Adulteration in Coconut and Virgin Coconut Oil

Implications and Detection Methods

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Coconut oil is one of the most important vegetable oils in the tropical region. Coconut oil is used extensively for various edible and industrial purposes. The oil is rich in medium-chain fatty acids and exhibits good digestibility (Che Man & Marina, 2006). Of late, coconut oil have been liable to adulteration either accidentally or intentionally (*Rohman et al., 2019*). Adulteration of food not only decreases its quality but also lead to a number of ill effects on the health. Due to the shortfall in production and consequent high price of oils, adulteration has emerged as a major issue worldwide. In 2018, FSSAI has banned 166 brands of coconut oil in Kerala as they were found to be adulterated. It is essential to have the knowledge on identification of pure and adulterated oil. The available methodologies to detect the adulteration at home level and/or industry scale is discussed in this paper.

Some of the coconut industries tend to mix the dried testa with copra and utilize the mixture for extracting the oil. The refined and deodorized testa oil is also adulterated along with coconut oil to reduce the cost of production of pure coconut oil.

Common adulterants in coconut oil

▶ *Palm kernel oil*

The physical and chemical characteristics of palm kernel oil are closest to coconut oil and it blends easily with coconut oil. Hence, adulteration detection becomes rather difficult, especially when the adulterant has similar chemical characteristics to that of the original oil (Anklam & Bantaglia, 2001). The price of the palm kernel oil is 60% less than coconut oil. Cochin Oil Merchants Association (COMA) reported that the current price of copra is 92.50/kg. Some of the coconut processing industries are selling coconut oil at Rs. 127/kg. (Business Line., April 30th 2019). It is hard to sell coconut oil at Rs. 127/kg. considering the unit operations involved in coconut oil production including labour cost, power, copra extraction, filtration, packaging and transportation costs. Hence, it is highly likely that the coconut oil available at a price below Rs.150/kg could be an adulterated product.

▶ *Testa oil*

Testa is a brown skin present in the coconut meat and the major by-product from the coconut processing industries including virgin coconut oil, dessicated coconut, coconut chips and flavored coconut milk. It is dried and sold at about 65% of cost of copra. The fat content in the testa ranges from 34 to 63% (*Appaiah et al., 2014*). In general, testa oil is used in the process of soap making. Some of the coconut industries tend to mix the dried testa with copra and utilize the mixture for extracting the oil. The refined and deodorized testa oil is also adulterated along with coconut oil to reduce the cost of production of pure coconut oil.

Argemone oil & Cotton seed oil are also used for adulteration of coconut oil.

Table 1. Authentication methods for virgin coconut oil (VCO)

Raw material	Instrumentation	Accuracy	Reference
VCO adulterated with palm kernel olein	FTIR spectroscopy	Successfully measured adulteration to the	
level of 1%	Manaf et al. (2006)		
VCO adulterated with soybean oil	Differential scanning calorimetry	Detect the samples that where adulteration exceeds 10%	*Marina et al. (2009)*
VCO adulterated with palm oil	FTIR spectroscopy	Successfully	
quantified the level of adulterant from 1 to 50%	Rohman and Che Man (2009)		
VCO mixed with refined, bleached and deodorized palm kernel olein	Electronic nose	Pure and adulterated samples could be differentiated with 1% detection limit	*Marina et al. (2010)*
VCO adulterated with corn (CO) and sunflower oil (SFO)	FT-MIR spectroscopy	The error value are relatively low, i.e. 1.68% and 1.32% (v/v), respectively for CO and SFO.	*Rohman and Che Man (2011)*
VCO adulteration with animal fats (mutton tallow, beef tallow, chicken fat or their mixture)	Two-dimensional gas chromatography (GC × GC–TOF/MS)	Possible to detect animal fats in VCO at a level as little as 0.25%.	*Xu et al. (2015)*
VCO adulterated with mustard oil	FTIR spectroscopy	Detected the adulterants level of 5% or more	*Pandurangan et al. (2017)*
VCO adulterated with lard (lard-fat from a pig)	FTIR spectroscopy	The measurement are within ±10% of the expected value for lard in VCO	*Lee et al. (2017)*
VCO adulterated with grape seed oil (GSO) and soybean oil (SO)	FTIR spectroscopy	It differentiates the pure VCO from that of oil adulterated with GSO and SO with an accuracy level of 100%	*Rohman et al. (2019)*

Second grade oil

Improper handling of coconut while producing copra leads to rotten product and/or fungus infestations. Inferior quality copra is made available at a low price compared to the good quality (white color) copra. Hence, in order to offset the production cost of coconut oil, the inferior quality, rotten copra could be mixed with good quality copra during oil extraction. It causes the rapid spoilage of oil due to its relatively high free fatty acid content.

Detection methods

According to the Food Safety and Standards Authority of India (FSSAI), some common adulterants and contaminants can be tested in home itself. The simple method to detect adulterants in coconut oil is to pour the oil in a transparent glass and place it in the refrigerator (do not keep it in the freezer). If it is pure coconut oil, it will solidify; otherwise adulterant forms a distinct layer.

The coconut oil adulterated with other edible oils can be detected by testing the Iodine Value (IV). A higher iodine value represents a higher content of unsaturated fatty acids. Coconut oil contains medium chain saturated fatty acids having an iodine value of about 7 to 10 whereas all other oils have relatively high iodine values. This feature could be used to distinguish other oils from coconut oil. Testa oil generally have an iodine value of about 20, palm kernel oil about 16-19, and for cotton seed oil the value ranges from 100-117 (Thomas, 2000). Hence, coconut oil possessing an iodine value of greater than 10 is an indication of adulteration.

Similarly, estimating other chemical parameters such as free fatty acid (FFA) or acid value also may be helpful to find out the adulteration. Lower the acid value better the quality. According to the FSSAI, the permissible limit of acid value is not more than 4.0 for edible oils.

Virgin coconut oil (VCO)

Virgin coconut oil (VCO) is obtained from the flesh of coconut meat by natural or mechanical means. Unlike the commercial coconut oil, VCO remains unrefined and therefore is not processed by deodorizing and bleaching (*Xu et al., 2015*). In this way, the natural chemical and volatile components in VCO are preserved, including vitamin E, pro-vitamin A, and polyphenols (*Dayrit et al., 2011; Manikantan et al., 2018*). VCO has received much attention among the consumers due to its antiviral and antimicrobial property (Marina, Che Man, & Ismail, 2009). The market price of VCO is approximately

Table 2: Comparative quality characteristics of VCO by hot and fermentation processes with commercial coconut oil and APCC/ FSSAI * standard for VCO

Chemical parameters	Hot process VCO	Fermented VCO	Commercial Coconut Oil	APCC/ FSSAI* standard
Tocopherol (µg/g)	15-20	20-30	2-6	-
Polyphenols (µg/g)	500-700	350-500	150-250	-
Antioxidant activity (%)	80-90	65-75	35-45	-
Mono-glycerides (%)	1.5-2.0	2.0-3.0	0.5-1.5	-
Phytosterol (µg/g)	2.5-3.0	2-2.5	0.5-1.0	-
Color (Lovibond)	0.1R+0.5Y	0.1R+0.1Y	0.1R+0.5Y	Water clean
Refractive Index at 40°C	1.4480-1.4490	1.4480-1.4490	1.4480-1.4490	1.4480-1.4492
Saponification value	250-260	250-260	250-260	250-260
Iodine value	7-8.6	7.5-8.4	7.4-8.1	4.1-11.00
Specific gravity at 30°C	0.915-0.920	0.915-0.920	0.915-0.920	0.915-0.920
Moisture (%)	0.09-0.1	0.08-0.1	0.08-0.1	0.1-0.5

*APCC – Asia Pacific Coconut Community, Jakarta, Indonesia; *FSSAI-Food Safety and Standards Authority of India (*Source: Manikantan et al., 2016*)

5 - 10 times higher than that of common plant oils (Rohman & Man, 2011). Therefore, VCO is extensively adulterated with cheaper plant oils. An analytical technique offering fast and reliable detection of such adulteration has been developed by researchers from different parts of the world (Table 1).

Based on the available quality standards such as Food Safety and Standards Authority of India (FSSAI) and Asian and Pacific Coconut Community (APCC) standards, it is hard to differentiate coconut oil and virgin coconut oil. The main differentiating feature of the coconut oil produced from copra and virgin coconut oil is the variation in tocopherol, polyphenols and antioxidant capacity (Manikantan et al., 2016). The comparative quality profile of VCO produced by different methods and commercial coconut oil (produced from copra) is depicted in Table 2.

Recent advancements have offered many equipments/tools that could be utilized for analysis

and quality control of food products. Analysis of adulteration in oils has been reported using differential scanning calorimetry, spectroscopy, e-nose, gas chromatography and many more. Most of these instruments are expensive, requires manpower expertise and arduous interpretation skills. There is a need for simple and cost effective techniques to check the adulteration in coconut oil and other oil-based food products. ■

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