Development and Performance Evaluation of Virgin Coconut Oil Cooker

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Development and Performance Evaluation of Virgin Coconut Oil Cooker

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Abstract

Virgin Coconut Oil (VCO) is the highly priced purest form of coconut oil obtained from fresh, mature coconut endosperm by mechanical or natural means, with or without applying heat, but without chemical refining, bleaching or deodorizing. This oil retains the characteristic scent and taste of coconut and is suitable for human consumption without any further processing. One of the different processes involved in VCO production is the hot process wherein the coconut milk is heated to produce coconut oil. A VCO cooker with a capacity of 125 litres per batch has been designed and fabricated for the purpose. VCO cooker is a double walled stainless steel container, which is open in top, with a diameter of 98 cm and a height of 38 cm. Thermic fluid is filled in between the outer and inner walls of the cooker at the bottom and the coconut milk in the cooker gets heated up by hearing the thermic fluid at bottom of the cooker. The VCO cooker could be found suitable for preparation of VCO by hot process by which class A and class B VCO can be produced. The class A virgin coconut oil is water clear having the aroma of steamed coconut. Class B oil is slightly brownish in colour and can be used for external applications. In the present study, fresh and matured coconut was grated and the milk was extracted from the grated coconut using a coconut grating machine and a semi hydraulic milk extractor, respectively. Coconut milk is an emulsion of oil and water that is stabilized by protein. To recover the oil from coconut milk, the protein bond has to be broken either by heat or by enzymes or some other mechanical means. In the present study, the extracted coconut milk was allowed to stand for maximum 3 hours so that the cream could be separated from the skim milk. The cream was cooked in the VCO cooker under controlled temperature till class A oil was obtained. The residue was further cooked to produce class B oil. The capacity of the VCO cooker was found to be 125 litres and it could produce 18.6 litres of virgin coconut in 3 hours cooking time.

Introduction

Virgin coconut oil is the unrefined purest premium grade coconut oil obtained from the fresh and mature kernel of coconut (*Cocos nucifera L.*) by mechanical or natural means with or without the application of heat, which does not lead to alteration of the oil. To protect the oil's essential properties, the production of virgin coconut oil does not undergo chemical refining, bleaching, or deodorizing. Said to be high in vitamins and minerals, it is fit for human consumption without the need for further processing (Villarino *et al.*, 2007). Virgin coconut oil (VCO) is growing in popularity as functional food oil and the public awareness of it is increasing.

Various methods have been developed to extract coconut oil, either through dry or wet processing. Dry processing is the most widely used form of extraction. Clean, ground and steamed copra is pressed by wedge press, screw press or hydraulic press to obtain coconut oil, which then goes through the refining, bleaching, and deodorizing (RBD) processes. During the RBD process, heating process is applied especially during deodorization process, which is carried out at high temperature between 204 and 245 °C (O' Brien, 2004). The copra industry also faced some problems such as contamination by aflatoxin in copra and cake and presence of high free fatty acids due to high moisture content (Guarte *et al.*, 1996). Recently, there is a trend towards producing coconut oil which does not have to go

through the RBD process. Rather than going to the normal dry process, this oil is obtained by wet processing which entails the extraction of the cream from the fresh coconut milk and consequently breaking the cream emulsion. This process is more desirable as no chemical or high heat treatment is imposed on the oil. The coconut oil produced through the wet method is known as virgin coconut oil (VCO).

VCO is generally produced from the coconut milk extracted from fresh coconut. Coconut milk is an emulsion of oil and water that is stabilized by protein. To recover the oil from coconut milk, the protein bond has to be broken either by heat or by enzymes or some other mechanical means. The different processes involved in VCO production are Hot-processing method, Natural fermentation method, Centrifugation process and direct micro expelling method. One of the different processes involved in VCO production is the hot process wherein the coconut milk is heated to produce coconut oil within the shorter period of time when compared to cold process. Virgin coconut oil is prepared conventionally by heating coconut milk in a container at low flame with continuous stirring. It is said that only half portion of a coconut spathe needs to be burned at a time, indicating the requirement of heating coconut milk at a very low flame. It is done manually and the constant stirring is a laborious process. Many a times the milk gets charred and the charred milk stick to the bottom and the sides of the vessel. This happens when the stirring is not proper or when excess fuel is burnt.

In order to avoid these limitations of the traditional Virgin Coconut Oil (VCO) production, a VCO cooker has been designed and fabricated to extract the VCO by hot processing. This paper discusses the development and performance evaluation of this equipment for extracting virgin coconut oil from coconut milk.

Materials and Methods

A virgin coconut oil cooker was designed and developed at the Workshop of Central Plantation Crops Research Institute, Kasaragod, Kerala, India. It is a batch type cooker and is operated mechanically using an electric motor and reduction gear box. VCO cooker is a double jacketed container made of stainless steel. The schematic diagram showing the parts of the VCO cooker is shown in **Fig. 1**.

Thermic fluid is filled in between the outer and inner walls of the cooker at the bottom. Thermic fluid is a mixture of synthetic hydrocarbons and is intended for use in the liquid phase for indirect process heating. It offers increased thermal and oxidation stability that translates in to more efficient heat transfer, longer fluid life and optimum operating economics. It has an optimum economic bulk operating range of −10 °C to 305 °C. It exhibits thermal stability markedly superior to that of mineral oils used for the same purpose. Thermic fluid resists the effect of oxidation up to ten times better than mineral oils. Less oxidation means less solids formation and much less fouling.

Proper insulation is provided between the outer and inner walls of the cooker to prevent heat dissipation. A mechanical stirrer is provided in the chamber of the cooker. The stirrer is having four arms. These four mixing arms, together cover the entire bottom and the sides of the stirrer where coconut milk is kept for heating. Contact portions of the stirrer are laminated with Teflon. Teflon is very non-reactive and reduces friction & wear when it comes in contact with moving part. The Teflon coated stirrer is connected to an electric motor (1 hp, 1440 rpm) through a reduction gear (W63/ U P60/B5). An inlet is provided at one side of the cooker to fill the double jacketed vessel with thermic fluid. An expansion tank (17.5 cm dia and 45 cm height) is also provided at the inlet. The expansion tank makes it easy to pour the thermic fluid and also helps to monitor the oil level in the cooker. A pressure release valve that acts as a safety valve is provided to the thermic fluid chamber to release the pressure build up, if any, occurs in it. An industrial, dial type, thermometer is provided in the thermic fluid chamber to monitor the temperature of the thermic fluid. An outlet is provided at the bottom of the milk chamber to take out oil. A three inch diameter outlet valve with a rubber washer to make it leak proof is provided in the bottom of the milk container. The outlet valve is opened and closed manually using a lever. Two LPG burners are pro-

Fig. 1 Schematic diagram of Virgin Coconut Oil Cooker

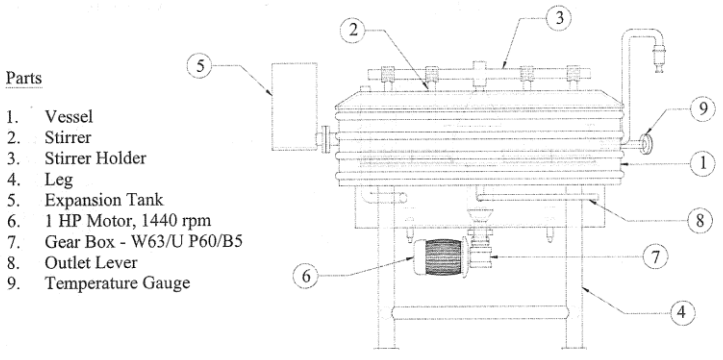


Table 1 Design details of the VCO cooker

Parameter	Dimension
Milk container diameter	Inner dia – 95 cm Outer dia – 109 cm
Milk container height	24.5 cm
Material used for milk vessel/container	Stainless steel-food grade
Milk container thickness	20 gauge
Stirrer arm	4 no.
Stirrer speed	25 rpm
Motor	1 hp, 1440 rpm
Legs	4 No.
Expansion tank	17.5 cm dia and 45 cm height

vided at the bottom of the cooker to heat thermic fluid chamber directly and in turn the thermic fluid chamber heats the bottom of the milk container. The entire cooker is supported by four legs. The schematic diagram showing the front and side view of the newly developed VCO cooker is shown in **Fig. 2**.

Power requirement of mixing arm

The horse power of motor required to rotate the mixing arm was calculated by using the following formula suggested by Khurmi and Gupta (2006).

Power required, hp = 2πNT / 4500

where,

hp = horse power of motor

N = RPM of the mixing arm

T = torque, kg-m

Self weight of the mixing arm = 6 kg

Coconut cream / milk to be mixed = 125 kg per batch

Speed of the mixing arm (assumed) = 25 rpm

∴ Coconut cream to be mixed per revolution = 40 kg

Total weight

= self weight + material weight

= 6 + 40 = 46 kg

Torque required

= Load × Distance

= 46 × 0.60 = 27.6 kg^{-m}

(Distance = contact distance in the container where the mixing is done = 0.60 m)

∴ hp = (2 × 3.14 × 25 × 27.6) / 4500

hp of motor required = 0.963 ≅ 1 hp

The design details of the developed VCO cooker are illustrated in the **Table 1**.

Working of VCO Cooker

Coconut milk was extracted from fully matured coconuts. The extracted coconut milk was poured in to the VCO cooker. Though, the cooker could be filled full, for operational convenience it was filled only up to 3/4 th capacity. The reason was to avoid any possible splashing when the stirrer is stopped and restarted in between operation. The cooker could be ignited even before loading. The cooker was heated by igniting the gas burners. The burners were burnt with full flame initially. After attaining the required temperature it was reduced as per requirement and quantity of coconut milk. Coconut milk was heated in the cooker till all the water gets evaporated and oil gets separated. The flame was reduced to minimum and finally it was switched off towards the end of the process. The separated oil and the residue, Kalkam, were taken out by opening the outlet.

The oil recovery was calculated as per the following formula.

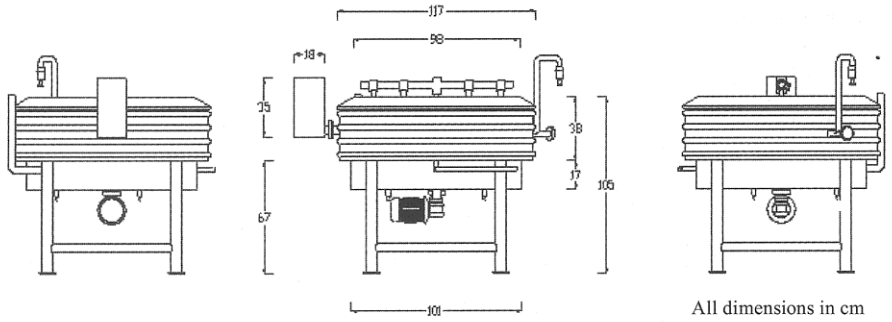
Oil Yield (%) = (Quantity of VCO obtained / Total quantity of coconut kernel) × 100

Results and Discussion

A Virgin Coconut Oil cooker was developed and evaluated for extracting virgin coconut oil from coconut milk. **Fig. 3** shows the working of the newly developed VCO cooker for extracting VCO from coconut milk.

Coconut milk was extracted from fully matured coconuts. Virgin coconut oil can be extracted from the milk by two different ways. Fresh coconut milk can be directly poured in to the cooker and it can be heated for extracting the oil. In the other method, coconut milk is allowed to settle for 3 hours to separate the skim milk from the cream. If the settling is done under refrigerated condition the time taken is only 1 hour and coco skim milk which is a nutritious beverage

Fig. 2 Schematic diagram showing front view and side views of Virgin Coconut Oil Cooker



containing protein and micronutrients can be recovered for human consumption (Bawalan, 2003). The coconut cream is further separated from the skim milk and can be heated in the specially designed VCO cooker under controlled temperature to extract virgin coconut oil. The double walled VCO cooker under slow heat coagulates the protein and release the oil. Heat was provided through LPG by heating the thermic fluid chamber. Temperature was monitored and accordingly the heat was regulated. A mechanical stirrer is provided to stir the milk to avoid the cream sticking to the bottom. For the first hour of heating, temperature was allowed to reach 120 °C. Further the temperature was brought down to 90 °C until the protein begins to coagulate and the temperature was reduced to 70 °C when the oil starts to separate. The temperature profile of thermic fluid and coconut milk during hot processing in VCO cooker is given in **Fig. 4**.

Oil was separated from the oil residue (kalkam) by straining the mixture through a stainless steel screen with fine mesh. This oil was colourless, transparent and with pleasant aroma and is known as class A oil. The remaining residue 'kalkam' was brown in colour and was further heated at a temperature of 80 to 90 °C so that maximum oil could be recovered. This oil was slightly dark in colour and is known as class B oil and is suitable for skin care and massage purpose. Total time taken for cooking was about 2.5 hours for extracting class A VCO and the timed required to extract class B VCO was 3 hours. The cream temperature at which the class A Oil started to separate was 90 °C where as the thermic fluid temperature was 170 °C during the class A oil separation. After collecting the class A oil, Subsequently the thermic fluid temperature was reduced to maintain the cream temperature at 100 °C to extract class B oil. Class A and class B oil were separately dried /heated to remove the moisture completely so that the shelf life of the VCO could be enhanced upto 1 year. The VCO yield obtained was 18.6 %.

Conclusion

A Virgin coconut oil cooker with a capacity of 125 litres of coconut milk per batch was developed. Premium quality virgin coconut oil could be extracted from coconut oil by hot process method utilizing the newly developed VCO cooker and the oil recovery was around 18.6 % in three hours processing time.

Acknowledgement

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Fig. 3 Working of newly developed VCO cooker

Fig. 4 Temperture profile of thermic fluid and coconut milk in VCO cooker