Physicochemical and Microbiological Characteristics of Fermented Synbiotic Milk Enriched with Inulin at Room Temperature as Functional Drinking Products

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Abstract. Fermentation of milk products has been widely known to offer various health benefits to human. In this research, we observe the physicochemical and microbiological characteristics of fermented milk fortified with inulin. The observed physicochemical characteristics include color, emulsion stability and activity, while the observed microbiological characteristics include total lactic acid content and total lactic acid bacteria. The fermented milk was divided into two groups, which were fermented milk with 2\% inulin fortification (K\(_1\)), and without inulin fortification (K\(_0\)) as the control. All of the data were then analyzed with ANOVA. This research concludes that 2\% inulin fortification can improve the physical characteristics of synbiotic fermented milk at room temperature which was needed to support consumer acceptability of the functional drinking product.

1. Introduction
Fermented milk is a functional food product that contains several food components, has a dietary function, contains an active biological component and is beneficial for improving health. During the fermentation process of milk with lactic acid bacteria, bioactive peptides which have biological activity will be produced. Fortification with prebiotics in the formulation of fermented milk to produce synbiotic fermented milk, stimulates the growth of beneficial bacteria in the intestine as a source of carbon [1]. Inulin is an indigestible carbohydrate, naturally containing fructooligosaccharides, as a food fiber and used as a food additive because of its prebiotic properties [2].

Inulin is known as a low-calorie sweetener, in the form of white powder, odorless, tasteless and very easily combined with other ingredients without affecting the flavor [3]. The addition of inulin in synbiotic fermented milk has a positive effect on rheology and product stability, can improve physical and organoleptic quality and prevent phase separation. Salem et al. [4] explained that the fermentation of symbiotic milk fortified with inulin would increase its total lactic acid, while also stimulate the growth of the probiotics. Fiber-fortified food products such as inulin for dietary purposes have become the choice of most consumers who are aware of healthy living, but are demanding food with the desired reception and taste, low fat and low calorie levels [1].
2. Materials and methods

2.1. Materials
The materials in this research were skim milk powder, inulin (CV. Gamma Scientific Biolab), standard yoghurt starter culture (Lactobacillus bulgaricus FNCC-0041 and Streptococcus thermophilus FNCC-0040 from the Center for Food and Nutrition Studies, Gajah Mada University) with a ratio of 1:1 (v/v).

2.2. Methods
The research was conducted with a completely randomized design consisted of two treatments, which were fermented synbiotic milk with 2% inulin fortification (K₁) and without fortification (K₀). The physicochemical properties were evaluated by measuring the emulsion stability [5], emulsion activity [6] and color (L*, a*, b*) by using a colorimeter [7] at room temperature. The observed microbiological characteristics include total lactic acid content and total lactic acid bacteria by following [8]. The data were statistically analyzed by using analysis of variance (ANOVA).

3. Result and discussion
Inulin as a stabilizer in the fermented milk product stabilizes the bond of inulin with casein, and some water becomes immobilised in the matrix that protect physical stability [1, 9]. Fortification of 2-3% inulin increases the stability of the emulsion because the reaction between proteins results in emulsifying properties in the yogurt emulsion system [10]. Possible interactions between casein proteins and inulin include hydrogen bonds and hydrophobic interactions [11].

Increasing the amount of inulin bring about greater emulsion activity [11]. Addition of Inulin with a decrease in pH gives increased emulsion activity. Casein without modification has a lower emulsion activity index and casein which experiences cross-link increases 10% of its emulsification activity [12].

Table 1. Physicochemical characteristics of symbiotic fermented milk

| Treatment | Emulsion stability (%) | Emulsion activity (m2/g) | L*     | a*     | b*     |
|-----------|------------------------|--------------------------|--------|--------|--------|
| K₀        | 74.96ᵇ                 | 1.98                     | 43.88ᵇ | 11.43  | 8.68ᵇ  |
| K₁        | 82.44ᵇ                 | 2.45                     | 66.13ᵇ | 11.49  | 13.76ᵇ |

Superscript xy in the same column indicated significantly different in the treatment (P <0.05)

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Table 2. Microbiological characteristics of the fermented symbiotic milk

| Treatments | Total lactic acid (%) | Total lactic acid bacteria (log cfu/ml) |
|------------|-----------------------|----------------------------------------|
| K₀         | 0.13                  | 9.02ᵃ                                  |
| K₁         | 0.26                  | 9.21ᵇ                                  |

Different superscripts in the same column indicate highly significant difference in the treatment (P <0.01)

Color plays an important role in food acceptability and becomes an important factor that influences consumer acceptance. In the fermented milk fortified with inulin, the addition of inulin result in brighter color (L*, color become whiter). Skim milk as raw material contains casein with white color and the addition of inulin increases the tendency of the L* color to go whiter. The inulin molecule interacts with casein micelles together with fat globules responsible for the diffusion of light so that it results in a higher L* value from the matrix [13]. The a* value and the b* value tend to increase with increasing of
Inulin concentration which shows the intensity of the redness level. Addition of inulin to yogurt causes an increase in total solid content which increases the value of b* [14].

The inulin fortification in the fermented milk could suppress the fermentation time and increase the lactic acid production [15]. Research by Salem et al. [4] showed that the addition of inulin would improve the biomass growth, lactic acid activity, and probiotics starter viability. Oliveira et al. [16] added that inulin would act as prebiotics in the fermented symbiotic milk and stimulate the growth of probiotics and its metabolism. On the other hand, inulin would support the growth of probiotics during fermentation [17].

4. Conclusion
It was concluded that 2% inulin fortification can improve the physical characteristics of synbiotic fermented milk at room temperature which was needed to support consumer acceptability of the functional drinking product.

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