA) Media grown in the yoghurt is Lactobacillus acidophilus.

**Discussion**

Organoleptic properties are also called subjective traits of Food our sensory properties because of measurement using organs of the human senses, sometimes also called the sensory nature because the assessment is based on sensory stimulation of the sense organs. Organoleptic properties are the most decisive factor in determining the level of consumer preference because it can be done quickly and directly. The test of organoleptic properties includes tests on colour, taste, aroma, and consistency. \(^{[19]}\)

The colour attribute involves the physical and psychological phenomena of perception by the visual system caused by the presence of light in the visible wave range. In the colour notation system, the colour assessment includes three attributes: the chromatic colour (the type of colour actually seen visually) called hue, value or brightness indicating the achromatic colour parameter and the sharpness or intensity of the colour called chroma purity or saturation. \(^{[19, 22]}\)

Colour uniformity is also an important parameter of appearance. Damage and degradation of food product quality are often indicated by the change of colour. \(^{[19, 22]}\) The smell or smell of food much determines the delicacy of these foods. In case the smell is more related to the five sense sensors. In general, the smell received by the nose and the brain is more a variety of herbs or a mixture of four major odours are fragrant, sour, rancid and charred. For the food industry, the assessment using the odour test is very important because it quickly gives the results of the assessment of a preferred product or not. \(^{[19, 20, 22]}\) Taste is a mixture of tastes, smells and touches that are combined with other impressions such as sight, touch, and hearing. Pain involves the taste senses of the tongue. Speech sensation can be grouped into four main ingredients, namely acid, salty, sweet and bitter. \(^{[20]}\)

Consistency or texture is a sensation of pressure that can be observed by mouth (when bitten, chewed and swallowed) or touch with the fingers. The boundaries of tactile nature are closely related to the type of material being observed, so it is very difficult to draw conclusions or to provide general restrictions. \(^{[21]}\)

Based on the proximate analysis such as of protein content showed results in the range 10.13 - 10.35, the largest result was the group with the addition of 1.0% (10.30 gr). In addition, fat content decreased 3.46 - 4.45. The lowest fat content was at a concentration of 1.2% of 3.48, and the highest was 4.45 by the control group. Mineral showed in the range of 2.21 - 2.34, the lowest group of 2.21 in the control group, while the increased spirulina content also affected the mineral content, as evidenced by the 1.2% group. Those result fat, ash content were closely other research product in spirulina.\(^{[23]}\) Based on observations pH levels are in acidic conditions (pH 4.0). The results of Judiono study on the potential of probiotics as anti-diabetic and the results significantly affected the decrease of blood fasting glucose and postprandial blood glucose, HbA1c, increase c-peptide and insulin\(^{[24]}\) proinflammatory cytokines such as IL\(_1\), IL\(_6\) and lipid peroxidation (MDA) and increase endogen antioxidants (SOD, Catalase, GPx) anti-proliferative cytokines IL\(_10\) and pancreatic beta cell function.\(^{[25]}\)

Analysis of probiotic levels in general spirulina yoghurt products is at a level of more than \(10^5\), with a degree of acidity ranging from 4.0.

**Conclusions**

Supplementation of spirulina to yoghurt products can be accepted by organoleptic, chemical and microbiological tests of concentrations of 1 and 1.2%. The material makes the blue colours more attractive and can be accepted by expert panellist. The result of organoleptic test on the colour, flavour, and consistency expected in the manufacture of spirulina yoghurt is at concentration of 1.2%, the aroma expected in the manufacture of spirulina yoghurt is equal to the control means there is no significant difference. Protein content in the highest 1% group of 10.30 gr, fat content with increased spirulina showed a low decrease. Microbial contamination was not found to be very good. It is recommended that the addition of concentrations of 1.0 and 1.2% is very potential and excellent in the yoghurt industry.
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