

Extraction processes of virgin coconut oil

Abstract

Virgin coconut oil is a new highly value added version of coconut oil in health food markets. Extraction of virgin coconut oil from coconut kernel is a major influential step for their commercialization. There are many extraction methods, among which cold and hot extraction are conventional extraction processes. The hot extractions carried out by pressing the clean, ground and fresh coconut, to yield coconut milk followed by heating at high temperature that could remove the useful micronutrient. In cold process, extraction of coconut oil takes place through destabilization of coconut milk emulsion without heating such as fermentation, chilling and thawing, or centrifugation, enzymatic treatment. Hot extraction processes has been provide better yield than cold extraction processes. In cold extraction processes there are various methods

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Introduction

Virgin Coconut Oil (VCO) is one of the edible oil growing in popularity as a nutritional supplements and functional food in the emerging functional food market.¹ The present health scenario characterized by the highest prevalence of cardiovascular diseases demands the consumption of oil and fats that can lower the lipid level in serum and tissues to sustain the human health.² In this context, coconut oil is given importance based on their medium chain fatty acid profile that could contribute to the healthy heart besides being a source of energy and fat-soluble vitamins in the maintenance of human nutrition.³ Virgin coconut oil has received much attention as a “healthiest oil in the world”, due to its rich amount of medium chain fatty acids especially 48-53% of lauric acid that could augment the metabolism, immunity, digestibility and ensure the sound serum lipid profile contributing to the healthy survival.⁴ VCO is oil derived from the fresh and mature kernel (12 months old from pollination) of the coconut (*Cocos nucifera* L.) by mechanical or natural means with or without the application of heat, which does not lead to alteration of the nature of the oil. VCO has not undergone chemical refining, bleaching or deodorizing and suitable for consumption in the natural state without the need for further processing and it is consists mainly of medium chain triglycerides, which are resistant to oxidation and the fatty acids present in VCO are distinct from animal fats, which contain mainly of long chain saturated fatty acids. Virgin coconut oil is colorless, free of sediment with natural fresh coconut scent. It is free from rancid odor or taste.⁵

Virgin Coconut Oil, coconut oil that has been expressed from copra obtained from the fresh kernel of coconut by mechanical or natural means with or without the application of heat and which does not lead to alteration of the oil in any way.

Virgin coconut oil is suitable for human consumption in its natural state without refining. Beside other standards one important proposal is that, no additives may be added to Virgin coconut oil.⁶ Extraction of oils from oilseeds is a major influential step for their commercialization. The extraction process has a direct effect on the quality and quantity of oils obtained.⁷ VCO is extracted from fresh and mature kernel of the coconut by natural and mechanical means with or without the use of heat and without undertaking chemical

treatment and refining procedure therefore, retaining the sensory and functional characteristics of fresh coconut.⁸ Various methods like Solvent extraction method, dry method and wet methods are available for extraction of coconut oil from coconut kernel.¹ The use of solvents for oil recovery has several drawbacks such as high safety hazard, high-energy input, low quality oil, environmental risk and low quality meal.⁹ In wet method, oil is extracted through coconut milk by heating and non-heating processes. In heating process, oil is extracted by direct heating of coconut milk whereas in non-heating process the oil is extracted through aqueous extraction process, fermentation process, supercritical fluid extraction process and enzymatic extraction process. In non-heating process, the coconut milk is not undergone to heating for the extraction of VCO therefore found to be advantageous over heating process in retaining the functional characteristics of fresh coconut.^{10,11}

Cold extraction processes

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 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.¹² 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.¹³ Even though the concept appears potentially attractive, however, the method yields comparatively low content of oil, which has discouraged its commercial use.⁷ Cold extraction processes reviewed and presented under the following heads.

Chilling, freezing and thawing method

The stability of coconut milk emulsion in this process is broken by chilling, 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.¹⁴ 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.⁷ 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 5000rpm up to 6min. During thawing, the oil coalesced due to loss of spherical shape and formed large droplets of varying sizes.¹ 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 VCO was studied by using various centrifugation speeds, temperature and time intervals. The results showed that the yield of VCO was 13.53% at 12000rpm, at 120minutes.¹ The highest yield of VCO 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 12000rpm for time varied from 30 to 105min, resulting that enhanced the demulsification of coconut milk in a very short time compare to the fermentation method and provide higher yield.¹⁵

Fermentation method

Fermentation is also a well-known method in cold process for the extraction of virgin coconut oil from the coconut milk.¹⁶ investigated the fermentation method to extract VCO by inoculating the pure culture of probiotic bacteria (*Lactobacillus plantarum* 1041 IAM) in different ratio of coconut kernel to water (1:1 to 1:3) at different temperature (30 to 70°C) and time (2-6h).¹⁷ The results revealed that inoculums assisted in the rapid breakage of emulsion and the release of 95% of the oil due to the virulence of a *Lactobacillus plantarum* strain in coconut milk compared to *Lactobacillus delbrueckii* inoculums.¹⁸

Extracted VCO uses bacterial cultures by adjusting the pH to destabilize the coconut milk emulsion. Similarly, also showed the improved quality and quantity of VCO by inducing fermentation method using *Lactobacillus* sp. Under controlled condition in a

bioreactor. However, the main disadvantages of fermentation based wet process are time consuming (24-48h) and poor quality of oil characterized by yellow in color and fermented odour, which can mask the characteristic coconut flavor of the oil due to the presence of unwanted microorganisms and uncontrolled conditions.

Investigated the effect of 25% (w/v) acetic acid to disrupt the coconut milk emulsion and revealed that treatment of acetic acid at a level 0.1 to 0.4% followed by reaction time of 10 to 14h at ambient temperature was assisted to release 58.3 to 60.3% of oil with improved quality.¹⁹ These processes were possible due to the fact the coconut milk proteins were easily coagulated and precipitated at pH 4.²⁰

Aqueous enzymatic extraction method

VCO extraction can also be carried out by the use of enzymes in the aqueous extraction process.²¹ Extracted coconut oil by an action of mixture of enzymes including Cellulase, Term amyl (endoamylase), Viscozyme L, neurase and alcalase (protease) 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, α -amylase, cellulase, hemicellulase and pectinase enzymes in an aqueous system.²² 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.¹⁸

Used a 1% (w/w) mixture of cellulose, α -amylase, polygalacturonase and protease enzymes at 60°C of pH 7 that yielded 73.8% of oil from grated coconut kernel.¹⁷ 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.²³ Showed that combined effect of galactomannase and a soya polysaccharide degrading enzyme complex treatment on desiccated coconut for releasing oil.²⁴ Extracted coconut oil through the enzymatic action of mixed enzymes including α -amylase, polygalacturonase and protease on diluted coconut paste resulting in an 80% yield of good quality oil that has not undergone any purification step.²⁵

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 VCO by heating coconut milk at 100-120°C for 60mints until the water was completely evaporated.²⁶ To extract the VCO from coconut milk, the protein is coagulate by slow heating in VCO cooker and releases the oil that separated from pertinacious residue by filtering through muslin cloth and remaining residue further heated to remove more oil.²⁷

Conclusion

The extraction of VCO form fresh coconut kernel, which has high nutritional value and functional property with a source of income to a numerous people in tropical region of the world. The extraction of VCO with or without heat has numerous nutritional and functional advantages over the solvent and mechanical extraction processes and the quality of extracted VCO also superior, particularly with respect to color and aroma. However further study need to development of more

effective processes for reduce the cost and increase the yield of VCO. Further investigation also needed to improve the downstream process operation which allows the separation of oil from aqueous layer.

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Conflict of interest

The author declares no conflict of interest.

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