Improving soy milk quality with development of technical standard parameters.

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Abstract: Soy milk is a known alternative drink for product diversification to increase protein consumption, and is produced by adding water to soy extract. In Indonesia, the Indonesian National Standard for soy milk products (SNI 01-3830-1995) has been provided along with a conformity assessment scheme. However, the accordance with BSN Regulation No. 6 of 2018 with regard SNI Review Guidelines, SNI, published over 5 years ago, needs to be reviewed. This study therefore provides recommendations for standard soy milk technical parameters, using the FACTS method (Framework for analysis, comparison and test of standards). The results of this study are intended to review SNI 01-3830-1995. In addition, the scope of this study is limited to stakeholder identification, technical parameter analysis and comparative analysis of international standards. This study was conducted at CV.X, a soy milk-producing Small and Medium Enterprise (SME) in Bekasi, Indonesia. The selection of SME as stakeholders was conducted to determine the ability to apply SNI. Meanwhile, technical parameter analysis was carried out through product laboratory testing, based on SNI 01-3830-1995. According to the laboratory test results, SMEs have not complied with SNI parameters, including protein, fat and pH requirements. The results of international standard analysis show 5 considerable parameters in CODEX STAN 175-1989, moisture, crude protein, ash, fat and crude fiber, for adoption in the SNI 01-3830-1995 review process, to improve the quality of soy milk in Indonesia.

Keywords: soy milk, SNI, review, quality, and standard.

1. Introduction
Soy milk is a cheaper food product, compared to cow milk, with high nutritional value as well as suitability for people with lactose intolerance and often without allergens. Thus, soy milk is a known alternative drink for product diversification, to increase protein consumption, and is also equivalent to 80% of cow milk’s quality, with a 2.3 protein efficiency ratio (PER) [1]. The Indonesian National Standard (SNI) defines soy milk as a product derived from mixing soybean seed extract with water, or as a solution of soybean flour in water, with or without the addition of other permitted food ingredients [2].

SNI 01-3830-1995 with regard to soy milk regulates the quality requirements, sampling method, test method, packaging method and labelling requirements, along with the conformity assessment scheme. However, accordance with BSN Regulation No. 6 of 2018, concerning SNI Review Guidelines, SNI, published over 5 years ago, needs to be reviewed. In this regulation, there are 4 criteria to carry out SNI review [3], as outlined below:

a) SNI requiring fundamental changes to support national interests and market needs.

b) SNI requiring changes due to developments in science, innovation and technology.
c) SNI requiring changes due to security, safety and environmental conservation functions reasons.
d) SNI references adopting international standards have been changed.

Therefore, SNI review process is defined as a review step towards the standard’s content and format, and is conducted to provide recommendations in the form of re-establishment, amendment or elimination of certain standards or regulations, as an effort to remain in line with national interests, stakeholder needs, development of science, as well as innovation and technology [3]. This review is sometimes proposed by stakeholders to BSN. In this study, the SNI quality parameters for soy milk and the ability to apply technical parameters for stakeholders are to be determined, in addition to conducting a comparative analysis of international standards. This study is a suitable reference for reviewing SNI 01-3830-1995, to improve soy milk quality, with the development of technical standard parameter.

2. Literature Studies
Table 1 describes the quality requirements for soy milk, in accordance with SNI 01-3830-1995.

| Parameter       | Unit     | Spesification |
|-----------------|----------|---------------|
| Odor            |          | normal        |
| Flavor          |          | normal        |
| Colour          |          | normal        |
| pH              |          | 6.5 – 7.0     |
| Protein         | % b/b    | min. 2.0      |
| Fat             | % b/b    | min. 2.0      |
| Total solid     | % b/b    | min. 2.0      |
| Lead (Pb)       | mg/kg    | max. 0.2      |
| Copper (Cu)     | mg/kg    | max. 2        |
| Zinc (Zn)       | mg/kg    | max. 5        |
| Tin (Sn)        | mg/kg    | max. 40       |
| Mercury (Hg)    | mg/kg    | max. 0.03     |
| Arsenic (As)    | mg/kg    | max. 0.1      |
| Total Plate     | colonies/ml | max. 2 x 10^2 |
| Numbers         |          |               |
| Coliform        | MPN/ml   | max. 20       |
| *Escherichia coli* | MPN/ml | <3           |
| *Salmonella*    |          | negative      |
| *Staphylococcus aureus* | colonies/ml | 0         |
| *Vibrio sp.*    |          | negative      |
| Yeasts          | colonies/ml | max. 50      |

Numerous literatures have described soy milk production, however, the process is generally similar, and is outlined below [4].
a. Clean soybeans to remove all dirt, then wash.
b. Boil the clean soybeans for about 15 minutes, then soak in clean water for about 12 hours.
c. Wash until the husk is completely removed, then grind.
d. Mix the finely ground soybeans with water, then stir until evenly distributed.
e. Strain the soy mixture with a filter cloth to obtain soy milk.
f. Add sugar and flavouring (as desired), as well as salt, then stir and heat until blended.
Improperly stirred soy milk tends to contain anti-nutritional compounds and off-flavour-causing compounds (storing flavour and aroma in soy products). These anti-nutritional compounds include antitrypsin, hemaglutinin, phytic acid, and oligosaccharides, while the off-flavour-causing compounds include glucosides, saponins, estrogens and allergens. Thus, soy milk must be free from the odour and unpleasant taste of soybeans, antitrypsin, and also have good stability (not settle or clump), to be suitable for consumption.

Soy milk has a distinctive odour and taste of soybeans as well as other raw nuts some consumers resent. This odour and taste are caused by the action of lipoxygenase enzyme in soybean seeds. The enzyme reacts with fat during grinding, especially in cases where cold water is used, resulting in the formation of volatile compounds, especially ethyl-phenyl-ketones. This distinctive odour and taste is removable by inhibiting lipoxygenase enzyme with heat (80-100°C hot water) in a soybean mill or soaking soybeans in hot water for 10-15 minutes, before grinding. Furthermore, soybeans are soaked in water or 0.5% NaHCO₃ solution for overnight (8-12 hours) followed by immersion in boiling water for 30 minutes, to remove antitrypsin [5].

The quality of protein in soy milk, with a protein efficiency ratio (PER) of 2.3, is almost the same as cow milk, with a 2.5 PER. A 2.3 PER means each gram of protein consumed results in a 2.3g weight gain in experimental animals (white rats), under standard experimental conditions. Soy milk does not contain vitamin B12 and minerals, especially calcium. Therefore, fortification or the addition of minerals and vitamins is required for soy milk produced by large industries [1].

3. Methods

This study utilized FACTS method (Framework for Analysis, Comparison, and Testing of Standards) developed by NIST (National Institute of Standards and Technology), covering the standard development stage to standard implementation. The FACTS method has several stages, including stakeholder analysis, technical parameter analysis, comparative analysis of international standards and standard testing [9]. However, the scope of this research is limited to stakeholder analysis, technical parameter analysis and comparative analysis of international standards.

This study utilized used primary data obtained from laboratory test results of soy milk produced by CV. X in Bekasi, as well as secondary data obtained through literature studies in the form of standard documents, national as well as international journals. In addition, the study used quantitative descriptive analysis to identify SNI quality parameters for soy milk as well as the ability to apply technical parameters for stakeholders and to conduct comparative analysis to international food standards published by CAC (Codex Alimentarius Commission).

4. Result and Discussion

4.1 Stakeholder analysis

The case study was conducted at CV.X, a soy milk-producing Small and Medium Enterprise (SME) in Bekasi, Indonesia, while the selection of SME as stakeholders was conducted to determine the ability to apply SNI. At this stage, the soy milk production process was identified, using interviews and direct observation of CV. X’s production process, from receiving raw materials to marketing. The soy milk produced was also sampled for laboratory testing.

4.2 Technical parameter analysis

Table 2 shows the results of CV. X soy milk analysis, performed according to SNI 01-3830-1995. The results showed several parameters have not complied with SNI, including protein, fat and pH. This reduction in protein content is possibly influenced by heat treatment, as this leads to protein denaturation, thus, protein is extracted in the soy milk. Protein denaturation is caused by a protein undergoing chemical structure change rate, and was influenced by temperature and heating time during soy milk processing [6]. The heating process possibly results in bond cleavage within protein molecules, and these molecules tend to be easily attacked by digestive enzymes.
Table 2: Test Results of CV. X Soy Milk Laboratory Analysis

| Parameter            | Unit   | Specification          |
|----------------------|--------|------------------------|
| Odor                 | -      | normal                 |
| Flavor               | -      | a little sweet         |
| Colour               | -      | Yellowish white        |
| pH                   | -      | 6.2                    |
| Protein              | % b/b  | 1.5                    |
| Fat                  | % b/b  | 1.0                    |
| Total solid          | % b/b  | 16.3                   |
| Lead (Pb)            | mg/kg  | not detected           |
| Copper (Cu)          | mg/kg  | 0.60                   |
| Zinc (Zn)            | mg/kg  | 3.04                   |
| Tin (Sn)             | mg/kg  | not detected           |
| Mercury (Hg)         | mg/kg  | not detected           |
| Arsenic (As)         | mg/kg  | not detected           |
| Total Plate Numbers  | colonies/ml | 8.0 x 10^0  |
| Coliform             | MPN/ml | 0.36                   |
| Escherichia coli     | MPN/ml | <0.3                   |
| Salmonella           | -      | negative               |
| Staphylococcus aureus| colonies/ml | 0                 |
| Vibrio sp.           | -      | negative               |
| Yeasts               | colonies/ml | <10             |

Fat content is also influenced by high temperature treatment, and this tends to cause fat damage, resulting in decreased soy milk fat content. Furthermore, hydrolysis reactions tend to occur in the presence of water and heat, thus, the use of water with high temperatures produces extremely high energy, with the ability to breakdown fat structure. Therefore, water and high temperatures are able to cause lipolysis or fat hydrolysis reactions and consequently, fat loss in soy milk [7]. Also, the amount of water influences soy milk’s chemical and physical properties, and therefore determines the quality of soy milk, while the composition of water and soybean tends to influence the protein and fat contents [10].

The pH value is an indication of the presence or absence of microorganism or enzyme activity in food, with the ability to influence many chemical and enzymatic reactions, as well as inhibit microbial growth. Meanwhile, low pH value indicates the presence of microorganisms or enzyme activity with the ability to cause changes in food quality. Several microbes have the ability to spoil food by hydrolyzing or degrading macromolecules composing the material into smaller fractions. This in turn produces acids lowering pH and forms gas decomposers with an impact on the smell and taste of ingredients [8]. Thus, there are three critical parameters of soy milk quality, and these parameter value requirements must be considered in an SNI review, to enable business actors apply the standards to products.

4.3 International standard analysis
In international standardization activities, the CAC (Codex Alimentarius Commission) sets the standards for food. The CAC publishes CODEX standard, raw, semi-finished and finished material standards. In addition, the organization has established CODEX STAN 175-1989, with regard to general standards for soy protein products, and this requires parameters of moisture, crude protein, ash content, fat and crude fiber contents. Thus, there are 5 considerable parameters in the CODEX STAN 175-1989, for adoption in the SNI 01-3830-1995 review process, to improve the quality of soy milk in Indonesia.

5. Conclusion
The accordance with BSN Regulation No. 6 of 2018 concerning SNI Review Guidelines, SNI, was been published over 5 years ago, and requires reviewing. This study showed SMEs have not complied with SNI parameters, including protein, fat and pH. These parameters must therefore be adjusted in line the industry capability, especially SMEs. The results of international standard analysis show 5 considerable
parameters in CODEX STAN 175-1989, moisture, crude protein, ash, fat and crude fiber, for adoption in the SNI 01-3830-1995 review process, to improve the quality of soy milk in Indonesia.

**Acknowledgement**

The authors are grateful to the National Standardization Body for the provision of financial support, and to the PT. Saraswanti Indo Genetech analytical laboratory, as well as all other supporting parties.

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