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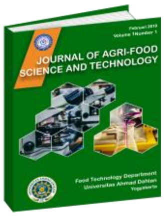

Chemical Characteristics of Non-Dairy Cheese from Coconut Milk as an Alternative Ingredient for Lactose Intolerance

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ABSTRACT

Lactose-intolerant people are unable to ingest cheese since it includes lactose. Lactose-free cheese can be made using coconut milk as an alternative. Coconut milk can substitute milk as a raw material for cheese production because it is rich in proteins such as albumin, globulin, prolamin, and glutelin. This research aims to determine how different proportions of coconut milk and soy extract affect the nutritional value of coconut milk cheese. Cheeses with 80:20, 70:30, and 60:40 ratios of coconut milk to soy extract are made by directly acidifying soy extract with lemon juice. Protein, lipid, and moisture content were all evaluated. At compositions 80:20, 70:30, and 60:40, the protein content of coconut milk cheese was 3.85%; 4.80%; and 5.73%, respectively. Coconut milk cheese had lipid contents of 28%, 27%, and 25.74%, respectively; the moisture contents were 64.93%; 61.92%; and 60.49%. This research contributes to utilizing coconut milk as a milk substitute.

1. INTRODUCTION

Cheese is a widely consumed dairy product. According to GEA (Global Engineering Alliance) data, Asia experienced the highest cheese market growth in 2016 with a Compound Annual Growth Rate (CAGR) of 5.3%. The substantial amount of cheese purchased from Southeast Asia as USDEC (US Dairy Export Council), raised cheese exports from the United States by 6% in April 2017. Because cheese includes lactose, the primary carbohydrate in cow's milk, people with lactose intolerance (LI) cannot consume it (Gambelli, 2017). The digestive symptoms of bloating, diarrhea, and excessive gas production are caused by lactose intolerance, which is caused by decreased activity or a lack of lactase, the enzyme responsible for digesting lactose (Deng et al., 2015). Notably, the most common health problem in Asia is lactose intolerance (LI). In children between the ages of 3 and 5 years, 6 to 11 years, and 12 to 14 years, the prevalence of LI was found to be 21.3%, 57.8%, and 73%, respectively, according to a study carried out in Indonesia. The USDA (2012) states that cheese has a lactose level that ranges from 0.35 to 7.05% per 100 grams.

Many researchers have attempted to create soy extract (non-dairy) cheese products with minimal or no lactose, specifically for people with lactose intolerance (LI) (Halim et al., 2022). According to a study conducted by Lorrungrung et al. (2014), they produced red cheese from soy extract using specific bacteria, namely *L. casei* and *M. purpureus*. The sensory analysis demonstrated that the texture and color of red soy cheese were identical to those of red cheese made from cow's milk. However, the panelists expressed a preference for the red cow's milk cheese over the red soy cheese due to the latter's milder flavor and scent. The expansion of fast food restaurants serving cheese as an ingredient, the cheaper cost of manufacturing non-dairy cheese compared to cheese made from milk, the fact that non-dairy cheese products can be modified to meet specific dietary demands, and other factors all contribute to the demand for this product (Kadbhane et al, 2019)

Cheese that is low in lactose or lactose-free can also be made with coconut milk as an alternative to cow's milk. It is a widely used ingredient in the creation of substitute milk-based goods (Amarasiri & Dissanayake, 2006). Coconut milk contains about the same amount of protein as cow's milk (3.2%, or roughly 3.33%) (Sangamithra et al., 2013). The production of non-dairy cheese with coconut milk as a substitute, has successfully developed. It produced a coconutty aroma and flavor cheese (Tipvarakarkoon et al, 2017). The protein in coconut milk allows the coagulation of the proteins needed to form cheese (Nugusu & Gudisa, 2016). Previous studies have shown that the protein properties of coconut milk and cow's milk differ enough that coagulation with rennet does not occur when using only coconut milk to make cheese (Tipvarakarnkoon, 2009). To facilitate the coagulation process, soy extract must be added to coconut milk when making non-dairy cheese. In order to enhance the flavor of cheese while masking the unpleasant smell of soybeans, coconut milk contains about 33% fat with a savory flavor (Sangamithra, et al., 2013). The amount of imported soybeans may be reduced if coconut milk is used as the primary ingredient in the manufacture of cheese. Soybean imports totaled 6.42 million tons in 2015, making up 86.95% of local soybean demand, per data from the Ministry of Agriculture. The productivity of the commodity coconut (the raw material needed to create coconut milk) is high in Indonesia, reaching 2.87 million tons in 2017.

2. MATERIALS AND METHODS

2.1. Materials

An assortment of stainless-steel vessels, thermometers, pH meters, spatulas, filter cloths, knives, filters, bowls, and stoves make up the manufacturing tools. The ingredients are Dolphin salt, grocery-store soy extract, local lemon juice, and Kara coconut milk. Analytical balance, knife, ruler, oven, desiccator, beaker, Soxhlet flash, fat flask, 100 ml Kjeldahl flask, distillation, electric heater/burner, measuring pipette, beaker glass, 100 ml volumetric flask, burette, and stative are some of the equipment used to measure the properties of coconut milk cheese. While the ingredients included white bread, aluminum foil, boiling stones, hydrochloric acid, filter paper, hexane, sodium hydroxide, concentrated sulfuric acid (H_2SO_4), and distilled water.

2.2. Research Methods

2.2.1. Material

Three different ratios of coconut milk to soy extract are used to create the cheesemaking ingredients: 80:20, 70:30, and 60:40. Based on earlier research (Tipvarakarnkoon et al., 2017) that produced cheese with a composition of coconut milk and cow's milk, specifically 50:50, the composition was determined. Since Soler's study found that it was not possible to successfully produce cheese using either of the two formulations (100 percent coconut milk or 90 percent coconut milk), neither of these options was explored further in the present investigation (2005).

2.2.2. Methods

Coconut milk cheese's moisture content is measured based on SNI 01-2891-1992 point 5.1 (drying method or oven method). The principle of the oven method is to remove some of the moisture from the food using heat energy. Using the Weibull hydrolysis method described in SNI 01-2891-1992 point 8.2, the lipid content of coconut milk cheese was determined. To release the sample's bound lipid content, the sample is first hydrolyzed with acid, then soxhlet extraction is performed. After the extraction process is complete, the collected extract is heated again with the aim of evaporating the solvent (Yenrina, 2015). Measurement of protein content in coconut milk based on SNI 01-2891-1992 point 7.1 (Semimicro Kjeldahl Method).

3. RESULT AND DISCUSSION

3.1. Moisture Content

Moisture content is one of the important parameters that affect the yield and quality of cheese. Moisture content in cheese can reduce the hardness of cheese and make it easier to spoil. Cheese's moisture content is one of the factors used to determine whether a product meets quality standards in terms of texture, shelf life, and specifications (Lee, Anema & Klostermeyer, 2004). The average moisture content of coconut milk with the ratio of the composition of coconut milk:soy extract is shown in Table 1. The results show that the moisture content of coconut milk cheese in each composition is different.

Table 1. The Moisture Content of Coconut Milk Cheese

Coconut milk:soy extract ratio	Moisture content (%)
80:20	64.93
70:30	61.92
60:40	60.49

In cheese, fat globules and moisture are both retained in the protein network matrix created during coagulation (MacGibbon, et al., 2006). As the composition of coconut milk changed and that of soy extract increased, the moisture content of coconut milk cheese also changed. The cheese's fat content may be to blame for the decrease in moisture content in coconut milk cheese. The syneresis process can be slowed down by the fat that is physically preventing the moisture from being released from the protein matrix that is trapped in the cheese (Everard, et al., 2011). In addition, trapped fat also limits the contraction or interaction of protein networks so that it can reduce the level of syneresis (MacGibbon, et al., 2006). Strong hydrophobic interactions between protein networks can force the water trapped in the protein network (matrix) out (Smith, 2013). Decreasing the composition of coconut milk in the cheese means that the fat content of the cheese decreases. When the fat content of the cheese decreases, the number of fat globules that occupy the gaps in the protein matrix decreases, thereby reducing barriers to whey separation and facilitating hydrophobic interactions between protein networks which accelerates the syneresis process. The syneresis process will remove a lot of moisture from the cheese protein matrix so that the moisture content in the cheese also decreases (Ferreira, 2011).

3.2. Lipid Content

The flavor, aroma, and consistency of cheese are all shaped by a number of factors, one of which is fat. Cheese flavor is enhanced by fatty acids produced as a result of lipase activity. Cheese's low fat content enables it to be flavorless (Estikomah, 2017). Table 2 displays the typical fat content of coconut milk along with the soy extract composition ratio of coconut milk. The findings indicate that there are differences in the amount of fat in each composition of coconut milk cheese.

As the proportion of coconut milk in the cheese grew smaller and the proportion of soy extract grew larger, the fat content of the cheese dwindled. This study's usage of coconut milk, which has a fat content of 24%, and soy extract, which has a fat content of 4.67%, is consistent with the composition of the components employed, as shown by the results (Hajirostamloo, 2009). A porous protein matrix structure (in the form of a cross-linking protein) will be created during the protein coagulation process, which can catch fat globules. During the coagulation process, fat globules may merge. According to research, the fat globules trapped in the protein matrix of cheese are larger than the fat globules that originally existed in milk (Lopez, 2005).

Table 2. Lipid Content of Coconut Milk Cheese

Coconut milk:soy extract ratio	Lipid content (%)
80:20	28.30
70:30	27.43
60:40	25.74

The amount of lipids used to make cheese might vary depending on the size of the fat globule. Small fat globules are less likely to get caught in protein networks than large fat globule aggregates (Rybak, 2016). The homogenization process frequently results in a reduction in the size of fat globules. The size of the fat globules is also influenced by the structure of the protein network generated in cheese. Fat globules cannot be trapped or gathered when there is a thick protein network matrix present. Smaller fat globules that are more difficult to trap in the protein matrix will result from preventing the merging of these fat globules (Lopez, 2005). This might account for both the increased soy extract concentration and the decreased fat content of coconut milk cheese. Less fat is retained in the cheese because soy extract, which has a higher protein content than coconut milk, forms a denser protein matrix and inhibits fat globules from merging and binding together.

3.3. Protein Content

Protein plays a significant role in the creation of cheese (when coagulants cause protein to cluster together). Table 3 compares the ratio of coconut milk to soy extract with the average protein content of coconut milk cheese. The findings indicate that each composition's coconut milk cheese contains a varied amount of protein.

Table 3. Protein Content of Coconut Milk Cheese

Coconut milk:soy extract ratio	Protein content (%)
80:20	3.85
70:30	4.80
60:40	5.73

As the composition of coconut milk changed, the protein content of the coconut milk cheese also changed. These outcomes are consistent with how the chemicals were formulated. Protein content in soy extract is 6.73%, compared to 2.6% in the coconut milk used in this study (Hajirostamloo, 2009). Differences in protein levels can also be caused by the protein characteristics of coconut milk and soy extract. The majority of the protein in coconut milk and soy extract is salt-soluble globulin. According to a sedimentation study, the features of coconut milk protein are the same as those of soy extract proteins, namely the 7S and 11S protein groups (Rasyid, Manullang, & Hansen, 1992). The protein in coconut milk is cocosin (11S) as much as 86% of the total globulin and vicilin (7S) as much as 14% of the total globulin (Garcia, et al., 2005). While the protein in soy extract is glycinin (11S) as much as 39-43% and β-conglycinin (7S) as much as 18-19%. The proteins that play a role in forming cross-linking during coagulation are the 11S cocosin and glycinin protein groups (Li, 2005). The 7S protein group can also form protein networks during coagulation, but the rate of formation is slower than the 11S protein (Dey, et al., 2017). Even though they belong to the same protein group, the amino acids in coconut milk and soy extract proteins are different. The most abundant amino acids in coconut milk protein are glutamic acid (16-17%) and arginine (11-14%) (Rasyid, Manullang, & Hansen, 1992). While the most abundant amino acids in soy extract protein are glutamic acid (19-20%) and aspartic acid (11-12%) (Wang & Cavins, 1989). Each amino acid has a different isoelectric point (pI). The isoelectric points of arginine, glutamic acid, and aspartic acid respectively are 10.8; 3,2; and 2.8 (Wade, 2010). The amount of arginine in coconut protein (11-14%) is higher than in soy extract protein (6-8%) (Wang & Cavins, 1989). Arginine, which has an isoelectric point of 10.8, does not coagulate optimally in cheese making which is carried out at a pH of 4.6. This can cause cheese with a higher coconut milk composition to have a lower protein content, and vice versa. While the amino acid protein of soy extract has an isoelectric point close to the pH of cheese-making so that the protein coagulation process takes place optimally and produces cheese with a higher protein content.

4. CONCLUSIONS

As the coconut milk's composition is altered and soy extract is added, the proportion of protein grows and that of fat and moisture decreases. The coconut milk and soy extract mixture with a 60:40 ratio had the highest protein content.

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