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NUTRACEUTICAL PROFILE OF MILLET LADDUS CONTAINING LAURIC ACID STABILIZED BY USING VIRGIN COCONUT OIL

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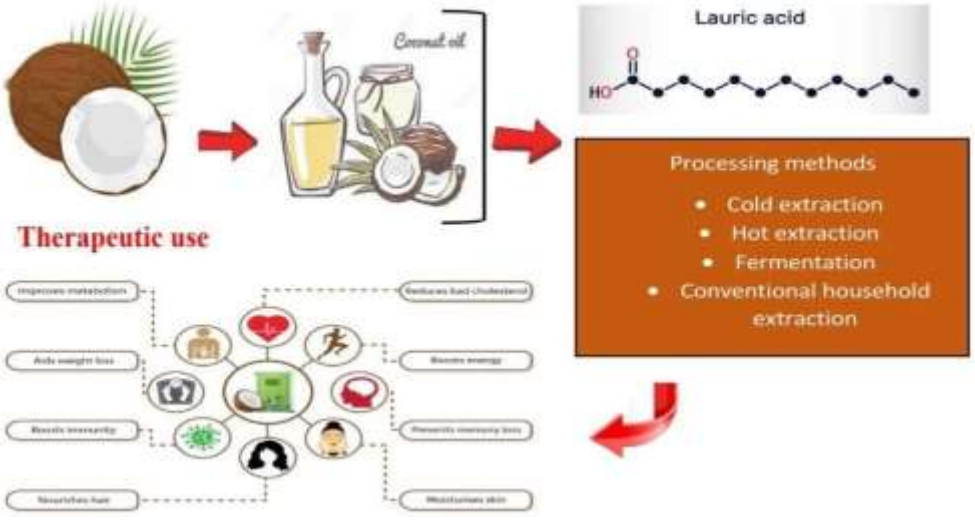
ABSTRACT

CVD being the primary cause of death in India, as well as other metabolic illnesses, there is an immediate need to establish tactics to combat it. Despite the great variety of factors that contribute to CVD, incorrect, unhealthy, and contaminated oil consumption plays a critical part in its progression. Virgin coconut oil (VCO) is highly valued oil with numerous health benefits is demanding research into the adoption of simple and convenient extraction procedures and their acceptability for consumption. The quality indices evaluation revealed that IV of VCO extracted from conventional method was higher (4.38±3.31) whereas SV was found higher for hot method (284.42±4.07). The more FFA value was observed in hot extraction method (0.38±1.02). The functional component of lauric acid in VCO from conventional method (50.17±0.07) was close to the upper limits of reference values and whereas when compared with other oils, the VCO had highest lauric acid than CO and ghee. Moreover the traditional product of millet laddu prepared by using VCO had highest acceptability scores (7.50±0.02) as compared with ghee and CO. Hence we recommend that VCO as a white ghee and can be replaced with normal ghee and also be considered as a general prophylactic against CVD as it has lauric acid and its derivatives.

Key words: Virgin Coconut Oil, Lauric acid, Extraction methods, Sensory evaluation, Fatty acids and Millets

Graphical Abstract



INTRODUCTION

Lauric acid (C_{12}) and its derivative, monolaurin, have been known for many years to have significant antiviral activity. Lauric acid is a medium –chain fatty acid which makes up about 50% of coconut oil; monolaurin is a metabolite that is naturally produced by the body's own enzymes upon ingestion of coconut oil and is also available in pure form as a supplement. Sodium lauryl sulphate, a common surfactant that is made from lauric acid, has been shown to have potent antiviral properties. Lauric acid, monolaurin and sodium lauryl sulphate as also known as sodium dodecyl sulphate are used in a wide range of products for their antiviral properties [Fabian M. Dayrit and Mary T. Newport 2021]

Virgin coconut oil (VCO) is a high value edible oil extracted from the kernels of mature coconuts (Cocos nucifera L.) [Mansor et al., 2012] and it has popularity in the functional food and supplement sector, owing to its enormous bioactive potential. The medium chain fatty acids (MCFAs) content of VCO, has been demonstrated to be useful in raising high density lipoprotein (HDL) cholesterol levels in healthy people [Chinwong et al., 2017].

VCO is mostly made up of MCFA, with lauric acid (LA) (C12) and its derivatives accounting for more than 90% of fatty acid composition. It makes up nearly half of the weight of coconut oil [Dayrit FM, 2015; Ma ZF and Lee YY, 2016]. It also differs from other cooking oils as it does not include long-chain fatty acids [Ghani et al., 2018]. VCO possess antiviral, antibacterial, antiplaque, antiprotozoal, healing, anti-inflammatory, and anti-obesity properties [German JB and Dillard CJ 2004; Gopala Krishna et al., 2010]. As a result, VCO may be beneficial in the treatment of a variety of mild ailments, including diarrhoea, skin inflammations, gastrointestinal issues, minor cuts, injuries, and swellings[Nevin KG and Rajamohan T 2010]. LA and its derivative, monolaurin, have been associated with their significant antiviral activity which was emphasized more during the Covid 19 pandemic [Fabianet al., 2020]. Due to the nutritional and medicinal benefits of its MCFA and other functional components , these features stimulate further therapeutic uses of VCO, making it a versatile nutrient supplement [Nevin KG and Rajamohan T 2010; Kabara et al., 1972].

CVD being the primary cause of death in India, as well as other metabolic illnesses, there is an immediate need to establish tactics to combat it. Despite the great variety of factors that contribute to CVD, incorrect, unhealthy, and contaminated oil consumption plays a critical part in its progression. MCFA being a readily available cellular energy source, it alters the lipidomic profile and improves the systolic functions, which in turns improves the clinical symptoms of cardiomyopathies [Francois et al., 2008].

Implementing evidence-based VCO extraction and promoting it for daily intake could be an effective way to lessen the burden of CVD as well as global burden of communicable diseases as well as promoting unadulterated oil consumption. As a result, this study was undertaken to evaluate the functional components of VCO extracted using various methods as well as the acceptability of millet laddu containing LA. Millets form the potential sources of functional nutrients; it has been enhanced with VCO and utilized for the laddu preparation for its easy consumption and acceptability by the consumers.

MATERIALS AND METHODS

Materials

Pure and fresh coconut milk of the TIPTUR cultivar was identified and obtained from the Horticulture College, Kolar, Karnataka. Everest brand baker'syeast (Saccharomyces cerevisiae) was obtained from a commercial brand (Lesaffre Group). All chemicals and reagents of analytical grade were obtained from Sigma-Aldrich Solutions Pvt Limited, USA. Millets and ghee (GRB brand) were procured at Reliance fresh super market, Kolar, Karnataka.

Extraction Methods

Four distinct extraction methods of cold, hot, fermentation and conventional were used to obtain VCO. The cold and hot extractions of VCO were carried out according to the procedures reported in a

study by Agarwal R K, 2017, while the fermentation process was carried out according to (Mansor et al., 2012).The conventional method was carried out with modifications described by Mansor et al., 2012 in which coconut oil was grated and blended well to a smooth paste by adding 1:1 ratio of water. The paste was then filtered using a cheese cloth top obtain coconut milk from the paste, which was poured into a plastic bag and closed tightly, and hung the bag and rested for 5-6 hours at room temperature. The coconut milk and water were then separated. The coconut milk was then boiled at medium flame for 15-20 minutes and then closed the lid and left for 2 minutes and separated the oil (Fig 1).

Fig 1. Conventional method of VCO extraction

Analysis

Evaluation of quality indices such as iodine value (IV), saponification value (SV), free fatty acids value (FFV), moisture content, fatty acid analysis and percentage oil recovery was determined using the IUPAC, 1979 and AOAC 2019 guidelines. The analysis was carried out in triplicates, and the standard deviation and mean were provided.

Preparation of Millet Laddu

Virgin coconut oil was added to a pan containing 1:1 ratio of ragi and pearl millet flour and roasted for 2-3 minutes on low flame till the roasted aroma developed. Then 30 g of powdered sugar and 1 g of cardamom powder were added to the flour and made laddus by adding boiled milk to the mixture (Fig 2). The prepared laddus were estimated for the proximate composition as per the AOAC 2019 procedures.

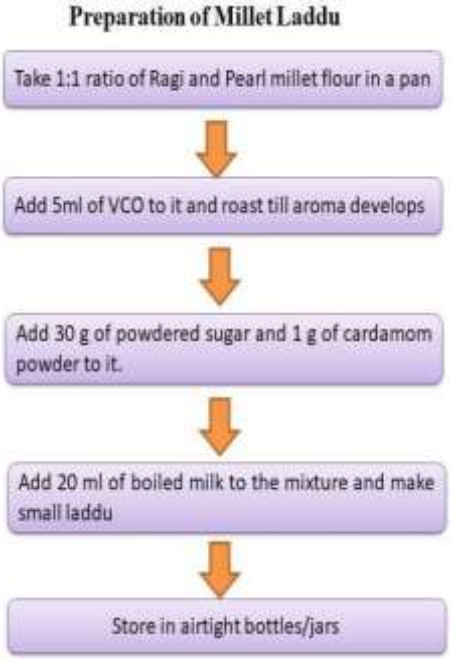


Fig 2. Preparation of millet laddu

Sensory Evaluation

A sensory panel of trained 20 judges (12 females and 8 males) were evaluated millet laddus prepared by using VCO for sensory characteristics such as colour, appearance, texture, flavor, mouth feel and overall acceptability on 9 point Hedonic scale (Swaminathan, 1979).

Statistical analysis

The statistical methods were performed by using SPSS statistical software version 20.0 and the mean differences were calculated and significant differences among means were expressed at $P<0.05$.

RESULTS AND DISCUSSION

Evaluation of Quality Indices

The mean IV of VCO extracted from conventional method was slightly higher (4.38±3.31) when compared to other methods of extraction (Fig 3a). The IV would have effects on overall quality parameters such as the shelf life of VCO, appearance as well as the taste and smell. As higher IV indicates the measure of unsaturation as well as oxidative stability, this may affect the storage quality of the products (Sanders, 2003). It was however found that the highest SV was from hot method (284.42±4.07) and the lowest was from fermentation method (243.73±4.21) (Fig 3b). The type of fatty acids would influence the SV and it was observed in present study that, different extraction methods showed slight differences (Mansor et al., 2012). As FFA is the quality indicator for suitability of oils for consumption, this study presented high FFA(0.38±1.02) value for hot extracted method and least value for fermentation method(0.19±3.31) and this values were slightly similar (Marina et al. (2009b). VCO obtained from conventional method had highest moisture content (0.26±1.05) followed by cold (0.24±2.1), fermentation (0.18±0.07) and hot (0.13±1.83) methods. These slight discrepancies could be caused by the different method of extractions applied (Osawa et al., 2007; Lawson, 1985). Viscosity forms an important parameter for the flow behaviour of fats and oils. The lowest recorded viscosity was from hot method (50.61±1.62) while the highest viscosity was from fermentation method (56.49±0.31). Conventional method resulted in highest percentage of oil recovery and least by hot method (62.09±2.21).

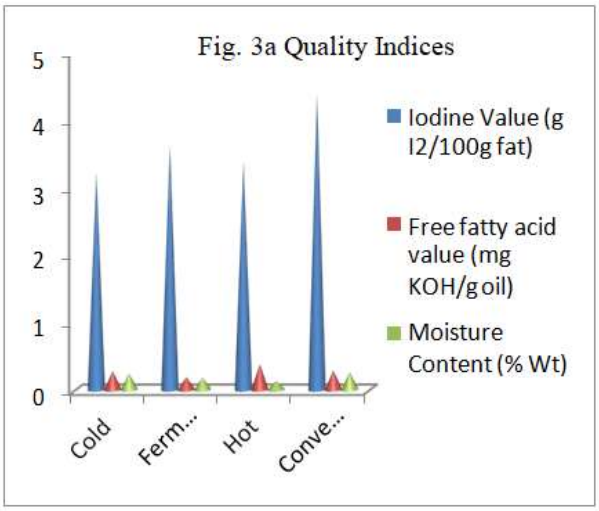


Fig 3a. Quality Indices of VCO extracted from various methods

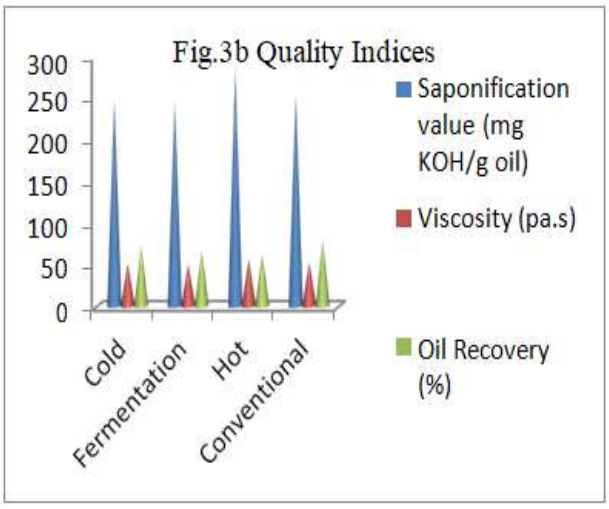


Fig 3b. Quality Indices of VCO extracted from various methods

Fatty acid Analysis

Table 1 indicates the values of fatty acid composition of VCO extracted from conventional method and was compared with the standards of APCC, 2003, where the total lauric acid in VCO of conventional method was closely higher (50.17±0.07) towards the upper limits of the standard values.

The functional components of lauric acid and its derivative monolaurin, have been known for many years to have significant antiviral activity. Lauric acid is a medium chain fatty acid which makes up about 50% of VCO and also lauric acid, monolaurin and sodium lauryl sulphate are used in a wide range of products for their antiviral properties (Fabian et al., 2020).

The fatty acid comparison between the VCO, CO and ghee (Fig 4) were highly significant between VCO and ghee. However there was no significant difference observed between VCO and CO. Although ghee showed more linoleic acid content, VCO and CO reported higher lauric acid content which forms the functional component exhibiting nutraceutical potential. Several *in vitro*, *in vivo*, and clinical trials support the potential of VCO, lauric acid and its derivatives as effective and safe agents against viruses like nCoV-2019 (Fabian et al., 2020).

Table 1. Fatty acid composition of VCO extracted from conventional method

Fatty acids	Conventional	APCC standards
Caproic acid	0.56±0.00	0.40- 0.60
Caprylic acid	7.24±0.00	5.00-10.00
Capric acid	5.96±0.01	4.50-8.00
Lauric acid	50.17±0.07	43.00-53.00
Myristic acid	19.43±0.00	16.00-21.00
Palmitic acid	8.92±0.01	7.50-10.00
Stearic acid	3.18±0.09	2.00-4.00
Oleic acid	5.78±0.01	5.00-10.00
Linoleic acid	1.13±0.00	1.00-2.50

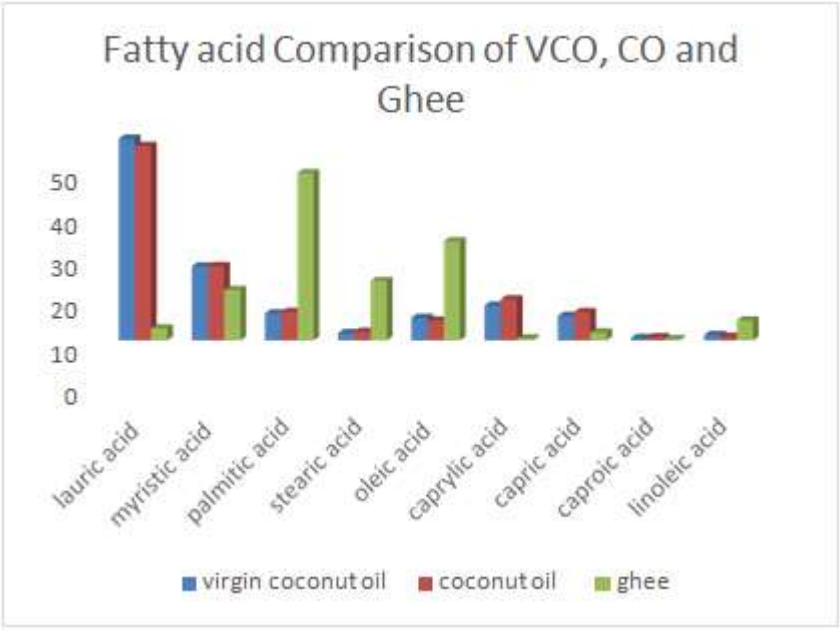


Fig 4: Fatty acids comparison between VCO, CO and Ghee

Proximate composition analysis

The proximate composition plays an important role for deciding nutritional and functional qualities of food products. The proximate composition of millet laddu prepared using VCO is presented in Table 2. The moisture, ash, protein, fat, carbohydrate and crude fiber content were 9.81 ±0.20, 1.97 ±0.03, 10.54 ±0.09, 5.16 ±0.25, 69.12 ±0.41, and 3.40 ±0.02 respectively. The values obtained for proximate composition of pearl millet are within the range reported in literature (Kulthe et al., 2016).

In India millets are consumed in different traditional products and it's been said from long that millets are suitable for therapeutic benefits due to its rich nutraceutical components. The study revealed that the proximate composition of millet laddu was highly comparable with the recommended values. It can also be suggested for the replacement of animal ghee (yellow ghee) with the VCO (white ghee) as it has got more therapeutic benefits for the vegans.

Table 2. Proximate composition of millet laddu

Parameters (%)	**Proximate Composition (g/100g)**
Moisture	9.81 ±0.20
Ash	1.97 ±0.03
Protein	10.54 ±0.09
Fat	5.16 ±0.25
Carbohydrate	69.12 ±0.41
Crude Fiber	3.40 ±0.02

Sensory Evaluation

According to the sensory scores, the laddu made with VCO had highest scores for mouth feel, texture and overall acceptability whereas laddu made with ghee had highest scores for aroma and flavor with slightly higher score for taste against laddu made with VCO (Fig 5). Millets are the most ancient food crops with nutrients dense, especially during the growth period, as children are susceptible to infection. Hence, in order to avoid the infections and associated problems, it is necessary to provide functional ingredient rich foods at early age. Therefore, VCO enriched laddu with lauric acid and its derivatives could be proposed for consumption in a traditional manner to prevent the infections in children.

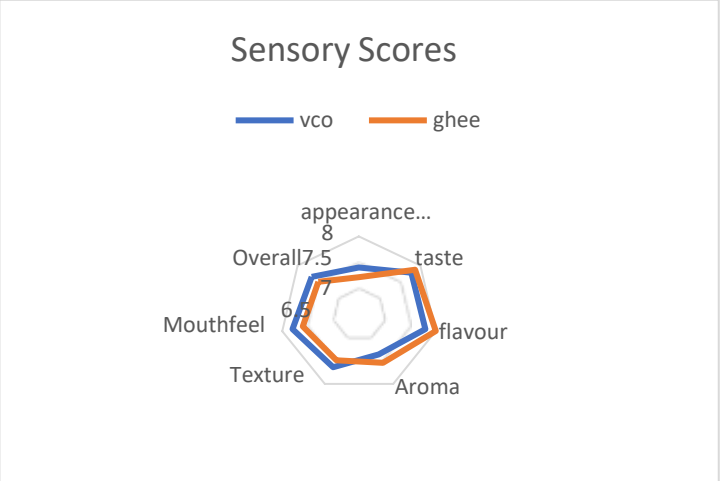


Fig 5: Sensory scores of millet laddu prepared using VCO and Ghee

CONCLUSION

The rising risk of CVD has sparked a wave of health awareness, and the health benefits of VCO are now well recognized. However, with the exception of Kerala, India, coconut oil consumption is still quite low throughout India. Furthermore, the usage of saturated fat-rich ghee in snacks and sweets is still common. The results of this study indicated that VCO is high in lauric acid, a functional component with a variety of health benefits. Furthermore, a sensory acceptability evaluation of millet laddu utilizing VCO revealed that it was accepted better than ghee. This clearly shows that, while VCO contains SFA, it is the lauric acid found primarily in VCO that has beneficial health effects, and this can be further examined *in vitro*, *in vivo*, and clinical trials to encourage people to consume more of it and replace "yellow ghee" with "white ghee."

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