The effect of processing methods on the quality of soy milk

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Abstract. The obstacle in the manufacture of soy milk is the beany flavour that derives from the soybean. Various soy milk processing technologies are used to eliminate the beany flavour, including soaking soybeans before grinding, peeling the soybean skin, heating, and giving them flavor. The objectives of this study were 1) to determine the protein content of soy milk by various processing methods; 2) to determine the level of consumer preference for soy milk by several processing methods and flavor variants. The results showed that the processing method using soybean skin and without hot water soaking had the highest soy milk protein content of 2.38\%, while the lowest was in the processing method skinless soybean and hot water soaking of 1.73\%. Organoleptic assays for color, aroma, viscosity, and taste parameters ranged from normal to liking for all treatments. For the parameter of beany flavor in soy milk, the control sample had the highest level. Organoleptically, giving coffee and chocolate flavor variants are proven to reduce the level of the beany flavor of soy milk.

1. Introduction
Soybeans are food ingredients in the form of whole grains that are high in protein. Protein in soybeans reaches 35\%, and soybean varieties reach 40-43\% which is much higher than other legumes [1,2]. Soybeans also contain nutrients needed by the body, such as minerals, fiber and vitamins [3]. Soybean skin contains high fiber and protein, so soybean skin can be used as quality food products and have better economic value [4]. Soybeans are widely used as raw materials in the manufacture of tempeh, tofu, yogurt and soy milk because it contains many nutrients [5].

One of the processing of soybean seeds is soy milk. Soy milk is a highly nutritious drink because of its protein content equivalent to cow's milk and also contains carbohydrates, calcium and phosphorus [6]. The obstacle in the manufacture of soy milk is the beany taste due to the lipoxygenase enzyme in soybeans [7]. If the soy milk is made in a bad way, the soy milk produced has a beany smell that comes from the soy raw material used. Many factors affect the quality of soy milk, such as the soaking conditions of soybean seeds, storage and enzymes present in soybeans [8].

Various soy milk processing technologies are used to eliminate beany flavor, including soaking soybeans before grinding, peeling the soybean skin, heating and imparting the taste. Soaking soybeans are an important step in the manufacture of soy milk [9]. According to Ismayasari et al. (2014), one way to get rid of the beany flavor and bitter taste of soybeans is by heating [10]. Soaking soybean seeds in hot water at 70\textdegree C can deactivate lipoxygenase, which causes beany flavor in soybeans [11,12]. According to Santos (2009), the beany flavor of soy milk can be disguised by adding flavors such as vanilla, pandan, chocolate, mocha, and cinnamon [13].
Based on the description above, the research problem is formulated whether there is an effect of several processing methods on the quality of soy milk in terms of protein content and soy milk organoleptics. The objectives of this study were 1) to determine the protein content of soy milk by various processing methods; 2) determine the level of consumer preference for soy milk by several processing methods and flavor variants.

2. Material and methods

2.1. Materials
The raw materials used in this study were imported soybeans obtained from the Ciruas market, Serang-Banten. Other ingredients used are hot water, sugar, vanilla flavor, coffee and cocoa powder. The equipment used includes basins, pans, trays, stoves, and scales.

2.2. Procedure
The following is the procedure of making soymilk:

![Figure 1](image-url)

**Figure 1.** Flow diagram of the process of making soy milk by various processing methods.
2.3. Experimental design
The study was conducted using a completely randomized design (CRD) with 3 factors and 3 replications. The first treatment was soybean seed treatment consisting of 2 levels, namely skinless and with soybean skin. The second factor is soaking the soybean seeds, which consists of 2 levels, namely soaking using hot water and without soaking in hot water. The third factor is the use of 3 flavors consisting of 3 levels, namely vanilla, chocolate and coffee.

2.4. Observation parameters and data analysis
The parameters observed were the protein content of soy milk and organoleptic testing. Organoleptic testing is done by using the hedonic test. Panelists were asked to taste soy milk then the panelists gave their level of preference for color, aroma, viscosity, and taste with a score of 1 = very dislike, 2 = disliked, 3 = slightly disliked, 4 = neutral/ordinary, 5 = somewhat like, 6 = like, 7 = really like). For parameters of beany flavor with a score of 0 = beany and 1 = not beany. The data obtained were then analyzed using ANOVA and if it was significantly different, then continued with the DMRT test (95% confidence level).

3. Result and discussion

3.1. Protein of soy milk
Soy milk is a source of protein so it can replace protein sources from cow's milk [14]. The protein content of soy milk using the soybean seed treatment method and soaking can be seen in table 1.

| Processing Method                        | Protein (%) |
|-----------------------------------------|-------------|
| Control                                 | 1.91        |
| Skinless and without hot water soaking  | 2.30        |
| Skinless and with hot water soaking     | 1.73        |
| With skin and without hot water soaking | 2.38        |
| With skin and with hot water soaking    | 2.02        |

The result of protein content analysis showed that the highest protein content of soy milk was found in treatment that used skin and without hot water soaking was 2.38%, while the lowest protein content was skinless with hot water soaking of 1.73%. From some of the protein content of soy milk produced, it has met the soybean quality standard 01-3830-1995, which is 2%. The protein content of soy milk is influenced by soybean seed treatment and soaking treatment.

The method of using skin and without hot water soaking is higher than other treatments because the soybeans used still have a skin where the skin soybean still contains 17.98% crude protein, 5.5% crude fat and 24.84% crude fiber [15]. Soybean skin contains high fiber and protein, so soybean skin can be used as quality food products and have better economic value [4]. Astawan et al. (2013) reported that the mineral content of soy is mostly found in the soybean skin [16].

In general, the heating process of food can reduce the mineral content of these materials. The mineral content of a food can be damaged during the heating process because minerals are very sensitive to pH, oxygen, light, and heat [17]. In addition, protein content, which is an important factor in the content of an ingredient, also decreases when it is heated.

The protein content in soybeans can be maintained a little by not soaking in hot water. Soaking in hot water causes protein to dissolve easily in water because protein cannot withstand heat. This is in accordance with the opinion of Meisara and Nurhidajah (2012) that protein content can dissolve in water at a temperature of 38-75 °C [18]. And supported by Li et al. (2019); Pan and Tangratanavalee (2003); Pagara (2011), that soaking at high temperatures can cause protein loss into water [9,19,20].
This is also consistent with the research of Prasetyo (2004) where the results of the analysis of soy milk protein are influenced by heat treatment in the blanching process. The heating process decreases the protein content because it dissolves in water [21]. This is also supported by the research results of Rani et al. (2013), where the protein content of soy powder is influenced by soaking soybeans before processing. The longer the soybean is soaked, the less protein content is due to the water-soluble protein [1].

Research results by Picauly et al. (2015) showed that the hotter water is used, the protein content of soy milk also decreases. This is due to protein denaturation [7]. The occurrence of protein denaturation is influenced by temperature and heating time during soy milk processing [22]. The higher the temperature used, the greater the decrease in protein content. The research results of Sundari et al. (2015) stated that fried foods experienced a higher reduction in protein when compared to boiled foods. This is because of the temperature used when frying is higher than the boiling temperature [23].

3.2. Sensory characteristics of soy milk

3.2.1. Color. The soy milk products produced were then tested for sensory analysis to determine the panelists’ preference towards the soy milk produced. Color is one of the main attributes in sensory evaluation because it is the fastest and easiest way to give an impression to a product. The organoleptic mean color of soy milk ranged from 4.68-5.64 (normal—somewhat like it).

| Treatments                                         | Average value |
|---------------------------------------------------|---------------|
| Control                                           | 4.8 ab        |
| Skinless. without hot water soaking, vanilla flavor | 4.68 b        |
| Skinless, without hot water soaking, chocolate flavor | 5.32 ab       |
| Skinless, without hot water soaking, coffee flavor  | 5.28 ab       |
| Skinless, hot water soaking, vanilla flavor        | 4.92 ab       |
| Skinless, hot water soaking, chocolate flavor      | 5.64 a        |
| Skinless, hot water soaking, coffee flavor         | 4.8 ab        |
| With skin, without hot water soaking, vanilla flavor | 5.04 ab       |
| With skin, without hot water soaking, chocolate flavor | 5.28 ab       |
| With skin, without hot water soaking, coffee flavor | 5.36 ab       |
| With skin, hot water soaking, vanilla flavor       | 5.04 ab       |
| With skin, hot water soaking, chocolate flavor     | 5 ab          |
| With skin, hot water soaking, coffee flavor        | 5.08 ab       |

Notes: The numbers followed by the same letters in the same column are not significantly different in Duncan’s Multiple Range Test α = 0.05.

Based on table 2, the highest color assessment is the processing method skinless, soaking in hot water, chocolate flavor of 5.64 (somewhat like) and the lowest is skinless, without hot water soaking, the vanilla flavor is 4.68 (normal). The addition of chocolate and coffee influences the color of soy milk. The color of soy milk with the addition of vanilla produces a white color, while the soy milk, which is added with chocolate is brown, so the resulting color attracts the attention of the panelists. This is in accordance with Handayani and Wulandari’s (2016) statement that soy yogurt color is influenced by the addition of ingredients and supporting components such as sucrose and milk [24].
3.2.2. Aroma. Based on the results of the soy milk aroma ANOVA, the soybean processing method with the soaking method had a significant effect on the organoleptic response to aroma. Research data can be seen in table 3.

Table 3. Effect of processing methods on the level of preference for the aroma of soy milk.

| Treatments                                      | Average value |
|-------------------------------------------------|---------------|
| Control                                         | 5.16 abc      |
| Skinless, without hot water soaking, vanilla flavor | 4.2 d         |
| Skinless, without hot water soaking, chocolate flavor | 5.12 a        |
| Skinless, without hot water soaking, coffee flavor | 4.58 ab       |
| Skinless, hot water soaking, vanilla flavor      | 4.6 cd        |
| Skinless, hot water soaking, chocolate flavor    | 4.84 cd       |
| With skin, without hot water soaking, vanilla flavor | 5.08 bc       |
| With skin, without hot water soaking, coffee flavor | 5.28 abc      |
| With skin, hot water soaking, vanilla flavor     | 4.56 cd       |
| With skin, hot water soaking, chocolate flavor   | 4.52 cd       |
| With skin, hot water soaking, coffee flavor      | 4.92 cd       |

Notes: The numbers followed by the same letters in the same column are not significantly different in Duncan’s Multiple Range Test α = 0.05

Based on table 3, shows the effect of soybean processing methods and soaking methods on the organoleptic response to the aroma. Soymilk produced by processing with skin, without hot water soaking, chocolate and coffee flavors had the highest average value of 5.28 and the lowest was skinless, without hot water soaking, and vanilla flavor. This is because soaking in hot water can reduce the beany smell of soybeans. This is in accordance with the opinion of Achyadi et al. (2020) that beany smell can be lost with hot temperatures [25].

The addition of chocolate and coffee flavors can reduce the beany smell of soybeans so that the acceptence rate is higher than that of vanilla. The caffeine content in coffee gives it a distinctive flavor. This is in accordance with the opinion of Hayati et al. (2012) that caffeine compounds provide a distinctive taste and aroma of coffee, making coffee popular with many people [26]. The beany flavor of soy milk can be disguised by adding flavors such as vanilla, pandan, chocolate, mocca, and cinnamon [13].

3.2.3. Viscosity. Anova results indicate that the processing method does not affect the level of viscosity preference of soy milk. So, there was no difference in thickness preference even though there was a difference in the mean score of the liking level (table 4). There is no difference in soy milk’s viscosity because the amount of water used during crushing (using a blender) for all treatments is the same, namely 1 liter. This is in accordance with the opinion Nirmagustina and Rani (2013) that the viscosity of soy milk is influenced by the amount of water added when making soy milk [14].
Table 4. Effect of processing method on the preferred viscosity level of soy milk.

| Treatments                                      | Average value |
|-------------------------------------------------|---------------|
| Control                                         | 4.68 a        |
| Skinless, without hot water soaking, vanilla flavor | 4.24 a        |
| Skinless, without hot water soaking, chocolate flavor | 4.76 a        |
| Skinless, without hot water soaking, coffee flavor | 4.84 a        |
| Skinless, hot water soaking, vanilla flavor      | 5.0 a         |
| Skinless, hot water soaking, chocolate flavor    | 4.92 a        |
| Skinless, hot water soaking, coffee flavor       | 4.76 a        |
| With skin, without hot water soaking, vanilla flavor | 5.04 a        |
| With skin, without hot water soaking, chocolate flavor | 4.72 a        |
| With skin, without hot water soaking, coffee flavor | 4.76 a        |
| With skin, hot water soaking, vanilla flavor     | 4.56 a        |
| With skin, hot water soaking, chocolate flavor   | 4.28 a        |
| With skin, hot water soaking, coffee flavor      | 5.52 a        |

Notes: The numbers followed by the same letters in the same column are not significantly different in Duncan’s Multiple Range Test α = 0.05.

3.2.4. Taste. Taste is the most important factor in determining the decision to accept or reject a food product. The level of acceptance of the taste of soy milk can be seen in Table 5.

Table 5. Effect of processing methods on the level of taste preference for soy milk.

| Treatments                                      | Average value |
|-------------------------------------------------|---------------|
| Control                                         | 5.14 a        |
| Skinless, without hot water soaking, vanilla flavor | 3.64 b        |
| Skinless, without hot water soaking, chocolate flavor | 5.04 a        |
| Skinless, without hot water soaking, coffee flavor | 5.08 a        |
| Skinless, hot water soaking, vanilla flavor      | 4.36 ab       |
| Skinless, hot water soaking, chocolate flavor    | 4.68 a        |
| Skinless, hot water soaking, coffee flavor       | 5.12 a        |
| With skin, without hot water soaking, vanilla flavor | 4.72 a        |
| With skin, without hot water soaking, chocolate flavor | 5.32 a        |
| With skin, without hot water soaking, coffee flavor | 5.12 a        |
| With skin, hot water soaking, vanilla flavor     | 5.24 a        |
| With skin, hot water soaking, chocolate flavor   | 4.48 ab       |
| With skin, hot water soaking, coffee flavor      | 4.6 ab        |

Notes: The numbers followed by the same letters in the same column are not significantly different in Duncan’s Multiple Range Test α = 0.05.

Based on Table 5, shows that soy milk skinless peeling, soaking in hot water, and vanilla flavor was the most preferred by the panelists with a score of 5.24 (somewhat like it). The lowest and significantly different from other treatments, namely skinless, without hot water soaking, vanilla flavor with a score of 3.64 (slightly dislike). The presence of beany flavor in soy milk causes this soy milk to be less liked by panelists. Various techniques such as heat treatment and soaking are used in soybean processing to increase the acceptance rate of soy products [27,28].
3.2.5. Beany flavor of soy milk. The resulting soybean milk lethargy score can be seen in table 6.

| Treatments                                      | Average value |
|------------------------------------------------|--------------|
| Control                                         | 0.32 d       |
| Skinless, without hot water soaking, vanilla flavor | 0.48 cd     |
| Skinless, without hot water soaking, chocolate flavor  | 0.84 ab     |
| Skinless, without hot water soaking, coffee flavor    | 0.84 ab     |
| Skinless, hot water soaking, vanilla flavor          | 0.4 cd      |
| Skinless, hot water soaking, chocolate flavor        | 0.8 ab      |
| Skinless, hot water soaking, coffee flavor           | 0.96 a      |
| With skin, without hot water soaking, vanilla flavor | 0.36 d      |
| With skin, without hot water soaking, chocolate flavor | 0.84 ab     |
| With skin, without hot water soaking, coffee flavor  | 0.88 ab     |
| With skin, hot water soaking, vanilla flavor         | 0.48 cd     |
| With skin, hot water soaking, chocolate flavor       | 0.64 bc     |
| With skin, hot water soaking, coffee flavor          | 0.92 a      |

Notes: The numbers followed by the same letters in the same column are not significantly different in Duncan's Multiple Range Test \( \alpha = 0.05 \)

The beany flavor parameters in soy milk, the control sample had the highest and lowest levels of beany were the skinless method, hot water soaking, and coffee flavor. Many factors can minimize the level of beany in soy milk, namely by soaking in hot water, adding water during the crushing of soybean seeds and giving it flavor. This is in accordance with the opinion of Ginting (2002), that the beany flavor of soy milk is influenced by the processing method. To reduce beany flavor in soy milk, by soaking or heating [29]. According to Chan et al. (2011) that the beany flavor of soybeans can be reduced by hot water blanching and grinding above 80°C [30]. The results of the study (Ikya et al., 2013) indicate that soy milk that can be accepted organoleptically is soy milk which is made by soaking and grinding at a temperature of 80-100°C [31]. According to Faturohman et al. (2020) beany flavor can also be suppressed by adding boiled water with a ratio of 1: 4 (w / v) [32]. And according to Mudjajanto and Kusuma (2005) the comparison of adding water and soy to soy milk processing can overcome beany flavor [33].

4. Conclusions
The conclusions that can be drawn from this research are as follows:
1. The processing method using soybean skin and without hot water soaking has the highest soy milk protein content of 2.38% while the lowest is the processing method skinless and hot water soaking of 1.73%.
2. Organoleptic testing for parameters of color, aroma, viscosity, and taste ranging from ordinary to like for all treatments.
3. The parameter of beany flavor in soy milk, the control sample has the highest level of beany flavor. Organoleptically, giving coffee and chocolate flavor variants are proven to reduce the level of beany flavor of soy milk.

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