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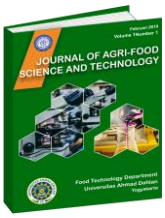

Effect of Soybean (*Glicyne max (L.) Merill*) with *Lamtoro gung* (*Leucaena leucocephala*) Proportion on the Characteristics of Soy Milk

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ABSTRACT (10 pt)

The utilization of soy milk is an alternative for people with lactose intolerance. Soy milk can be made with lamtoro gung substitution because the nutritional content of lamtoro gung is close to soybeans. This research aimed to determine the effect of soybean/lamtoro gung proportion on the characteristics of soy milk. This research was conducted from May until July 2022. The experimental study used a randomized block design with the treatment were soybean (K) with lamtoro gung (L) proportion S1 (K 100%: L 0%), S2 (K 95%: L 5%), S3 (K 90%: L 10%), S4 (K 85%: L 15%), S5 (K 80: L 20%), S6 (K 75%: L25), S7 (K 70%: L 30%) S8 (K 65%: L 35%), and S9 (K 60%: L 40%). The data obtained were then analyzed using analysis of variance and further test BNJ 5%, the organoleptic test used Friedman test, and determine the best treatment used effectiveness index. The results showed a significant effect of soybean with lamtoro gung proportion on protein content, vitamin C content, vitamin A content, pH, viscosity, TDS, *and hedonic test of aroma and taste. The best treatment was S3 (soybean 90%: lamtoro 10% with characteristics of protein content 3.304%, vitamin C content 0.291%, vitamin A content 2.239 mg/g, pH 5.917, viscosity 3.533×10^3 mPa.s,* TDS *7.833 °brix, and hedonic test of color 3.40, aroma 3.30, taste 3.40, and texture 3.20. This study contributes to evaluate the soy milk characteristics from soybean and lamtoro gung.*

1. INTRODUCTION

Milk is one of the sources of nutrients needed for metabolism in the body. Some nutritional contents include proteins, essential fatty acids, vitamins, and minerals (Katz, 2018; Muehlhoff et al., 2013). On the other hand, milk contains lactose which needs to be hydrolysed by the lactase enzyme into glucose and galactose to be absorbed by the intestinal wall. The presence of such enzyme deficiencies will lead to a condition called lactose intolerance (Hegar

& Widodo, 2015; Vandenplas, 2015). In this case, soy extract becomes an alternative to milk replacement because soy contains almost the same protein as cow's milk and does not contain lactose. Soy extract has a yellowish-white color and resembles milk, so it is often called soy milk (Wang et al., 2004; Zhao et al., 2023).

Soy milk is a highly nutritious drink, especially its protein content, soy contains 35% protein even in high-yielding varieties, its protein content can reach 40–43% (Liu & Chang, 2004; Rohmani et al., 2018; Zaeim et al., 2022). Soy milk is also known as a health drink because of its phytochemical content, which is a compound in foodstuffs that has beneficial properties. Soy milk does not contain cholesterol and is suitable for consumption for all age groups (De et al., 2022; Hassan Sohouli et al., 2021; Zaeim et al., 2022). Nowadays, many substitutions or mixtures of other ingredients are carried out in making soy milk (Niyibituronsa et al., 2019; Peng et al., 2023; Vallath et al., 2022).

The substitution of *lamtoro gung* for soybeans has been widely practiced, including in the manufacture of soy sauce (Nur et al., 2023; Rahayu & Purwoko, 2005). *Lamtoro gung* seeds are often used as an alternative to soybeans because of their fairly complete nutritional content and are not much different from soybeans (Fitriani et al., 2022; Nursiwi et al., 2018). Based on preliminary research results, the substitution of *lamtoro gung* up to 40% in the manufacture of soy milk produces an acceptable taste by consumers. Therefore, a study was contributed to determine the proportion of soybeans with the best *lamtoro gung* in the manufacture of *lamtoro gung* seed soy milk and find out the characteristics of the resulting *lamtoro gung*-soy milk.

2. MATERIALS AND METHODS

2.1. Materials

The main ingredients used in this study were soybeans and *lamtoro gung* seeds obtained from Pasar Baru Tulangan, sugar (Gulaku), water, and CMC. While the materials for chemical analysis are aquadest, NaOH 0.1 M, formaldehyde, amylum, pp indicator, and potassium oxalate.

The tools used in this study include blenders (Philips), electric ovens (Memmert), desiccators, petri dishes, vortex, UV-Vis spectrophotometers (B-ONE UV-Vis 100 D), and pH meters (Ecoscan).

2.2. Research Methods

This study used a Randomized Block Design (RBD). The treatment in this study was the proportion of soybeans with *lamtoro gung*, with nine treatments and three replications, so there were 27 experimental units, namely, S1 (100% Soybeans/control), S2 (Soybeans 95%:*lamtoro* 5%), S3 (Soybeans 90%:*lamtoro* 10%), S4 (Soybeans 85%:*lamtoro* 15%), S5 (Soybeans 80%:*lamtoro* 20%), S6 (Soybeans 75%:*lamtoro* 25%), S7 (Soybeans 70%:*lamtoro* 30%), S8 (Soybeans 65%:*lamtoro* 35%), and S9 (Soybeans 60%:*lamtoro* 40%). The parameters measured were protein, vitamin C, vitamin A, TDS, pH, viscosity, and hedonic tests by 30 panelists.

The data obtained were analyzed using the analysis of variance (ANOVA). Then if the results show a noticeable difference, a further test via the Tukey test (5%) is carried out. Organoleptic analysis was analyzed using the Friedman test, and the best treatment was determined using the effective index method.

3. RESULT AND DISCUSSION

3.1. Characteristics of Soy Milk

The various analysis results showed that the proportion of soybeans with *lamtoro gung* seeds had a very noticeable effect on protein levels, vitamin A, vitamin C, pH, TDS, and viscosity of soy milk (Table 1).

Table 1. Characteristics of Soy Milk

Treatment	Protein content (%)	vitamin C levels (%)	vitamin A levels (%)	pH	TDS (˚brix)	Viscosity (mPa.s)
S1	3.044^{a}	0.146^{a}	0.340^{a}	6.457^{c}	8.267^{c}	3543^{c}
S2	3.174^{a}	0.204^{b}	0.864^{a}	6.043^{abc}	7.433^{abc}	3300^{bc}
S3	3.044^{a}	0.291^{c}	2.239^{b}	5.917^{abc}	7.833^{bc}	3533^{c}
S4	4.100^{abc}	0.288^{c}	2.760^{bc}	5.800^{ab}	6.933^{ab}	3013^{abc}
S5	4.078^{abc}	0.295^{c}	3.482^{cd}	5.700^{ab}	6.433^{ab}	2407^{a}
S6	3.945^{ab}	0.303^{c}	3.414^{cd}	5.670^{abc}	6.700^{ab}	2980^{abc}
S7	4.706^{bc}	0.302^{c}	3.657^{d}	5.553^{a}	6.367^{a}	2547^{a}
S8	4.758^{bc}	0.308^{c}	3.687^{d}	6.040^{abc}	6.600^{ab}	2654^{ab}
S9	5.299^{a}	0.318^{c}	3.732^{d}	6.163^{bc}	7.033^{abc}	3063^{abc}
BNJ 5%	1.228	0.041	0.755	0.595	1.298	726.64

Description: Numbers followed by the same letter in the column show significant differences based on the test.

Protein is the primary source of nutrition, namely as a source of amino acids. The protein content in foodstuffs varies both in quantity and type. Besides being a source of nutrition, protein also provides essential functional properties in shaping the characteristics of food products (Loveday, 2019). The average protein of *lamtoro* seed soy milk ranges from 3.044% to 5.299%. The lowest average S1, although not significantly different from S2, S3, S4, S5, and S6 treatments, is substantially different from others. The protein content of *lamtoro* seed soy milk increases as the proportion of *lamtoro* seeds used increases. This is thought to be because lamtoro seeds' protein is higher than soy proteins. The protein content of soybeans is 34.9%, while the protein content of *lamtoro* seeds is 46.4%.

Vitamin C is one of the vitamins that have the function of increasing endurance. A prominent chemical property of vitamin C is as an antioxidant (Bendich et al., 1986; Cheng et al., 2016). The average vitamin C content of *lamtoro* seed soy milk ranges from 0.146% to 0.318%. Vitamin C levels were lowest in the S1 and were significantly different from other treatments. Vitamin C levels of *lamtoro* seed soy milk tend to increase as the proportion of *lamtoro* seeds used increases. This is because *lamtoro* seeds have a relatively high vitamin C content of 9.3%.

Several types of carotenes have vitamin A activity in foodstuffs, such as α-carotene, β-carotene, lutein, lycopene, and cryptoxanthin. Besides being a source of vitamin A, carotene in foodstuffs also acts as an antioxidant (Pérez-gálvez et al., 2020). The average vitamin A content of *lamtoro* seed soy milk ranges from 0.340 mg/g to 3.732 mg/g. The lowest vitamin A levels in the S1, although not significantly different from the S2 treatment, but significantly different from other treatments. Vitamin A levels of *lamtoro* seed soy milk tend to increase as the proportion of *lamtoro* seeds used increases. This is because *lamtoro* seeds have a higher vitamin A content than soybeans. The vitamin A level of soybeans is 110 SI, while the vitamin A level of *lamtoro* seeds is 189 mg/g.

The pH or acidity of food products is influenced by organic acids in foodstuffs. The average pH of *lamtoro* seed soy milk ranges from 5.553 to 6.457. Although the lowest pH in the S7 is not significantly different from the treatment of S2, S3, S4, S5, S6, and S8, it is

significantly different from the treatment of S1 and S9. In general, the pH of *lamtoro* seed soy milk tends to decrease along with the increasing proportion of *lamtoro* seeds used. This is thought to be because the pH of *lamtoro* seed soy milk is influenced by the vitamin C content of *lamtoro* seed soy milk, where the higher the vitamin C content, the lower the pH or, the more acidic.

Total Dissolved Solids (TDS) can be used to interpret the amount of sugar contained in a product. Dissolved solids contained in a food product consist of water-soluble components such as glucose, fructose, sucrose, and water-soluble proteins (Gray et al., 1982). The average TDS of *lamtoro* seed soy milk ranges from 6,367 brix to 8,267 brix. The lowest TDS in the S7. The TDS of *lamtoro* seed soybean juice shows a downward trend along with the increase in *lamtoro* seeds used. This is because *lamtoro* seeds have a higher water content than soybeans. The moisture content of soybeans is 7.5%, while the moisture content of *lamtoro* seeds is 10.2%.

Viscosity is the degree of viscosity of a food product. Viscosity is one of the properties of a liquid that determines the amount of resistance to friction force. Viscosity occurs mainly due to the interaction between liquid molecules. The average viscosity of *lamtoro* seed soy milk ranges from 2.407×10^3 mPa.s to 3.543×10^3 mPa.s. The lowest viscosity is the S5 treatment. The viscosity of *lamtoro* seed soy milk shows a volatile value but tends to decrease as the proportion of *lamtoro* seeds used increases. This is thought to be because the viscosity of the product is influenced by the total dissolved solids as well as the moisture content in the material, where the higher the TDS and the lower the moisture content, the higher the viscosity

3.2. Organoleptic Test of Soy Milk

The results of Friedman's analysis showed that the proportion of soy with *lamtoro gung* seeds significantly affected soy milk's organoleptic aroma and taste (Table 2). Color is the first organoleptic test that can be seen directly by panelists. Color is the first impression that will determine food quality (Chambers, 2019; Isaskar et al., 2021). The panelists' favorability value for lamtoro seed soy milk color ranged from 2.80 (dislike-neutral) to 3.36 (neutral-like). The lowest favorability value was in the S6, although the difference was not noticeable with the other treatments. The panelists' favorability for lamtoro seed soy milk color showed a tendency to decline as the proportion of *lamtoro* seeds used increased. This is because adding *lamtoro* seeds with more concentration causes the color of soy milk to be slightly greenish. This also proves that the panelists prefer soy milk which is white like the color of cow's milk.

Scents are stimuli generated by the material being smelled, especially those felt by the senses of the smeller. The aroma in food is not only determined by one component but by several specific components as well as the ratio of the number of components of the ingredients (Chambers, 2019; Watson, 1992). The panelists' favorability value for the aroma of *lamtoro* seed soy milk ranged from 2.73 (dislike-neutral) to 3.57 (neutral-like). Although the lowest favorability value in the S4 was not really different from the S5, S7, and S9 treatments, it was significantly different from other treatments. The panelists' favorability for the aroma of *lamtoro* seed soy milk showed a tendency to decrease as the proportion of *lamtoro* seeds used increased. This is because *langu* odors from soybeans and *lamtoro* seeds are still detected, thus reducing the panelists' favorability level.

The taste of a product will affect the level of consumer acceptance. If the taste is not liked, then the product will be rejected. The panelists' favorability value for the taste of *lamtoro* seed soy milk ranged from 2.43 (dislike-neutral) to 3.67 (neutral-like). The lowest favorability value in the S6 treatment, although not really different from the S5 treatment, is significantly different from the other treatments. The panelists' favorability level for the taste of *lamtoro* seed soy milk at a proportion of 95% soy with 5% *lamtoro* seeds showed the highest value, but the panelists' liking level for the taste of *lamtoro* seed soy milk tended to decrease as the

proportion of *lamtoro* seeds increased to 25%, and increased again at the proportion of *lamtoro* seeds 30% to 40%. This is following the results of preliminary research that has been carried out that the taste of *lamtoro* seed soy milk is still acceptable to a concentration of 40%.

Table 2. The Level of Panelists' Preference for the Sensory Properties of Soy Milk

Treatment	Color	Scent	Flavor	Texture
S1	3.37	3.57	3.50	3.50
S2	3.40	3.03	3.67	3.67
S3	3.40	3.23	3.40	3.50
S4	3.30	2.73	3.17	3.57
S5	2.93	3.07	2.67	3.47
S6	2.80	3.27	2.43	4.03
S7	3.07	3.03	3.20	4.20
S8	3.23	3.13	3.37	3.90
S9	2.90	2.80	3.10	3.97

The decrease in the panelists' preference for the taste of *lamtoro* seed soy milk was possible because the ingredients' composition influenced the product's taste. As is known in the treatment of the proportion of *lamtoro* seeds 10% to 25% indicates the pH of the product below 6.00. This means that panelists tend to dislike *lamtoro* seed soy milk with a sour taste.

Textures are a group of physical properties evoked by structural elements of foodstuffs that can be perceived by the sense of touch, related to deformation and disintegration measured organoleptically by the eyes, time, and distance (Wahjuningsih et al., 2020). The panelists' favorability value for lamtoro seed soy milk texture ranged from 2.87 (dislike-neutral) to 3.43 (neutral-like). The lowest favorability value was in the S6, although the difference was not noticeable with the other treatments. The panelists' favorability for lamtoro seed soy milk texture was highest in the S1 and decreased as the proportion of *lamtoro* seeds used increased. This result is in line with the viscosity results of *lamtoro* seed soy milk, where there is a tendency to decrease in viscosity as the proportion of *lamtoro* seeds used increases, but due to testing the texture of *lamtoro* seed soy milk based on the level of favorability by the panelists. Hence, the panelists' assessment shows an unreal difference.

3.3. Best Treatment

The best treatment in a study is needed to determine how the treatment affects the observed variables. The calculation of seeking the best treatment is determined based on calculating the effective value through the weighting procedure. The results were obtained by multiplying it with the average data of the analysis of protein content, vitamin C levels, vitamin A levels, pH, Viscosity, TDS, and organoleptic test results of color, taste, aroma, and texture of *lamtoro* seed soy milk in each treatment.

In this case, the weighting given is protein content (0.9), vitamin C content (0.9), vitamin A content (0.9), pH (0.8), viscosity (0.8), TDS (0.8), and organoleptic test results of color (1.0), taste (1.0), aroma (1.0), and texture (1.0). The best treatment calculation results were *lamtoro* seed soy milk at S3 treatment with a characteristic protein content of 3.304%, vitamin C content of 0.291%, vitamin A 2.239 mg/g, pH 5.917, the viscosity of 3.533×10^3 mPa.s, TDS of 7.833 °brix, an organoleptic color value of 3.40 (neutral-like), an aroma of 3.30 (neutral-like), a taste of 3.40 (neutral-like), and texture of 3.20 (neutral-like).

4. CONCLUSIONS

The proportion of soybeans with *lamtoro* seeds is very pronounced against protein content, vitamin C levels, vitamin A levels, pH, Viscosity, TDS, and organoleptic tests of the aroma and taste of *lamtoro* seed soy milk. The best treatment of this study was found in the S3

with a characteristic protein content of 3.304%, vitamin C content of 0.291%, vitamin A 2.239 mg/g, pH 5.917, a viscosity of 3.533×10^3 mPa.s, TDS 7.833 °brix, and color organoleptic value of 3.40 (neutral-like), aroma 3.30 (neutral-like), taste 3.40 (neutral-like), and texture 3.20 (neutral-like).

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