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Replacing Fat with Soy Milk and Lecithin: Impact on the Quality of Steamed Sponge Cake

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Abstract

Background of study: Steamed sponge cake is a type of cake that uses eggs as the primary raw material for foam formation, emulsification, and coagulation. Soybean flour, a plant-based protein source, has the potential to replace the functional roles of eggs in steamed sponge preparation. The addition of an emulsifier is also required to maintain the final product quality.
Aims and scope of paper: This study aimed to analyze the effects of soy milk substitution, lecithin addition, and their interaction on the physical, chemical, and organoleptic characteristics of steamed sponge cake.
Methods: The experiment was conducted using a factorial Completely Randomized Design with two factors: the egg-to-soy milk ratio (100:0, 75:25, and 50:50) and the level of soy lecithin addition (2% and 4%). Data were analyzed using two-way ANOVA at a 5% significance level, followed by Duncan's Multiple Range Test (DMRT) to determine significant differences among treatments.
Result: Soy milk significantly affected moisture content, volume, hardness, cohesiveness, springiness, chewiness, gumminess, resilience, protein content, and fat content. Lecithin addition significantly affected moisture content, volume, specific volume, hardness, springiness, chewiness, gumminess, resilience, and protein content. The interaction between soy milk substitution and lecithin addition significantly influenced specific volume, hardness, springiness, gumminess, and resilience.
Conclusion: Soy milk substitution and lecithin addition, individually and in combination, significantly influenced multiple physical and chemical properties of steamed sponge cake. These findings demonstrate the potential for partial replacement of eggs with soy milk, combined with soy lecithin, to produce high-quality steamed sponge cake with possible cost benefits.

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INTRODUCTION

The bakery industry is currently facing a wide variety of consumer preferences. Consumers are increasingly seeking healthier bakery products. Consequently, several manufacturers have begun to adapt to these preferences, which poses challenges in maintaining the quality of flavor, texture, and volume of bakery products. Many producers replace part or all of conventional ingredients such as sugar, eggs, and wheat flour. Consumers select the composition of bread ingredients they wish to consume for health reasons; for example, they may only choose products that are low in sugar, gluten-free, egg-free, or plant-based. This condition encourages the development of healthier ingredient alternatives to replace the function of egg fat (Agrahar-Murugkar et al., 2016; Munialo & Vriesekoop, 2023). Plant-based foods such as soybeans are one of the solutions as fat substituters because soybeans contain high fat and protein that are able to form emulsions in dough. Total replacement of eggs with soy milk often results in increased batter density and reduced cake volume, leading to a denser texture (Hedayati & Tehrani, 2018).

Soybean proteins exhibit excellent emulsifying capabilities, stabilizing oil-water mixtures effectively. Soy-based emulsifiers are utilized in plant-based creamers and as fat replacers, demonstrating versatility in food formulations (Deng, 2021). Soy milk is derived from soybeans, which are naturally low in saturated fats and cholesterol-free, making it a healthier alternative to animal milk, which contains cholesterol and higher levels of saturated fats (Goldberg et al., 2021). In addition to soy milk, other soy-based ingredients such as roasted full-fat soy flour also offer valuable nutritional and functional properties that can be utilized in bakery applications.

The sensory qualities of roasted soybeans, including color, appearance, and roasted odor, are generally improved, with optimal results observed at specific roasting conditions (Hung, 2018). Moreover, roasting soybeans at 180°C significantly increases the phenolic components by 19.86% and enhances the antioxidant activity (Thakur et al., 2022). Roasted full fat soy flour is a flour produced from whole soybean seeds that are roasted and finely ground. The roasting process in soybeans not only improves the taste but also reduces anti-nutrient compounds, thereby increasing its nutritional value. This full-fat soybean flour contains high protein, healthy fats in the form of unsaturated fatty acids, fiber, and isoflavones that have health benefits. The protein content in roasted full fat soy flour also has functional properties such as emulsifiers and water binders, which are important in shaping the structure and texture of baked products. Studies have shown that lecithin can partially or fully replace eggs in cake recipes, maintaining desirable sensory attributes such as taste and texture. For instance, replacing 50% of the egg content with soy lecithin resulted in cakes with better physical appeal and higher specific volume (Agu et al., 2021; Hedayati & Tehrani, 2018). Soybean flour has a lecithin content of 1.48-3.08% and in eggs of 2.94% (Min et al., 2012). The incorporation of soy lecithin improves the stability and texture of the sponge cake, counteracting some negative effects of soy milk alone (Handayani, 2022; Hedayati & Tehrani, 2018).

This research needs to be carried out to determine the physical and chemical, properties of steamed sponge with the addition of soybean flour and lecithin. The addition of soybean flour and soy lecithin as a partial substitute for eggs in steamed sponges is expected to maintain the texture, softness, and development of the dough that usually relies on eggs, while increasing nutritional value with the addition of vegetable protein and fiber from soybean flour. Soy lecithin acts as a natural fat replacer and emulsifier that helps create a homogeneous dough, so that the steamed sponge remains soft and unbroken. In addition, it reduces the content of saturated fat, as well as providing a healthier alternative to health. Steamed sponge cake was selected as the model product due to its widespread consumption and cultural significance in many Asian countries, as well as its simple ingredient composition and relatively delicate structure. Its texture and volume are highly dependent on the aeration and emulsification properties of the batter, making it an ideal food matrix for studying the functional effects of fat replacement. Furthermore, steamed sponge cakes are prepared without baking, thereby minimizing thermal degradation of sensitive ingredients and allowing clearer observation of changes in quality parameters resulting from the substitution of conventional fats with soy milk and lecithin.

METHOD

Tools and Materials

The tools used in this study were steamed sponge mold pans, mixers, stoves, boilers, grinders and 80 mesh sieves, digital scales, porcelain cups, texture analyzer TX-700, kjeldahl flasks, measuring flasks, test tubes, Pasteur pipettes, Erlenmeyer, 100 mL measuring cups. The raw materials used in the study were eggs, soybeans, soy lecithin, wheat flour, baking powder, vanilla powder, emulsifier (SP), vegetable oil and sugar, aquadest, n-hexane, HCl, H_2SO_4 and NaOH.

Experimental Design

The study employed a Factorial Completely Randomized Design (CRD). Factor I comprised the ratio of eggs to soy milk (T) at three treatment levels: T1 (100%:0%), T2 (75%:25%), and T3 (50%:50%). Factor II involved the addition of soy lecithin at two levels: L1 (2%) and L2 (4%). Each treatment combination was replicated three times, resulting in a total of 18 experimental units.

Making Roasted Full-fat Soy Flour

The process of making Roasted full-fat soy flour was adapted from Amadi & Ovuchimeru (2020), Soybeans were first sorted to remove moldy seeds, then soaked in water for 8 hours. After soaking, the soybeans were drained and manually dehulled. The dehulled seeds were dried in an oven at 100 °C for 8 hours until the moisture content reached 9%. The dried seeds were then roasted in a pan at 180 °C for 10 minutes. Following roasting, the soybean kernels were ground using a grinder and sifted through an 80-mesh sieve to obtain a fine and uniform flour.

The Stages of Soy Milk Production

The procedure for preparing soy milk was adapted from Rahmati & Tehrani (2015). Roasted full-fat soy flour was dissolved in hot water at 90–95 °C in a weight ratio of 3:1 (water:roasted full-fat soy flour). The mixture was then stirred using a mixer for 20 minutes.

Procedure for the Preparation of Steamed Sponge Cake

The procedure for preparing the steamed sponge cake was adapted from Baharudin et al. (2023), with modifications to several ingredient quantities. The preparation began with the arrangement of equipment and ingredients. A mixture of 140 g of eggs, 3 g of SP, and 100 g of granulated sugar was placed in a container and beaten using a mixer until the volume increased and the color turned pale white. 150 g of wheat flour, 2.5 g of baking powder, 2 g of vanilla powder, 30 mL of vegetable oil, and soy milk (in specified ratios to whole eggs) together with soy lecithin at concentrations of 2% and 4% were then incorporated into the mixture. The batter was poured into an 18 cm mold and placed on a baking dish. Steaming was carried out for 20 minutes at a temperature of 80–100 °C. The steamed sponge was then removed, cooled to room temperature, and released from the mold.

Moisture Content Analysis

The moisture content measurement refers to AOAC (1995), the cup was sterilized using an oven for 1 hour at a temperature of 105 °C, then put in a desiccant for 15 minutes to cool and weigh. The mashed ingredients were weighed as much as ±2 g in an empty cup of known weight. The ingredients were dried in the oven at 105 °C for 5 hours. Next, the sample was cooled in a desiccant for 15 minutes and weighed. This treatment was repeated until a constant weight is achieved. The calculation of moisture content can be calculated on the following formula:

$$\text{Moisture Content} = \frac{(\mathrm{B} - \mathrm{C})}{(\mathrm{B} - \mathrm{A})} \text{ X } 100\%$$

Information: A: Weight of empty cups, B: Cup weight + ingredients before drying, C: Cup weight + material after drying

Volume and Specific Volume Analysis

The measurement of the volume of steamed sponge cake was adapted from Handayani (2022) and performed using the seed displacement method with millet grains. The volume of the mold was first determined by filling it with millet grains and weighing the contents. The mold was then filled halfway with millet grains, after which the steamed sponge—previously wrapped in plastic—was placed into the mold. The remaining space was filled with the rest of the millet grains. The millet grains that did not fit into the mold were weighed. The volume of the steamed sponge cake was calculated using the following formula:

$$\text{Volume } (cm^3) = \frac{W1\ (g)}{W2\ (g)} \times mold\ volume$$

Information:

W1 = Weight of remaining millet seeds, W2 = weight of whole millet seeds

The specific volume of steamed sponge is calculated by the following formula:

$$\text{Specific Volume } (cm^3/\text{g}) = \frac{Volume\ kue\ (cm^3)}{Berat\ kue\ (g)}$$

Profile Texture Analysis

Referring to Handayani (2022), texture analysis was carried out using the Texture Analyzer TX-700. Steamed sponges were cut in the form of cubes with a diameter of 4.5 cm before testing. The measurements included hardness, cohesiveness, springiness, chewiness, gumminess, and resilience values based on the graph of test results. The test was carried out by pressing the sample up to 25% of its original height at a speed of 100 mm/min. The test equipment used is in the form of a cylindrical probe with a diameter of 3 mm.

Protein Content Analysis

Referring to the (AOAC, 1995), the protein content testing in steamed sponge cakes uses the Kjeldahl method. The sample was weighed ± 0.5 g then the sample was put into the Kjeldahl pumpkin. Then 7.5 g of K_2S_2O4 and 0.35 g, H_2SO_4 were added. concentrate and HgO as much as 15 mL, then all ingredients are heated in the Kjeldahl flask in an acid cabinet and then heated until the liquid is clear and allowed to cool. Add 100 ml of aquades in kjeldahl pumpkin and 15 ml of 4% K_2S and 50% NaOH solution as much as 50 ml. Then the Kjeldahl pumpkin is heated to a boil. Distillate collection using erlenmeyer consists of 50 ml of HCl solution (0.1 N) and 5 drops of red methyl indicator, carried out until the distillate is contained up to 75 ml. After that, the distillate is titrated until it is yellow.

$$\text{N} = \frac{(A-B)X\ N\ HCl\ x\ 14{,}007}{L\ (g)} \text{x } 100\%$$

Information: A = mL sample titration, B = mL blank titration, L = Sample Weight (g), Conversion factor = 6.25, % Protein content = % N x Conversion Factor

Fat Content Analysis

Referring to the AOAC (1995), the analysis of fat content in steamed sponges was carried out based on the Soxhlet method. The fat pumpkin is dried in the oven at 105°C for 30 minutes, then cooled in a desiccant before being weighed. A total of 2 g of samples were weighed, wrapped in filter paper, and then put into a fat casing. The sleeve is covered with fat-free cotton and placed inside the extractor chamber of the Soxhlet tube. The extraction process is carried out by dousing the hexane solvent, then the Soxhlet tube is attached to the distillation device and refluxed for 5–6 hours until the solvent returning to the fat flask appears clear. After that, the solvent is distilled, and the pumpkin containing the extracted product is dried in an oven at 105°C for 60 minutes. Drying is repeated until it reaches a constant weight. Then the fat pumpkin is cooled in a desiccant for 20 minutes and weighed. The calculation of fat % is calculated using the formula:

$$Fat\ content = \frac{initial\ weight - final\ weight}{sample\ weight} \text{x } 100\%$$

Data Analysis

The data obtained physical catharsis and chemical characteristics were analyzed by Analysis of Variance (ANOVA) using the SPSS 26.0 application to determine the effect between treatments. The treatment that had a real effect was then continued using DMRT (Duncan's Multiple Range Test) at a significant level of 5% (α=0.05) to find out the real difference between the treatments given. DMRT was used following ANOVA to identify and compare significant differences among treatments.

RESULTS AND DISCUSSION

Results and Discussion

The parameters tested in this study consisted of physical characteristics (moisture content, texture, volume, specific volume and color), chemical characteristics (protein content and fat content) and organoleptic steamed sponge based on color, aroma, taste, texture and overall parameters. The results of ANOVA physical characteristics, chemistry of steamed sponge with a comparison of eggs: soy milk and the addition of lecithin can be seen in Table 2.

Table 1. ANOVA Results of Steamed Sponge

Parameters Observation		Egg: Soy Milk	Lecithin	Eggs: Soy Milk*Lecithin
Physical Characteristics	Moisture Content	*	*	ns
	Texture:			
	Hardness	*	*	*
	Cohesiveness	*	ns	ns
	Springiness	*	*	*
	Chewiness	*	*	ns
	Gumminess	*	*	*
	Resilience	*	*	*
	Volume	*	*	ns
	Specific Volume	*	*	*
Chemical Characteristics	Protein Content	*	*	ns
	Fat Content	*	ns	ns

Description: notation (*) indicates a real effect treatment and ns (not significance) indicates an intangible effect treatment.

Physical Characteristics

Moisture Content

The water content is done to determine the water content in egg-based steamed sponges, soy milk and lecithin. Moisture content is a characteristic that determines freshness, affects the texture and durability of food ingredients and the appearance of food ingredients. Food ingredients affect the shelf life of food products (Nadia et al., 2023). The average water content of steamed sponge with the addition of soy milk and lecithin can be seen in Figure 1.

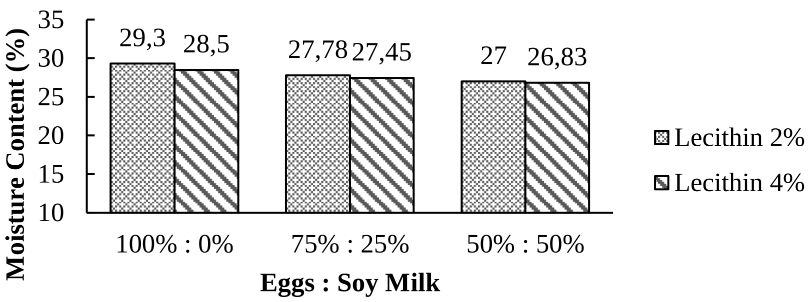

Figure 1. Effect of Egg Comparison: Soy Milk and Lecithin on Water Content of Steamed Sponge

The water content of steamed sponges decreases with the increase of soy milk and lecithin. This is because the protein content in soy milk has the ability to retain water better than egg protein, it is related to the content of aspartic acid in it which can bind 4-7 water molecules (Jarpa-Parra et al., 2017). The moisture content in steamed sponges decreases as the percentage of lecithin in steamed sponges increases. Lecithin has the property of binds water from the hydrophilic group so that the water that started as free water becomes water that can no longer move freely because it has been bound by the hydrophilic group lecithin (Fitriyaningtyas & Widyaningsih, 2015). This is in line with

Handayani (2022), research, in the manufacture of sponge cakes, the higher the percentage of lecithin can reduce the moisture content in sponge cakes, because lecithin has properties as an emulsifier that is able to increase the interaction between fat and water, thereby reducing excess water retention in the dough. The moisture content in this steamed sponge meets the standard of SNI 8372:2018 quality requirements, which is a maximum moisture content of 40% sweet bread.

Volume and Specific Volume

Volume

The volume of steamed sponge is the power of flowering, which is the increase in the volume of steamed sponge between before and after steaming. The average volume level of steamed sponge with the addition of soy milk and lecithin can be seen in Figure 2.

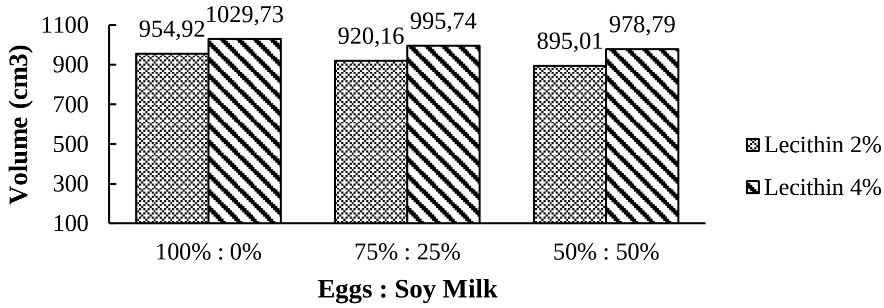

Figure 2. Effect of Egg Comparison: Soy Milk and Lecithin on the Volume of Steamed Sponge

The volume of sponge during steaming sponge dough is changed to a porous structure due to starch gelatinization and protein coagulation depending on the source of starch and protein. When the dough is heated, the air bubbles trapped in the cookie dough will expand and cause an increase in the volume of the sponge. The results of this study are in line with the research of Rahmati & Tehrani (2015), in making cakes without eggs using soy milk can cause the volume of the cake to decrease, this is due to the higher ability of soy milk in water absorption to reduce the amount of steam and air cells produced in the cake. Eggs increase the volume of steamed sponges because their albumin protein can form a stable foam when whipped, capture air, and expand when steamed. Albumins can form strong cohesive interfacial layers around air bubbles, resulting in stable foams. Their foaming properties are comparable to whey and egg white proteins, making them effective in capturing air and expanding when steamed, unlike globulin (Yang et al., 2022). In addition, Albumin proteins in egg white can form stable foams when whipped due to their ability to rapidly adsorb at the air-liquid interface, capturing air and expanding (Lomakina & Míková, 2006). This property is essential for creating volume and stability in foams. The fat and lecithin in egg yolks also help distribute air well (Imami, 2018). In contrast, soybean flour contains globulin proteins that are less effective at forming foam, as well as fiber that absorbs excess water, making the dough denser and the volume of the cake lower. The volume of steamed sponge has increased as the percentage of lecithin increases. This is due to the emulsifying properties of lecithin. During the emulsification process, mixing the dough plays a role in combining air bubbles in the dough and supporting the formation of foam. The results of this study are in line with the research of Hedayati & Tehrani (2018) in cake making, the addition of 4% lecithin to the cake making formulation can increase the volume and height of the cake.

Specific Volume

Specific volume is the volume of bread per unit weight that indicates the rate of its development. Higher values indicate better bread development, so it is expected to have great value (Sandri & Lestari, 2020). The average specific volume level of steamed sponge with the addition of soy milk and lecithin can be seen in Figure 3.

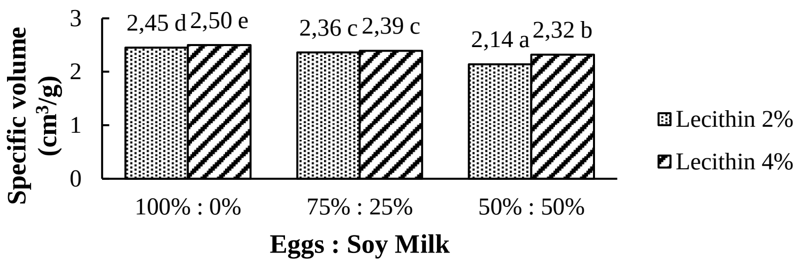

Figure 3. Effect of Egg Comparison: Soy Milk and Lecithin on the Volume of Steamed Sponge

Description: Superscript diffs show treatment differences that have a noticeable difference to other treatments on each line

The higher the percentage of soy milk added, the lower the specific volume of the steamed sponge, while the higher the percentage of lecithin added, the greater the specific volume of the steamed sponge. This is due to the ability of soy milk to be higher in water absorption, causing steamed sponges to lose the amount of steam and air produced. This is in line with the research of Rahmati & Tehrani (2015), that soy milk has a high water absorption effect from eggs which causes the cake to lose moisture and reduce the amount of steam and air produced in the cake. The specific volume of steamed sponge with 4% lecithin added is higher than 2% lecithin added. The results of this study are in line with (Handayani, 2022) research, the specific volume of sponge cake increases as the percentage of lecithin increases, This happens because soy lecithin is able to maintain the stability of the foam in the dough by stabilizing the dough tension and tension between water and fat. As a result, the resulting steamed sponge has a larger specific volume.

Texture

Texture is one of the important properties in food products that has an influence on consumer acceptance. Texture testing can be done using a texture analyzer. Hardness describes the hardness of steamed sponges which indicates the level of resistance of the cake to pressure (Rahardjo et al., 2021). Cohesiveness describes the ability of a product to maintain its structural integrity when undergoing deformation or mechanical stress, springiness or elasticity of the plastic and elastic value of a material to return to its original position after a change of shape (Afni et al., 2023), then chewiness is the energy needed to chew food or meaning chewiness and gumminess is the energy used to shrink food ingredients so that they can be swallowed (Iswara et al., 2019). Resilience is a description of the ability of food products to return to their initial form after undergoing deformation due to pressure (Indiarto et al., 2014). The values of Hardness, cohesiveness, springiness, chewiness, gumminess, resilience of steamed sponge can be seen in Table 2.

Table 2. Results of Comparative Observation of Eggs: Soy Milk and Lecithin on the Texture of Steamed Sponge

Eggs: Soy Milk: Lecithin	Hardness (N)	Cohesiveness	Springiness	Chewiness	Gumminess	Resilience
100 : 0 : 2%	0,49a	0,76	1,01d	0,38	0,37a	0,17a
100 : 0 : 4%	0,55a	0,78	1,01d	0,43	0,43a	0,22a
75 : 25 : 2%	111,39b	0,97	0,15a	18,01	109,03b	1,88b
75 : 25 : 4%	246,02c	0,98	0,29b	72,01	240,85c	1,97b
50 : 50 : 2%	369,45d	0,99	0,41c	151,15	364,17d	2,54b
50 : 50 : 4%	411,98d	0,99	0,45c	187,78	406,02d	4,49c

Description: Superscript diffs show treatment differences that have a noticeable difference to other treatments on each line

Table 2 shows that the hardness value of steamed sponge increases if soy milk and lecithin are added. Steamed sponge with the addition of a percentage of soy milk and lecithin causes the hardness value to increase, this can be due to the content of soy flour protein and lecithin used for soy milk making materials is higher than that of eggs, protein particles form a strong structure and coagulation occurs during steaming and the resulting texture is denser. This is in line with Handayani (2022), a study that the increasing substitution of soybean flour and lecithin in the manufacture of sponge cakes, the hardness value of cakes is increasing.

The cohesiveness value in steamed sponge shows that it increases when soy milk and lecithin are added. Cohesiveness is not affected by the addition of lecithin in the formulation of steamed sponges. This parameter indicates the degree of deformation in the sample before it breaks. The cohesiveness value increased because the protein in soy milk could make the tissues bind so that they were more compact, but the samples with the addition of soy milk were more susceptible to mechanical stress and their internal structure was destroyed by the compression force of the TPA probe. This is in line with the research of Rahmati & Tehrani (2015), in making cakes without eggs, more and more soy milk substitutions to replace eggs can increase the cohesiveness value of sponge cakes.

Springiness is an indication of the sample's ability to recover its original height after mechanical stress has been removed. Springiness in steamed sponges is associated with protein aggregation (Wilderjans et al., 2013). The results of this study are in line with Hedayati & Tehrani (2018), revealing that the addition of soy milk in the making of eggless cakes decreases the value of springiness while the addition of lecithin increases springiness.

The chewiness value of steamed sponge is increasing as the addition of soy milk and lecithin increases. This can be interpreted on the grounds that the hardness value of the steamed sponge produces a similar chewiness of the steamed sponge. According to Rahmati & Tehrani (2015), the chewiness value is related to the gumminess and springiness values, therefore the same energy value is measured for chewing a cake sample with similar texture hardness. This is in line with Handayani (2022) research, the chewiness value increases along with the addition of the ratio of soybean flour and lecithin substitution in sponge cakes.

The gumminess parameter is used to determine the energy needed to shrink semi-solid food so that it can be swallowed. The gumminess value in steamed sponge increases along with the addition of soy milk and lecithin, this gumminess value is positively correlated with the hardness and cohesiveness values. According to Iswara et al. (2019), gumminess is a characteristic of semi-solid foodstuffs, the higher the hardness value, the higher the gumminess value.

Resilience is the ability of food to return to its initial form after a short period of time when pressure is applied. Resilience is affected by the protein content in steamed sponge. Proteins form elastic tissues that help food return to its original shape (Indiarto et al., 2014).

Chemical Characteristics

Protein Content

Protein is an important nutrient for the body, plays a role as a source of energy and functions in the formation and regulation of various body processes. In addition, protein is also a source of amino acids that contain elements hydrogen (H), carbon (C), nitrogen (N), oxygen (O), which are not found in fats or carbohydrates (Suryani et al., 2018). The average level of protein content of steamed sponge with the addition of soy milk and lecithin can be seen in Figure 4.

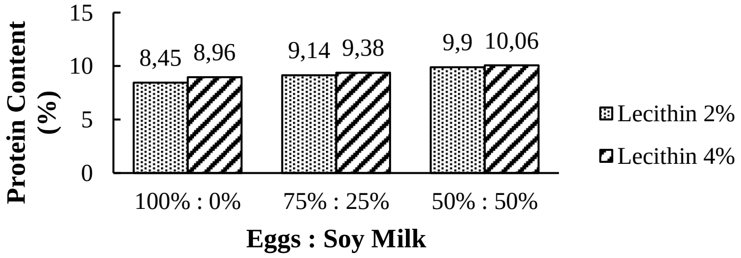

Figure 4. Effect of Egg Comparison: Soy Milk and Lecithin Addition on Protein Levels of Steamed Sponge

The high protein content causes the hardness value in the texture test to increase (Table 8). The protein content of steamed sponge increases with the increase in soy milk. This is because the protein content produced is influenced by the protein content of soy milk made from soybean flour which is quite high. This increase in protein levels can occur because according to Apriliani et al. (2024), the protein content in soybean flour is 45%, while the protein content in eggs is 12.14% and the protein content in lecithin is 1.4% (Bakhtra et al., 2016).

Fat Content

The average level of fat content of steamed sponge with the ratio of eggs: soy milk and the addition of lecithin can be seen in the graph of fat content of steamed sponge which can be seen in Figure 5.

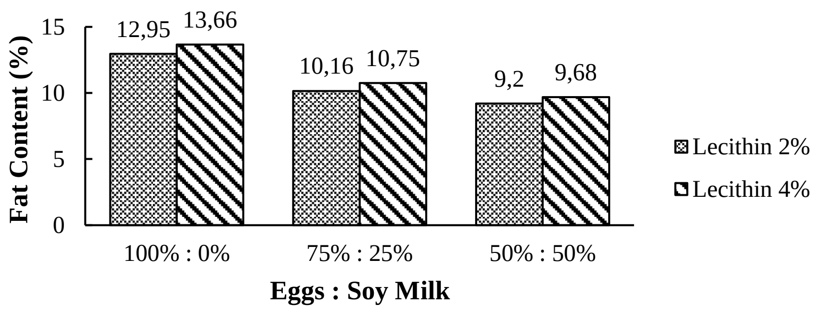

Figure 5. Effect of Egg Comparison: Soy Milk and Lecithin on Fat Levels of Steamed Sponge

The fat content affects the texture of steamed sponge, high fat content can provide a softer texture (Pareyt et al., 2009). According to Bakhtra et al. (2016), the fat content in eggs is 11 g per 100 g, while soybean flour contains 20 g per 100 g. Although soy flour has a higher percentage of fat, the amount of soy flour used in soy milk is less, so the total fat in the dough remains lower. Eggs and soybeans have different types of fats, namely eggs are a type of saturated fat, while soybean flour has a type of unsaturated fat. Lecithin contains 50% fat, so the more lecithin is added, the fat content in steamed sponges increases (Estiasih et al., 2013).

This material substitution (egg) offers practical advantages for both producers and consumers. For producers, the use of soy milk and soy lecithin can reduce dependence on animal-based ingredients, potentially lowering production costs and increasing product shelf life due to the stabilizing properties of soy components. For consumers, the substitution provides an alternative suitable for individuals with egg allergies, or those following vegetarian or vegan diets, while maintaining desirable sensory qualities such as texture, volume, and flavor. Studies showed that substituting up to 75% of eggs with soy milk in cake recipes resulted in cakes with low density, high volume, and satisfactory texture and sensory properties (Rahmati & Tehrani, 2015).

CONCLUSION

The results showed that soy milk had a real effect on moisture content, volume, specific volume, texture, protein content and fat content. The addition of lecithin had a significant effect on water content, volume, specific volume, hardness, springiness, chewiness, gumminess, resilience and protein content. The interaction between soy milk and lecithin had a significant effect on specific volume, hardness, springiness, gumminess, resilience.

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AUTHOR CONTRIBUTION STATEMENT

LAP conducted the experiments and collected the data. LAP, LH and UA conceived and designed the study, interpreted the results, and contributed to the drafting and revision of the manuscript. MZI, MQR, and KE served as the proofreader, ensuring clarity, consistency, and linguistic accuracy throughout the final manuscript.

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