

**A CRITICAL REVIEW ON DIFFERENT METHODS OF EXTRACTION FOR  
“VIRGIN COCONUT OIL”**

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**Abstract**

Thousands of years before century, people exploited virgin coconut oil for consumption as well as for cure. Even though there are many methods for extracting the virgin coconut oil, the quality and quantity of the oil obtained may vary in each method. Oil is extracted from fresh coconut meat using different methods such as mechanical or natural methods. This oil is different in its chemical composition, from the oil extracted from dried coconut. Pure virgin coconut oil is colorless, sediment free, has natural fresh coconut scent, and tastes lighter.

**Keywords:** Virgin coconut oil, Extraction.

**Introduction**

Virgin coconut oil (VCO) is growing in popularity as functional food oil and the public awareness of it is increasing. It is expected that the virgin coconut oil will experience a dramatic growth in the market. Virgin coconut oil is extracted from fresh coconut milk obtained from mature kernel of coconut by mechanical or natural means, with or without the application of heat, which does not lead to alteration of the nature of the oil. Virgin coconut oil can be consumed in its natural state without the need for further processing. Hence, virgin coconut oil does not undergo chemical refining, bleaching or deodorizing. Virgin coconut oil is colourless, free of sediment and has natural fresh coconut scent. It is free from rancid odour or taste. Virgin coconut oil consists mainly of medium chain fatty acids. The important fatty acid found in virgin coconut oil is lauric acid. Lauric acid possess powerful anti microbial properties capable of destroying disease causing bacteria, fungi, viruses and parasites. Virgin coconut oil has considerable potential for therapeutic uses such as antimicrobial, for anti-cancer therapy and for the treatment of Alzhiemer’s disease.

### **Virgin coconut oil production by boiling the coconut**

Heat 4 cups of water. Place the water in a saucepan and put it on a burner. Turn the burner to medium high and heat the water until it starts steaming. Grate the meat of 2 coconuts. Use a fully developed brown coconut instead of a young green one. Open the coconut, scoop out the meat and grate it into a bowl. Blend the coconut and water. Put the grated coconut in a blender. Pour the hot water over the coconut and close the lid of the blender. Hold the lid of the blender in place and puree the coconut and water into a smooth mixture. Don't fill the blender more than halfway full with hot water. If your blender is on the smaller side, blend the coconut and water in two batches. Filling the blender too high may cause the lid to fly off. Hold the lid in place while you're blending the mixture; otherwise it could come off while you're blending. Strain the coconut liquid. Place cheesecloth or a fine-mesh strainer over a bowl. Pour the pureed coconut over the cloth or strainer so that the coconut milk drips into the bowl. Use a spatula to push the pulp and squeeze out as much liquid as possible. If it's easier for you, you could pick up the cheesecloth and squeeze it over the bowl with your hands. To extract even more liquid, pour more hot water over the pulp and squeeze it again. Boil the coconut liquid. Place it in a saucepan on a burner and turn the heat to medium high. Bring it to a boil and cook, stirring constantly, until the water has evaporated and the cream has separated from the oil and turned brown. The process of boiling the liquid until it reaches the right state could take over an hour. Be patient, and stir constantly<sup>2</sup>. If you'd rather not boil the mixture, you can allow it to separate on its own. Place the liquid in a bowl and cover it with plastic wrap. Leave it at room temperature for 24 hours, and then place it in the refrigerator so the oil solidifies and floats to the top. Strain the oil from the liquid<sup>3</sup>.

### **Virgin coconut oil production through Fermentation System**

The coconut type used for making virgin coconut oil was according to method of Rindengan and Novarianto.,2004<sup>4</sup>. The coconut cultivars used in this experiment were kelapadalam, genjahsalak, and genjahkuning. Matured coconut was grated and the grated coconut was then mixed with hot tap water. After squeezing and filtering, coconut milk was pooled into a clean jar and stayed for 1h. After separating into two layers those were cream on upper part which is rich in oil content while skim layer is rich in protein on below part was drained off, and the remained cream one was then fermented overnight to prepare virgin coconut oil.

The fermentation of coconut cream occurred when the enzymatic starter had been employed for processing. Crude coconut oil was formed due to a phenomenon of protein digestion that plays a role to stabilize emulsion of the coconut cream into a soluble material. The enzymatic starter with high capacity of amylolytic and proteolytic could hydrolyze carbohydrate and protein which contained in the coconut the cream as its substrate into soluble sugar and amino acid and peptide<sup>5</sup>. The extraction process of coconut oil via fermentation or enzymatic system involved microbial cell and enzymes those could solve the emulsion; however, their activities were influenced by some conditions of substrate, enzyme, pH, temperature, and incubation period<sup>6</sup>. Preliminary step on extraction process of virgin coconut oil was initiated after separating the coconut cream which higher in lipid content from coconut skims which higher in carbohydrate and protein content. After addition with starter followed by overnight fermentation of the coconut cream at room temperature, the starter containing enzymes were stimulated to digest starch and ferment it into alcohol and organic acids that coagulate protein in consequence of phases formation of oil on upper part, protein in the middle and water layer on lower part<sup>4</sup>. Due to a lower molecular weight, the oil part formed through the process could be directly separated from protein and water part by draining off both of them through a valve. To reduce interference of water content or insoluble materials into the oil part, a further process of obtaining oil by refining through filter paper or vacuum filter and rinse with hot water following by vacuum evaporation was required to avoid chemically processing to achieve the virgin state of oil. Fermented coconut oil has been known well as virgin coconut oil since high temperatures, chemicals or other physical treatment are not used in its processing.

### **Virgin coconut oil production by induced fermentation with *Lactobacillus***

Fresh coconuts were dehusked and water was collected from the pore in separate container, further used in the fermentative production of coconut water alcoholic beverage and vinegar. Coconuts were broken and solid endosperm was collected, testa was removed by using kitchen peeler, white coconut balls were disintegrated into small pieces and grind with 1:2 ratio of water for 10 min. Ground mass was transferred to the cheese cloth, pressed manually for coconut milk extraction; the same process was repeated twice and coconut milk was pooled up. Extracted coconut powder was dried and preserved for another application. Coconut milk sterilization In coconut milk extraction microbes may enters through water, environment and utensils in to coconut milk. Exposing of coconut milk to Ultra Violet light

in laminar air flow was done for 20 min per liter in glass beaker. Seed culture preparation Seed culture was prepared by using of Nutrient broth medium, culture flasks were incubated at 37°C for 36 hours at 100 RPM in orbital shaker and same was maintained for entire the study. By the serial dilution and spread plate method approximately amount of microbes were calculated by colony count. Fermenter scale-up process according to the Spectrochem-India Biotron model bioreactor user manual probes of dissolved oxygen , pH were standardized, they were fixed to the fermenter vessel lid, closed the fermenter and sterilized at 121°C for 15 min. in autoclave. Sterilized coconut milk was poured in to bioreactor vessel at aseptic conditions. Further, the parameters were arranged according to the designed study. Virgin coconut oil recovery after successful completion of bioreactor runtime, the fermented milk was centrifuged in temperature controlled centrifuge at 27°C and 6000G for 10 min. Separated virgin coconut oil was collected and pooled. Virgin coconut oil of all batches were finally centrifuged for clear oil at above conditions<sup>7</sup>.

#### **Virgin coconut oil production by natural fermentation**

About 500gms of grated coconut and water at 70°C at a ratio of 1:2 was kneaded by hand for 5 min. Mixture was strained through a cheese cloth to obtain coconut milk. The coconut milk was left to ferment naturally for 16 h at 40°C. Oil was separated from fermented curd by centrifuging at 4000 rpm for 30 min at room temperature. The separated coconut oil was heated at 50°C to remove aromatic compounds. It was then weighed, flushed with nitrogen and stored in dark brown bottles at 5°C<sup>8</sup>.

#### **Virgin coconut oil production by “Cold Press Production”**

A cold press production starts with the coconuts being ground into an even paste. This paste is slowly stirred, encouraging the oil to separate from the solid parts and clump together. Once this happens, pressure is applied, forcing the oil out. This can be done with a machine, generally a hydraulic press, producing more friction and heat. The press action is not all just about pressure, it takes a scrubbing and heating action to shear the oil cells allowing the oil to release itself. Oils that are cold pressed are supposed to be in a heat controlled environment, keeping temperatures below 120 °F. The phrase 'cold pressed' has been used erroneously in the U.S. for years, often employed as a marketing tool for oils which have been expeller pressed or even refined, exposing the oil to temperatures of up to 470 °F<sup>9</sup>

### **Enzymatically extracted Virgin coconut oil**

About 500gms of grated coconut was mixed with water (1:4) and the temperature of mixture was brought to 40°C using a water bath. Amylases (1%) from *Aspergillusoryzae*, pectinase (1%) from *Aspergillusniger* and proteases (1%) from *Streptomyces griseus* were added to the coconut mixture and temperature was maintained at 40°C and agitated for 3 h using a shaking water bath. After 3 h, the solution was centrifuged at 4000 rpm for 30 min at room temperature to obtain upper coconut oil layer. Coconut oil was weighed, flushed with nitrogen and stored in dark brown bottles at 5°C<sup>8</sup>.

### **Virgin coconut oil production by centrifugation**

Centrifugation is a fourth generation coconut oil extraction process involving centrifugal force for the sedimentation of mixtures. This process is used to separate two immiscible liquids. The rate of centrifugation is specified by the angular velocity measured in revolutions per minute. The particles' settling velocity in centrifugation is a function of their size and shape, centrifugal acceleration, the volume fraction of solids present, the density difference between the particle, the liquid, and the viscosity. In theory, regarding virgin coconut oil processing, it should be working at room temperature since the oil separation is based on centrifugal force. In reality though, coconut milk emulsion has a high viscosity (thickness), which would put the centrifugal force to no effect; thus, coconut emulsion must be thinned, and the only cheap, effective way is to apply heat; the higher the temperature, the better the efficiency. Those who claim to produce virgin coconut oil generally will manipulate the coconut emulsion before centrifuging by introducing enzymes and fermentation to break down the coconut emulsion, increasing oil output.

About 500gms of grated coconut was mixed with water (1:1) to extract the coconut milk. Centrifugation was done twice (4000 rpm) to destabilise the oil-water emulsion for 30 min at room temperature. Initial centrifugation was to obtain the cream and the second centrifugation separated the cream into three layers like; oil, cream and aqueous. The top oil layer was decanted, weighed, flushed with nitrogen and stored in dark brown bottles at 5°C prior to analysis<sup>8</sup>.

### **Virgin coconut oil production by expeller pressing**

An expeller press is a screw-type machine that presses oil seeds through a caged barrel-like cavity. The machine uses friction and continuous pressure to move and compress

the seed material. Pressure involved in expeller pressing creates heat in the range of 120–210 °F. As the raw material is pressed, friction causes it to heat up. With coconuts, higher pressures are required, which can exceed temperatures of 120 °F, rendering the oil “un-raw”. This process of extraction is the most popular in the coconut oil the industry due to its high quantity and low cost production<sup>9</sup>.

### **Virgin coconut oil production by Wet mill method**

Split a coconut with a sharp cleaver. Use a mature, brown coconut, rather than a young green one. Scrape the meat of the coconut from the shell. Use a coconut scraper, sharp pairing knife or a sturdy metal spoon. A butter knife is much better than a sharp pairing knife. You can slide it in between the meat and the shell and 'pop' pieces off, rather than slip, and cut your hand. Cut the coconut meat into small pieces or shred the coconut flesh with the scraper. Place the pieces into a food processor. Turn on the food processor to a medium speed and blend until well shredded. Add a little water to help it blend if necessary. Filter the coconut milk. Put a coffee filter or cheesecloth over a wide-mouth jar. Pour or spoon a small amount of the coconut mixture onto the cloth. Wrap the cloth around the coconut mixture and squeeze the milk into the jar. Squeeze hard, to make sure you get every last drop. Repeat this process until all of the coconut mixture has been used. Leave the jar unattended for at least 24 hours. As it sets, the coconut milk and oil will separate and a layer of curd will appear at the top of the jar. Refrigerate the jar so the curd hardens more quickly if you'd like. If you'd prefer not to refrigerate it, leave the jar in a cool room. Scoop out the curd with a spoon and discard it. The pure virgin coconut oil is left in the jar<sup>1,2,3</sup>.

### **Virgin coconut oil production by chilling and thawing**

About 500gms of grated coconut was mixed with water (1:1), hand kneaded for 5 min and filtered to extract coconut milk. Coconut milk was centrifuged at 3220 ×g for 10 min and the upper layer of cream was removed for chilling. Chilling was done at 0°C for 6 h and then the chilled cream was thawed slowly at room temperature to extract the oil. Centrifugation was applied at 4000 rpm for 30 min at room temperature to obtain coconut cream. Coconut cream was further centrifuged at 4000 rpm for another 30 min to produce virgin coconut oil. Oil was weighed, flushed with nitrogen and stored in dark at 5°C prior to analysis<sup>8</sup>.

### **Refined Virgin coconut oil**

About 500gms of grated coconut was oven dried using at 75°C to a moisture content of 7%. Oil was extracted from the dried coconut by solvent extraction using n-hexane in a Soxhlet apparatus. Thermal cycle was done at 80°C for 8 h. Solvent was recovered using a rotary evaporator at 40°C under vacuum. Solvent extracted oil was refined. The coconut oil was preheated to 80°C and 85% phosphoric acid was added and temperature maintained at 85°C for 20 min. One percent of bleaching earth/activated carbon (10:1) was added to the oil and temperature was further adjusted to 95°C under vacuum for another 20 min. The bleaching earth was removed by filtration with aid of vacuum using Whatman No. 1. Oil was deodorized by heating under pressure and high temperature for 1.5 h. Oil was weighed, flushed with nitrogen and stored in dark at 5°C prior to analysis<sup>8</sup>.

### **Virgin coconut oil production by Nutralock system**

Nutralock System is a kind of fifth generation extraction process which uses no heat to extract the oil, always keeping the coconut meat at room temperature. The system consists of a closed-loop dehumidifying system that extracts the moisture out of the fruit while leaving all of the 100% raw nutrients of the coconut intact.

This is a machine is never heated above room temperature, which ensures that the medium-chain fatty acids and lauric acid get completely intact. Skinny coconut oil has the mild smell of coconuts, exceptional clarity due to low processing temperature, and almost no impurities leading to a much longer shelf life.

The Nutralock system not only locks these vitamins and minerals, but prevents oxidation. Oxidation occurs at higher temperatures and reduces the coconut oil's role as an antioxidant in the body<sup>9</sup>.

### **Virgin coconut oil production by cold extraction**

Cold extraction is the term used for the extraction coconut oil from coconut milk by breaking the emulsion without heating. The high stability of the coconut milk emulsion need the destabilization of coconut milk can be done in three stages.

In the first stage cream is separated by the action of gravitational force resulting in two phases, the top phase with the creamy layer and the down phase with aqueous layer.

The second stage is flocculation and clustering in which the oil phase moves as a group and which does not involve the rupture of the interfacial film and which does not involve the rupture of the interfacial film that normally surrounds.

The third phase is most critical phase in the destabilization of coconut milk, coalescence in this stage the interfacial areas is ruptured and reduce that help to joined oil globules together<sup>12</sup>.

This method appears more desirable due to elimination of solvent and refining, bleaching and deodorizing process, which reportedly may lower the investment cost and energy requirements, thus more environmentally friendly than the solvent extraction. Therefore, it can be carried out at home by anyone who is interested in producing their own natural oil<sup>13</sup>. Even though the concept appears potentially attractive, however, the method yields comparatively low content of oil, which has discouraged its commercial use<sup>11</sup>.

### **Virgin coconut oil production by Freezing**

The stability of coconut milk emulsion in this process is broken by freezing and thawing, and thawed cream separated by centrifugation. The emulsion was centrifuged before chilling and thawing to allow better packing of the coconut oil globules<sup>14</sup>. used the temperature 10°C and - 4°C for chilling and freezing process, respectively, and the thawing process was carried out in a water bath at 40°C until the coconut cream reached room temperature (25°C). In addition, this action also helps in removing un-dissolved solids after extraction. The removal of solids present in high percentages in the dispersion of oil seed was important for efficient recovery of oil by centrifugation<sup>11</sup>. The centrifugation step was followed to enable the packing of cream oil globule to crystallize on lowering the temperature. Centrifugation process as carried out from 2000 to 5000 rpm up to 6 min. During thawing, the oil coalesced due to loss of spherical shape and formed large droplets of varying sizes<sup>10</sup>. Investigated the freezing and thawing techniques using Robledano-Luzuriage and Krauss-Maffei methods as alternative of fermentation method. In the Robledano-Luzuriage method, the cream was exposed to control enzymatic conditions and oil was obtained by repeated centrifugation following by freeze-thaw operation. However, in the Krauss-Maffei method, first, the autoclaved coconut kernels was grated using cutter mill and roller mill and then pressed in hydraulic press to extract milk emulsion. The emulsion was centrifuged and the separated cream was heated at 92°C to obtain oil. Even though the yield of oil is slightly higher (89%), the quality of oil is lower, in Krauss-Maffei process. The study

shows that quite a high recovery of oil was obtained, but the temperature employed was slightly high, which might destroy some of its minor components such as phenolic compounds. Centrifugation Method The extraction of virgin coconut oil was studied by using various centrifugation speeds, temperature and time intervals. The results showed that the yield of virgin coconut oil was 13.53% at 12000 rpm, at 120 minutes<sup>10</sup>. The highest yield of virgin coconut oil was 13.80% at centrifugation temperature of 40°C. studied the potential of the centrifugation in demulsification of coconut milk that was collected from local market and centrifuge at different speed from 6000 to 12000 rpm for time varied from 30 to 105 min, resulting that enhanced the demulsification of coconut milk in a very short time compare to the fermentation method and provide higher yield<sup>15</sup>.

### **Virgin coconut oil production by aqueous enzymatic extraction**

Virgin coconut oil extraction can also be carried out by the use of enzymes in the aqueous extraction process<sup>21</sup>. Extracted coconut oil by an action of mixture of enzymes including Cellules, Term amyl ,Viscozyme L, neutrase and alcalase on fresh coconut kernel through coconut milk that yielded 83% of good quality oil. Augmented the yield of coconut oil up to 65.5% from copra by using a mixture of protease,  $\alpha$ -amylase, cellulase, hemicellulase and pectinase enzymes in an aqueous system<sup>22</sup>.Reported that extraction of coconut oil from the freshly grated coconut kernel using a commercial the gamanase enzyme. Used a 2% mixture of hemicellulase, pectinase, cellulase and gamanase enzyme that yielded 84% of oil from the desiccated coconut kernel<sup>18</sup>.Used a 1% (w/w) mixture of cellulose,  $\alpha$ -amylase, polygalacturonase and protease enzymes at 60 °C of pH 7 that yielded 73.8% of oil from grated coconut kernel<sup>17</sup>. Revealed that cellulase treatment of fresh and desiccated coconut kernel reduced the fibrous content by 17% and 62%, respectively and significantly increased the extractability of oil and protein<sup>23</sup>. Showed that combined effect of galactomannase and a soya polysaccharide degrading enzyme complex treatment on desiccated coconut for releasing oil<sup>24</sup>. Extracted coconut oil through the enzymatic action of mixed enzymes including  $\alpha$ -amylase, polygalacturonase and protease on diluted coconut paste resulting in an 80% yield of good quality oil that has not undergone any purification step <sup>25</sup>. Hot Extraction Process In Hot extraction processes, coconut oil is extract from coconut milk by heating. Due to heating the proteins of coconut milk are denatured and destabilized the milk emulsion. Extracted the virgin coconut oil by heating coconut milk at 100-120°C for 60 mints until the water was completely evaporated<sup>26</sup>. To extract the virgin

coconut oil from coconut milk, the protein is coagulate by slow heating in virgin coconut oil cooker and releases the oil that separated from pertinacious residue by filtering through muslin cloth and remaining residue further heated to remove more oil.

## Conclusion

Virgin coconut oil can be used in cooking because it adds a delicate vanilla flavor and is much healthier than traditional fats like lard or butter. Compared to other edible oils, virgin coconut oil is not processed or chemically treated and therefore retains all of its healthy plant-based nutrients. Cold-processed virgin coconut oil retain more of its naturally healthy benefits, anti-oxidants and vitamins. Freezing and then thawing the coconut pieces before feeding to the food processor will soften the coconut and allow more milk extraction. Virgin coconut oil is believed to have many amazing health benefits. Consumption of a spoonful daily can increase immunity, reduce blood pressure, relieve joint pain and even helps in the treatment of cancer. It can also be applied to the hair and skin to enhance moisture levels and repair damaged cells and follicles. Other benefits include improved circulation, normalized thyroid function, boosted metabolism and weight loss.

Hence, further investigation of virgin coconut oil need to be carried out, including fractionation, to isolate active constituent and subsequent pharmacological evaluation.

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