Accelerate of virgin coconut oil extraction using acidification methods in solar heater

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Accelerate of virgin coconut oil extraction using acidification methods in solar heater

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Abstract. The duration of the VCO oil extraction process affects quality. The centrifugation method produces high VCO quality but requires expensive in investment and operational costs. The acidification method with solar heat was produced VCO, but it took quite a long time (8-12 hours) with the success rate depending on the weather. This study aims to increase the success rate of acidification with a solar heat method through the use of solar heater. It also compares it with the standard of coconut oil quality requirements in SNI 01-2902-2001. The study was conducted in Malonas Village in 2016 involving 15 women farmers. The VCO was analyzed at the BB Pascapanen Laboratory, Bogor. The acidification/ chemistry method of VCO was tested in a solar heater and without it. The incubation process is carried out by observing the temperature, yield and drying time. VCO was tested for the percentage content of free fatty acids (FFA), yield, visual and aroma test. The result was decrease in processing time in separation coconut milk to oil, water, and blondo from 8.30 hours + 0.51 (without solar heater) to 3.45 hours + 0.16. Oil yield increased by 0.9% and the FFA level was below SNI standard and APCC.

1. Introduction
The oil extraction process from coconut can use mechanical processes (solid, copra), extraction using solvents (water, heating coconut milk) and biochemically. If coconut oil is expected in the form of virgin coconut oil (VCO), the process will not use heating method. High-temperature in the heating process will damage the active compound content of VCO such as lauric acid and vitamin E [1]. Coconut milk is a water and oil emulsion that is formed from the help of protein emulsifiers so that both can be fused. The separation of VCO process from coconut milk by heating, oil addition in stimulating process, centrifugation, and enzymatic aims to damage the emulsion system [2].

The stimulating process uses coconut oil addition in coconut milk will break emulsion need more than 10 hours to harvest it. Addition of protease enzymes or the yeast also damage the protein in coconut milk and release VCO but require more time than stimulating process. Increasing processing time also increases the levels of FFA and peroxide in oil. High peroxide number will trigger rancidity and it also detected in the heating process (traditional process). The Nonyl methyl ketone compounds which are abundant in coconut milk will changes in volatile form in high temperature (heating process) and release a specific aroma. The centrifugation technique is known as best method to separate oil from coconut milk by combining stimulating techniques, fermentation, acidification and heating with a certain temperature on a large scale production but need high investment in equipment. It also requires high
voltage and electricity consumption so that production costs are high so it is less suitable for home industries.

The separation of oil from coconut milk using acidification has been successfully produced [3], but the yield depends on weather conditions. Processing time to harvest VCO after addition acetate acid was 8-20 hours. The presence of acid in coconut milk will cause the pH of the solution to reach the isoelectric point of the protein. The isoelectric point is the degree of acidity (pH) when a zero-charged macromolecule is due to an increase in proton or loss of charge in an acid-base reaction, so that part or all of the charges in the particle will be lost during the ionization process. This study aims to determine the level of success, characteristics, and quality of VCO resulting from the method of acidification with the use of greenhouse type heaters and compare it with the standard of quality of coconut oil SNI 01-2902-2001.

2. Material and Methods
The research was conducted in Malonas Village in 2016 involving 15 women farmers. The VCO results were analyzed at the BB Pascapanen Laboratory, Bogor.

2.1 Material
Coconut milk is extracted from aged coconuts which are 10-12 months after flowering. Acetic acid (vinegar) in 25% solution was purchased in the local market. Filter cloth, basin, wood stirrer are equipment to extracted coconut milk. The solar heater was built in 2m x 2.5m x 2m using an iron frame and plastic coated around it (figure 1).

![Figure 1. Solar heater.](image)

2.2 Methods
Grated coconut from 50 coconuts was weighed and then extracted into coconut milk by adding water and squeezed. Coconut milk is extracted until the juice is no longer cloudy and stored in a transparent container for 2 (two) hours inside the solar heater. After two hours, coconut milk will split into water and thick coconut milk at the top. Water in bottom of container has to release out and add vinegar 25 ml to thick coconut milk, then the acidic thick coconut milk solution was stirred evenly and stored again in the solar heater. Another manufacturing procedure which is compared to the solar heater was used coconut milk extracted from 50 coconuts and through all stages of the process but not used inside heater equipment.

Temperature changes in solar heater and coconut milk were collected in every hour. The average processing time was obtained from 15 farmers who carried out both of VCO methods. The processing time was processed by independent-samples t-test (independent t-test) compares the means between two unrelated groups. The variables observed for VCO include objective observation, namely oil yield analysis (mass balance), free fatty acid levels, peroxide numbers, and impurities. The composition of VCO was analyzed using gas chromatography.
3. Results and Discussion

3.1 Temperature changes inside the solar heater

The temperature produced by the solar heater in the greenhouse type was higher than the ambient temperature (figure 2) and the maximum temperature that can be reached was 50°C. This showed that this heater can increase the temperature inside the device and it was still in safe limits for the manufacture of VCO which requires that the heating temperature of coconut milk should not exceed 60°C [1,4].

The increasing temperature inside solar heater chamber was not linear with ambient temperature. The relationship between solar heater temperature and ambient temperature was quadratic in the range of environmental temperatures of 30-39°C [5]. The coconut milk was separated into three part; water, blondo and oil as a finished process. The average time of the separation process used solar heater was 3.45 hours ± 0.16 after addition vinegar lower than separation time without equipment was 8.30 hours ± 0.51.

Figure 2. Changes in ambient temperature, heating and coconut milk based on hours.

Figure 3. VCO Separation inside of solar heater.
3.2 VCO Mass Balance
Mass balance calculation was based on addition and removing material in the process. In figure 4 was presented mass balance in producing VCO. Yield VCO using a solar heater was 12.3% higher than yield VCO without equipment (11.40%). The effect of water ratio to soak grated coconut also affected yield because more solvent was used in process will extract oil more. One liter of coconut milk was extracted oil 35.2% [6]. In traditional extracted methods using cooking will produced higher yield oil from coconut milk because the oil contained in blondo is 3-4%.

| VCO Process Stage                        | Without Solar Heater | Total   | Using Solar Heater | Total   |
|------------------------------------------|----------------------|---------|--------------------|---------|
| Grated Coconut                           | 25000 g              | 25000 g | 27500 g            | 27500 g |
| + Water Addition                         | + Water 35000 g      | 60000 g | Water 30000 g      | 57500 g |
| Squeeze                                  |                      |         |                    |         |
| - Coconut Pulp                           | 21750 g              | 38250 g | Coconut Pulp 22000 g | 35500 g |
| Incubation                               |                      |         |                    |         |
| Thick coconut milk separation            | - Water 34000 g      | 4250 g  | Water 30000 g      | 5500 g  |
| Vinegar addition                         | + Vinegar 25 g       | 4275 g  | Vinegar 25 g       | 5525 g  |
| Incubation                               |                      |         |                    |         |
| Oil, water and blondo separation         | - Water 1425 g       | 2850 g  | Water 2142 g       | 3383.3 g|
| VCO                                      | 3125 ml              | 2850 g  | 3125 ml            | 3709.8 ml|
| Yield                                    | 11.40 %              |         | 12.30 %            |         |

Figure 4. VCO mass balance calculation.

3.3. VCO Characteristics and Quality
VCO was produced using acidification and solar heating combination has a level of FFA around 0.15-0.18% which is lower than APCC standard. High FFA level in VCO was caused by manually separation method. [7] explain this process occurs due to a reaction between oil and water trapped in oil so that free fatty acids are produced known as hydrolytic rancidity. The process of adding excess acetic acid will not agglomerate blondo even at isoelectric pH, this is because coconut oil residue in blondo blocks the contact between acid and proteins. [8] suspected that the longer fermentation time could cause the pH of coconut milk to be back away from the pH of the isoelectric point so that the protein returned to dissolve. Protein which was dissolved will affect damage to oil. In table 1, a comparison of the quality of VCO Oil acidification method, SNI Standards, and APCC were presented.
Table 1. Comparison quality of VCO from acidification method, SNI Standards and APCC.

| Quality component | VCO Method and Standard |
|-------------------|-------------------------|
|                   | SNI Standard*            | APCC Standard*     | Acidification method | Acidification used solar heater |
| FFA (%)           | Max 5%                   | Max 0.5%           | 0.15                 | 0.18                            |
| Peroxide (meg/Kg) | Max 3                    | Max 5             | -                    | 1.83                            |
| Iod (wijs)        | 8-10                     | 4.1-11            | -                    | 14.36                           |
| Yield (%)         | -                        | -                 | 11.4                 | 12.3                            |
| Color             | Clear                    | Clear             | Clear                | Clear                           |
| Aroma             | Specific                 | Specific          | Specific              | Specific                        |
| Taste             | Normal                   | Normal            | Normal               | Normal                          |
| Laurat (%)        |                          |                   | 40.50                |                                 |
| Caprylic (%)      |                          |                   | 3.70                 |                                 |
| Caprat (%)        |                          |                   | 3.87                 |                                 |
| Palmitate (%)     |                          |                   | 18.69                |                                 |
| Oleate (%)        |                          |                   | 11.89                |                                 |

Source: [9]

Adding acid in coconut milk will cause the pH of the solution to reach the isoelectric point of coconut protein. If the pH is below the isoelectric point, then the charge of colloidal particles will be positively charged but if the pH is above the isoelectric point, the colloidal charge will turn neutral or negative. The protein in coconut milk contains NH$_2$ groups having a positive charge and a negatively charged in the carboxylic group [9]. Each molecule will have opposite changes and it will be more optimal if aided by temperature differences and mixing. Water and oil in coconut milk were united because there are proteins surrounding the oil molecules.

In the conventional method, coconut milk was heated in high temperature will separate oil from emulsion because the protein was broken out. In a stimulating method, oil in coconut milk will be pulled by oil which was added in the system. The initial oil which was release after ion changes (isoelectric point) will attract oil to reunite. [1] said increasing oil in water-oil emulsion will change the form of emulsion to oil-oil. Heating addition in system will accelerate the process to break out the emulsion. The acidification and solar heated was an optimal technique to separate oil and water from coconut milk using least cost and energy. VCO which produced in the centrifugation method (without heating) significantly positive reduced blood glucose in diabetic mellitus rats rather than other methods [10].

4. Conclusion
There was a decrease in processing time in separation coconut milk to oil, water and blondo from 8.30 hours ± 0.51 (without solar heater) to 3.45 hours ± 0.16 (using equipment). Oil yield increased by 0.9% and FFA level was below SNI standard and APCC.

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