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Engineering intervention for production of virgin coconut oil by hot process and multivariate analysis of quality attributes of virgin coconut oil extracted by various methods

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Abstract

ICAR-Central Plantation Crops Research Institute, India, has designed and developed a virgin coconut oil (VCO) cooker for the extraction of oil by the hot process. However, a number of VCO production processes being followed in India and elsewhere cause variations in the physicochemical properties, which in turn potentially affect the nutritional and medicinal properties of VCO. The physical and biochemical properties of VCO from the hot process (VCO-Hot), fermentation (VCO-Fer), expelled from dried gratings (VCO-EDG), centrifugation (VCO-Cen), and conventionally prepared copra coconut oil (CCO) were investigated in light of the design concept of the VCO cooker. The nutritionally important total phenolic content (mg GAE/100 g) and antioxidant capacity of all the VCOs were found to be in the range of 0.446 ± 0.041 (VCO-Cen) to 2.867 ± 0.152 (VCO-Hot) and 3.87 mM Trolox equivalent (TE) (VCO-Cen) to 11.31 mM TE (VCO-Hot), respectively. Multivariate analysis revealed that quality attributes viz., total phenol, total flavonoid, and cupric ion reducing antioxidant capacity of VCO-Hot defined by principal component 1. Hierarchical clustering showed that the VCO-Hot belonged to the group with high total phenolic and flavonoids content and strong antioxidant capacity. Comparative biochemical properties along with multivariate analysis differentiated the various VCO samples.

Practical Applications

Production of virgin coconut oil (VCO) by the hot process has been standardized by ICAR-CPCRI and the technology has been successfully adopted by several entrepreneurs. VCO has a tremendous export potential and hence has a greater demand in the international market. The quantum of VCO export from India has been 818 MT to various destinations such as the United States, Japan, Australia, United Kingdom, and Middle East (https://www.coconutboard.in). The export earnings of VCO have reached over Rs. 260 million in 2015–2016. The consumers are not aware of the different VCO production methods and the resultant properties of VCO (Manikantan

et al., Virgin Coconut Oil: Hot and Fermentation Process, Technical Bulletin No. 108, Centenary Publication 43, ICAR-CPCRI & AICRP on PHET, Kasaragod). Considering the commerce potential and nutraceutical importance, the quality profile of VCO produced in different methods has to be compared among and with the coconut oil produced from copra. Additionally, it is crucial to discriminate the various VCO samples based on their quality profile.

1 | INTRODUCTION

Virgin coconut oil (VCO) is extracted from the fresh and mature kernel of coconut (*Cocos nucifera* L.) through the application of physical methods such as cold pressing, expeller-pressed, centrifugal force, or by natural means utilizing microbes with or without the use of heat. Nevertheless, VCO production does not entail refining, bleaching, or deodorizing (RBD) processes that a conventional copra coconut oil undergoes. VCO has attained greater relevance owing to its nutritional properties, medicinal benefits and has been a component of a functional food (Marina, Man, & Amin, 2009; Villarino, Dy, & Lizada, 2007). VCO intake promotes cardiovascular health by improving serum lipid profiles. Marked reduction of bad cholesterols such as low-density lipoprotein and very low-density lipoprotein, triglycerides and concomitant improvement in high-density lipoprotein were documented with VCO uptake (Nevin & Rajamohan, 2004). Diet supplemented with VCO has provided improved anti-oxidation status in animal studies (Nevin & Rajamohan, 2006).

In general, the biochemical and physical characteristics of VCO and copra coconut oil were investigated to identify the bioactive components responsible for the observed health benefits. Spectroscopy and spectrometry techniques (NMR spectroscopy and HS-SPME coupled with GC–MS) could not differentiate the VCO and commercially produced RBD coconut oil (RCO), however, VCO recorded low diglyceride (1.55 w/w%) compared to RCO (4.1 w/w%) (Dayrit et al., 2007). Furthermore, Marina, Che Man, Nazimah, and Amin (2009) reported the superiority of VCO over RCO in terms of phenolics content.

Traditionally VCO is being produced from various processes including the use of a shallow pan to heat coconut milk and to extract oil. Continuous stirring of heated coconut milk is crucial for VCO production because a momentary lapse in the stirring causes charring of the milk that eventually sticks to the heating pan. Traditionally, VCO produced at the homestead farms has several drawbacks including the charring effect of coconut oil due to the uncontrolled heat and presence of inadvertent and undesirable microbial population, and so forth. To avoid these undesirable effects during the production of VCO, ICAR-CPCRI has devised a double-jacketed cooker to extract VCO utilizing heat (VCO-hot). This method of extraction involves the application of controlled heat to the coconut milk to extract VCO. The oil recovery from the hot process is 20–22% of the fresh weight of coconut endosperm (Manikantan et al., 2016). Cold processes involve extraction of VCO from microbes enabled fermentation (VCO-Fer) with an oil recovery of 16–18%, VCO extraction by applying centrifugal force (VCO-Cen) characterized with an oil recovery of 18–20%, and VCO obtained from the dried endosperm gratings in a process called extraction from dried gratings (VCO-EDG) with an oil recovery of 22–27% (Manikantan et al., 2016). Fatty acid and triacylglycerol components of various VCOs varied to some extent nevertheless, tocopherols content of oils did show little differences (Mansor, Man, Shuhaimi, Afiq, & Nurul, 2012). Investigations on the bioactive components revealed the high anti-oxidation capacity of the VCO from the hot process compared to the VCO from cold processes and copra oil (Srivastava, Semwal, & Majumdar, 2016).

The quality attributes and medicinal benefits of VCO have been compiled and reviewed comprehensively (Amri, 2011; Krishna, Gaurav, Singh, Kumar, & Preeti, 2010). Nonetheless, the quality profiles of different kinds of VCOs produced in India have not been compared and analyzed yet. Furthermore, VCO produced from India has a tremendous export potential and greater demand in the international market. The export earnings of VCO were at Rs. 50 million in 2013–2014 that has increased significantly to over Rs. 260 million in 2015–2016. The quantum of VCO export has been 818 MT to various destinations such as the United States, Japan, Australia, United Kingdom, and Middle East (https://www.coconutboard.in). Hence, it is imperative to generate the quality profile of VCO produced in India and compare it with that of coconut oil produced from copra. It is also essential to discriminate the samples based on the quality profile. In this work, the physicochemical properties of various VCOs namely, VCO-Hot (ICAR-CPCRI process), VCO-Fer, VCO-Cen, VCO-EDG, and copra coconut oil (CCO) are compared. Correlation and multivariate analysis were performed to define the quality parameters of various VCO from India.

2 | MATERIALS AND METHODS

2.1 | The design concept of VCO cooker

VCO production in the hot process involves the unit operation of heating the coconut milk. Traditionally VCO has been prepared by heating the coconut milk in a shallow depth pan at low flame. Continuous stirring is a laborious and high-energy consumption process. Hence, ICAR-CPCRI, Kasaragod, India, had designed and developed the VCO cooker (Figure 1) to extract the oil by the hot process. This article does not contain any studies with human or animal subjects.