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Technological Engineering for Traditional Coconut Oil Making

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Abstract

This study aims to determine the effect of pineapple extract concentration and duration of fermentation on the characteristics and good quantity and to determine the concentration of pineapple extract and fermentation duration that can produce coconut oil with the highest yield with characteristics that meet Indonesian National Standard No. 01-2902-1999. This research was carried out at the Food Analysis Laboratory, Faculty of Agriculture, Universitas Warmadewa. This research is a factorial experiment with Randomized Block Design (RBD) consisting of 2 (two) factors, namely: factor I, pineapple extract concentration composed of 4 levels, namely pineapple extract concentration 10%, 15%, 20%, and 25%. Factor II, fermentation duration consisting of 3 degrees, 12 hours, 24 hours and 36 hours. The variables observed for coconut oil include objective observations namely analysis of oil yield, water content, free fatty acid levels, peroxide numbers, levels of impurities and acid numbers. While subjective views include the test of flavor, color, taste and overall acceptance, the best quality of coconut oil is objectively obtained in the addition of 15% pineapple extract with 12 hours of fermentation. Subjectively the influence of each treatment on the highest variable of color, flavor, taste, and acceptance was obtained in the addition of 25% pineapple extract with 12 hours of fermentation. Compared to Indonesian National Standard No. 01-2902-1999 found that the tested variables met the requirements except for oil impurities that were still very high (more than 0.05%) and the water content in the pineapple extract treatment was 10%, and fermentation duration was 36 hours exceeding the standard of 0.533% (SNI requirements maximum of 0.5%).

Keywords: Coconut Oil; Fermentation; Pineapple Extract

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1. Introduction

Cooking oil or food oil is one of the basic needs of the community. As one of the essential food substances for the human body, Oil is an energy source where 1 gram of oil can produce 9 kcal [1]. It plays an essential role in processing foods because oil has a high boiling point. Therefore, it can be used to fry food to make it dry and contain less water.

Coconut oil which is traditionally processed (physics/heating) has the disadvantage of a high peroxide number which will trigger rancidity [2, 3]. The price of coconut oil tends to be expensive because in the process of producing coconut oil that is less efficient. The method of producing coconut oil traditionally requires some stages in heating the coconut milk to produce coconut oil so that it consumes a lot of fuel and a relatively long time. In addition to affecting production costs, long time heating can affect the quality of oil, especially reducing the nutritional value of it. Therefore, it is necessary to improve the processing of coconut oil that does not use precipitating and bleaching chemicals, namely by fermentation.

Fermentation treatment is expected not to require chemicals and avoid the formation of trans fatty acids. The excess extraction of coconut oil by fermentation is practical, energy saving, low residue blonde, low acid numbers and free of cholesterol-inducing compounds [4]. One of the fermentation

treatments that can be done in producing coconut oil is the addition of enzymes.

Producing fermented coconut oil is a process of making oil by breaking down the protein-fat bonds in the coconut emulsion with the help of enzymes. Proteins in lipoprotein bonds are broken down with the help of protease enzymes. One source of this enzyme is pineapple [5]. In pineapple, the enzyme contains bromelain. The bromelain enzyme is a type of protease enzyme that can hydrolyze the peptide bonds in proteins into smaller molecules namely amino acids so that the body easily digests them. Bromelain enzymes are present in all pineapple plant tissues. About half of the protein in pineapple contains bromelain protease. Among the various types of fruit, pineapple is a high-concentration protease source in ripe fruit [6].

The use of bromelain enzymes in the production of coconut oil is still in liquid form (juice). Enzymatically producing coconut oil, in this case, using bromelain enzyme is done by a wet method where the enzyme will degrade the protein component and break down the coconut cell wall so that the oil is more easily separated from the water. The addition of bromelain enzymes in the manufacture of coconut oil traditionally is expected to reduce the length of heating so that the process of producing coconut oil saves energy and produces more oil and has a quality that meets the Indonesian National Standard.

Based on the description above, a research was conducted on the effect of pineapple extract concentration and fermentation duration on the quality and quantity of coconut oil, as well as on the level of how and for how long fermentation is needed to produce coconut oil of the highest quality.

2. Materials and methods

Location and time of research

The study was conducted at the Food Analysis Laboratory of the Faculty of Agriculture, Universitas Warmadewa. The study was conducted for five months, namely from March to July 2018.

Material and equipment

The raw material used in this study was medium-sized coconut fruit obtained from coconut plantations of farmers in *Banjar* Dukuh, Penebel Village, Tabanan. The coconut fruit used is about 11-12 months old, characterized by brownish skin and when it is shaken there is the sound of water. Pineapple used in this study was Honey Pineapple from Malang which was purchased from UD. Pala, having its address at Jalan Setia Budi, Denpasar. Other ingredients used are water. The chemicals used in the analysis were distilled water, 0.1 N KOH solution, pineapple, 0.1 N NaOH solution, 0.1 N sodium thiosulfate, 96% alcohol, indicator phenolphthalein, chloroform, glacial acetic acid, petroleum ether, saturated KI solution, 0.5 N HCl solution, 1% starch indicator, filter paper and Whatman paper No.42.

The tools used in the process of producing coconut oil in this study are pots, plastic washbasins, pans, spoons, stoves, stirrers, plastic hoses, plastic funnels, filter cloth, and thermometers. While the tools used for analysis are the beaker, funnel, stirring rod, measuring cup, blender, Erlenmeyer, stative, clamp, oven, porcelain cup, and drop pipette.

Research design

This research is a factorial experiment with Randomized Block Design (RBD). Grouping is based on different sample processing times. This study consisted of 2 (two) factors: factor I, pineapple extract concentration composed of 4 levels, namely pineapple extract concentration 10%, 15%, 20%, and 25%:

factor II, fermentation duration consisting of 3 degrees, 12 hours, 24 hours and 36 hours. Each treatment was repeated two times to obtain 24 experimental units. The data collected were then analyzed for variance and if there was a real or very significant effect between the treatment (pineapple extract concentration and fermentation duration) then continued with LSD test 5% and 1%.

Research Implementation

The research stage consisted of making pineapple extract, producing coconut oil and analyzing the quality of the oil. Making pineapple extract is done by peeling pineapple from the skin, cut it small and blended, the water produced is then filtered so that the filtrate is used as a starter in producing coconut oil. Producing coconut oil begins with making coconut milk. Coconut milk is then allowed to stand for 2 hours until the skim and cream are separated. The cream is then ground and pineapple extract is added according to the treatment and then fermented. After fermentation, there will be three layers, namely the lowest layer (water), an oil layer and blonde layer. The lowest layer (water) is removed, while the oil layer and blonde layer are heated at a temperature of 100-110 ° C while stirring continuously for 30 minutes. The oil produced is then analyzed according to the parameters observed.

Observation Variable

The variables observed for coconut oil include objective observation, namely oil yield analysis, water content, free fatty acid levels, peroxide numbers, impurities, and acid numbers while subjective views include the test of flavor, color, taste and overall acceptance.

Data analysis

The data obtained from objective tests were processed by analysis of variance (F test) if the results showed a significant / very significant effect on the oil characteristics then continued with BNT test 5% and 1%. Whereas the organoleptic test of flavor, color, and overall acceptance were carried out by data analysis with Duncan's distinguishing test.

3. Results and Discussion

Traditional coconut oil which production process was modified by fermentation is analyzed objectively with the parameters of yield, water content, dirt content, free fatty acid content, peroxide number, and the acid number by the Indonesian National Standard (SNI) and subjective analysis of color, flavor, taste and overall acceptance. The interaction between the addition of pineapple extract and fermentation duration showed a very significant effect ($P < 0.01$) on peroxide numbers, significantly ($P < 0.05$) on moisture content and free fatty acid levels and no significant impact ($P > 0.05$) against other variables. The subjective variables showed that the color observations and overall assessment showed a very significant effect ($P < 0.01$) while the observation of flavor and taste showed an unreal impact ($P > 0.05$).

Objective Variables

The highest yield was obtained by adding 25% pineapple extract with 24 hours fermentation time which was 21.75% w/v. The results of the analysis showed that the more pineapple extract added there was a tendency for more yields to be obtained but statistically different was not real. This indicates that the higher the addition of pineapple extract, the fermentation process becomes optimal because the enzyme bromelain can break down the protein bonds in the coconut emulsion. With the breakdown of the protein, the lipoprotein bond in the coconut milk will also break itself. Then, the oil that is bound by

the bond will come out and collect into one [7]. At specific substrate concentrations the reaction speed increases with the increase in enzyme concentration, this is because more and more substrates can be associated with the active part of the bromelain enzyme which causes the reaction speed to increase and the number of reaction results increases [8]. Fermentation for 24 hours becomes an effective fermentation time to produce the highest amount of oil yield. This means that pineapple extract takes 24 hours to hydrolyze all peptide bonds so that with the oil emulsion damaged, the oil points are all free. The average value of water content from the effect of adding pineapple extract and fermentation time can be seen in Table 1.

Table 1.
The average water content of coconut oil (%) in the treatment of addition to pineapple extract and length of fermentation

Treatment	Fermentation Treatment		
Addition of Pineapple Extract	12 hour	24 hour	36 hour
Extract 10 %	0.20 c (b)	0.45 b (a)	0.53 a (a)
Extract 15 %	0.17 c (b)	0.37 b (a)	0.48 a (a)
Extract 20 %	0.26 b (ab)	0.44 a (a)	0.45 a (a)
Extract 25 %	0.34 b (a)	0.42 a (a)	0.46 a (a)
LSD (0.05)	0.08		

The water content of coconut oil obtained from the addition of pineapple extract and the duration of fermentation when compared to the Indonesian National Standard [9] showed only one treatment that did not meet the standards, namely the addition of 10% pineapple extract with 36 hours of fermentation with 0.53% higher than SNI, namely max. 0.5%. Determination of water content is essential because water contained in oil can affect the quality of the oil. The lower the water content provided in the oil the better the quality. The high water content in the addition of 25% pineapple extract is caused by pineapple extract containing a certain amount of water so that the higher the concentration of pineapple extract, the higher the water contained in the oil. Thus, it takes longer to warm up to evaporate water in oil. Longer fermentation times also appear to be able to increase the water content of coconut oil, this is due to the content of ingredients such as more protein and enzymes. This is evidenced by the yellow color of the fermented oil. Moisture is associated with hydrolysis reactions from fat. If there is water or fat in the oil, the oil will be hydrolyzed to produce free fatty acids and glycerol.

Coconut oil impurities obtained from the addition of pineapple extract and the duration of fermentation did not meet the requirements of the Indonesian National Standard [9]. Dirt content based on SNI is a maximum of 0.05%, while the dirt content of coconut oil is made between 1.56% - 3.97%. The highest impurities obtained in the addition of 10% pineapple extract with 36 hours of fermentation time is 3.97%. The high level of contaminants in 36 hours of fermentation is due to the longer fermentation, the more protein, carbohydrates, and polypeptides are degraded to produce a lot of material dissolved in oil. The high level of impurities in coconut oil is caused by the traditional coconut oil making process using ordinary filter cloth so that there are still many fine impurities that escape. Dirt in coconut oil consists of 3 groups, namely 1). oil-insoluble impurities such as seeds, mucus, and latex,

fibers that come from skin, ash or minerals, 2). Contaminants in the form of colloidal suspensions in oil such as phospholipids, carbohydrates, nitrogen-containing compounds, and other complex compounds, and 3). Impurities dissolved in oil such as free fatty acids and sterols. The high level of dirt in the oil makes the oil becomes unclear and the quality decreases and if it is left to stand it settles on the bottom of the container. The duration of fermentation shows an increase in dirt content in coconut oil.

The content of coconut oil free fatty acids obtained from the addition of pineapple extract and the duration of fermentation met the requirements of the Indonesian National Standard (SNI) Number 01-2902-1999, where the levels of free fatty acids in SNI requirements were a maximum of 5%. From the observations of the highest free fatty acid levels obtained in the addition of pineapple extract 25% with a 24-hour fermentation duration of 0.83%. High free fatty acids in oil are caused by high water content. Free fatty acids are formed due to the hydrolysis process. Oil hydrolysis can be caused by the amount of water contained in the oil [8]. Average levels of free fatty acids in the addition of pineapple extract and fermentation duration can be seen in Table 2.

Table 2.
Average coconut oil free fatty acid levels in the treatment of addition to pineapple extracts and length of fermentation

Treatment	Fermentation Treatment		
Addition of Pineapple Extract	12 hour	24 hour	36 hour
Extract 10 %	0.51 a (b)	0.68 a (ab)	0.62 a (ab)
Extract 15 %	0.59 a (b)	0.52 a (b)	0.74 a (a)
Extract 20 %	0.82 a (a)	0.66 ab (ab)	0.43 b (b)
Extract 25 %	0.43 a (b)	0.83 a (a)	0.42 b (b)
LSD (0.05)	0.25		

The coconut oil peroxide number obtained from the addition of pineapple extract and the duration of fermentation met the requirements of the Indonesian National Standard (SNI) in 1999 which is a maximum of 5%. The results showed that the coconut oil peroxide number ranged between 0.538% - 3.036%. Peroxide numbers are the most important value to determine the degree of damage to oil or fat. The highest peroxide number was obtained in the addition of 10% pineapple extract with 36 hours of fermentation time which was 3.04%. Peroxide numbers are the result of hydrolysis and the oxidation process and degradation of ketones which are triggered in the presence of air, heating, light, water, and catalyst. In the 36 hour fermentation period the peroxide of coconut oil increased and was higher than all treatments. This is because the longer the fermentation time, the unsaturated fatty acids contained in coconut oil will get bigger and make oil can be in direct contact with oxygen. Thus the reaction of free radical formation which is then converted to hydroperoxide will increase. This is supported by the opinion of [10], that the oxidation reaction of oil begins with the formation of free radicals caused by factors that can accelerate reactions such as light, heat energy, metal catalysts, and enzymes. Free radicals with oxygen will form active peroxides which can form hydroperoxides which are very unstable. The average value of peroxide number from the effect of adding pineapple extract and fermentation duration can be seen in Table 3.

Table 3.
The average level of coconut oil peroxide number in the treatment of addition to pineapple extract and length of fermentation

Treatment	Fermentation Treatment		
Addition of Pineapple Extract	12 hour	24 hour	36 hour
Extract 10 %	2.25 b (a)	1.42 c (b)	3.04 a (a)
Extract 15 %	1.45 b (b)	2.39 a (a)	1.98 ab (b)
Extract 20 %	1.70 a (ab)	1.34 b (b)	1.56 a (bc)
Extract 25 %	0.54 b (c)	2.16 a (a)	1.16 b (c)
LSD (0.05)	0.73		

The level of acid numbers produced in this observation ranged from 2.55 to 5.33%. In the SNI there is no requirement for the level of the coconut oil acid number. Coconut oil acidic values ranged from 1.0 -10.0% [11, 12]. The average value of the effect of adding pineapple extract showed an unreal effect (P> 0.05). Based on Table 3.6 the addition of pineapple extract can be seen from the average acquisition of the highest acid number obtained in the addition of pineapple extract 25% that is equal to 4.44% which is not significantly different from other treatments. While in the treatment the duration of fermentation showed that the average acid number was 36 hours fermentation which was 4.79% which was not significantly different from the 24-hour fermentation treatment which was 4.48% and significantly different from the 12 hour fermentation time of 3.21 %. The acids contained in pineapple are citric acid, malic acid, and oxalic acid. The most dominant type of acid is citric acid 78% of total acid [13]. The more concentration of pineapple extract added to the oil making process, the higher the acid oil number, this is probably due to the acids contained in the pineapple extract dissolved into coconut oil. The duration of fermentation also increases the acid number because pineapple extract has longer direct contact with oil so that the organic acids in pineapple extract are more soluble in coconut oil.

Subjective Variables

Based on the analysis of variance showed that the effect of adding pineapple extract and fermentation time had a very significant impact (P <0.01) on the color of coconut oil. The average value of oil color ranges from 2.20 to 4.85 which is rather yellow to very yellow. The yellow color of coconut oil comes from the color pigments carried by pineapple extract. Pineapple contains carotenoid and xanthophyll pigments which are soluble in oil and give a yellow oil color [1]. The highest value of the highest panelist preference was obtained by adding 25% pineapple extract with 12 hours fermentation duration of 4.85 (yellow-very yellow) which was not significantly different from the 25% pineapple extract addition treatment with 36 hours fermentation time of 4.60 (yellow-very yellow) and the addition of 25% pineapple extract with 24 hours fermentation time is 4.55 (yellow-very yellow). The more pineapple extract added to coconut oil makes the color of the oil more yellow, so it is preferred by panelists.

The distinctive flavor of oil arises because of the volatile compound nonyl methyl ketone found in the ingredients that appear during heating. The addition of pineapple extract and the duration of fermentation does not affect the flavor of coconut oil. The coconut oil produced still has a distinctive characteristic of the oil. The average value of the character of oil ranges from 3.05-3.90 which is a neutral flavor to the unique taste of the oil. Analysis of variance showed that the effect of the treatment of adding pineapple extract and fermentation duration had no significant impact (P> 0.05) on the flavor of coconut oil.

Analysis of variance showed that the effect of the addition of pineapple extract and fermentation

duration has a different impact not significant (P> 0.05) on the taste of coconut oil. The average value of the oil taste ranged from 4.75-6.05 which is rather like to like. In testing the taste of coconut oil, it is used to know as a carrier because the tofu has a bland taste so that the oil that is bound to the tofu can be felt by the panelist when tasting. The addition of pineapple extract and the duration of coconut oil fermentation do not affect the taste of coconut oil and can be accepted by the panelists.

The addition of pineapple extract and the duration of coconut oil fermentation influence the acceptance of coconut oil and can be accepted by the panelists. The average value of overall oil acceptance ranges from 3.80 to 6.45, which is normal to like. The treatment that received the highest total acceptance value was the addition of 25% pineapple extract with a 12-hour fermentation duration of 6.45 (like it).

4. Conclusion

Based on the results of the study it can be concluded that the coconut oil which is made from the addition of pineapple extract and the duration of fermentation can increase the yield of coconut oil and reduce water content and free fatty acid levels. However, the production of traditional coconut oil by fermentation increases the levels of impurities, peroxide numbers, and oil acid numbers.

The best characteristics of coconut oil are objectively obtained by the addition of 15% pineapple extract with 12 hours of fermentation. Subjectively the influence of each treatment on the highest variable of color, flavor, taste, and acceptance was obtained in the addition of 25% pineapple extract with 12 hours of fermentation. Compared to the Indonesian National Standard (SNI) No. 01-2902-1999, it was found that all variables tested met the requirements except oil impurities which were still very high (more than 0.05%) and the water content in the pineapple extract treatment was 10% and fermentation duration 36 hours exceeding the standard that is 0.533% (the maximum SNI requirement is 0.5%).

The suggestions that can be submitted from the results of this study are 1). To produce oil quality using the best fermentation objectively, it can use 15% pineapple extract formulation with 12 hours fermentation time, 2). The impurity level of coconut oil is still very high so that in filtering the oil it is necessary to use a filter that is smaller in size or requires refining of coconut oil, and 3). Further research is needed regarding the shelf life of traditional coconut oil fermented with the addition of pineapple extract.

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