

Antiviral Potential of Coconut (*Cocos nucifera* L.) Oil and COVID-19



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Abstract: Background: COVID-19 caused by the novel SARS Coronavirus-2 (SARS-CoV-2) is causing serious problems in the global public health sphere. In the absence of a powerful antiviral treatment, the exploration of plant-based products with antiviral potential has gained interest.

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Scope and Approach: This commentary presents the prospects of utilizing coconut oil directly or its derivatives such as monolaurin in treating COVID-19 with a special emphasis on their biochemical characteristics features. The potential pitfalls therein and way forward are also highlighted.

Key findings and conclusions: There are enough research-backed evidences to demonstrate the antiviral capabilities of coconut oil and monolaurin. The possibility of developing a medium-chain fatty acid-based nasal spray as a prophylactic or therapeutic is also discussed. Nevertheless, the potential impediments in devising suitable therapeutic models to treat SARS-CoV-2, are presented.

Keywords: Antiviral therapy, immune-modulation, medium-chain fatty acids, lauric acid, SARS-CoV-2, *Cocos nucifera* L.

1. INTRODUCTION

Coronavirus disease-2019 (COVID-19), the pandemic caused by novel SARS Coronavirus-2 (SARS-CoV-2), has been wreaking havoc in the global health sphere. At this point in time, no specific drugs or therapeutic agents are prescribed to control the disease even though on-going clinical trials are in various stages. As the number of confirmed COVID-19 cases are increasing (22.2 million cases and the death toll of 782456 as of 20/ Aug/2020) (<https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports>), lot of interests has been generated towards the identification of compounds of plant origin with antiviral potential. These developments have renewed interest in studying coconut oil and its variant virgin coconut oil (VCO) against COVID-19.

Coconut (*Cocos nucifera* L.) is a tropical palm, which is aptly called 'tree of life' (*kalpavriksha*) as it supplies a wide range of food products of human consumption *viz.*, coconut oil, tender nut water, endosperm, inflorescence-sap derived sugar, etc. Coconut oil has been attributed to many nutritional and health-conferring properties owing to its unique fatty acid composition [1]. The principal biochemical components of coconut oil and their potential health benefits are

presented in Table 1 [2-10]. Coconut oil is rich in medium-chain triglycerides (MCTs) (C6 to C12 fatty acids). Coconut oil derived-MCTs are easily soluble and digestible by salivary and pancreatic lipases in comparison to triglycerides of other vegetable oils, which are predominantly long-chain triglycerides (LCTs). Lauric acid (C12) is one of the prime medium-chain fatty acids (MCFAs), and its content in coconut oil varies from 45-53% [1]. Around 60% of the coconut triacylglycerol (TAG) comprises MCFAs (both lauric acid and capric acid) in its positions *sn-1*, and *sn-3* [1]. Studies have demonstrated that LCFAs predominantly enter the lymphatic system, whereas MCTs are absorbed through portal veins [11]. Differential absorption of MCTs ensures its faster digestion, absorption and rapid energy expenditure, thereby alleviating the adiposity in humans [4].

2. COCONUT OIL AND ANTIVIRAL PROPERTY

MCTs of coconut oil are known to have antimicrobial effects besides hypolipidemic effects. Most conspicuously, lauric acid and its monoglyceride derivative, monolaurin, have been demonstrated to possess anti-microbial properties against gram-positive bacteria [12, 13], and many viruses such as Junin virus (JUNV), vesicular stomatitis virus, Simian immunodeficiency virus (SIV), *etc.* are infecting humans [14-18]. Coconut oil has been an effective remedy for the treatment of many of the enveloped viruses such as Cytomegalovirus, Epstein-Barr virus, hepatitis C virus, influenza virus, leukemia virus [3, 5, 6]. The antiviral property of

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Table 1. Biochemical components of coconut oil and their potential health benefits.

S. No.	Components	Percentage Mean Values	Potential Health Benefits
1	Fatty acid profile		Coconut oil predominantly comprises medium-chain fatty acids (MCFAs), which are characterized by hypolipidemic effects, cardiovascular benefits, anti-microbial effects [2-7]
	C6:0 Caproic acid	0.50	
	C8:0 Caprylic acid	6.76	
	C10:0 Capric acid	6.37	
	C12:0 Lauric acid	47.10	
	C14:0 Myristic acid	17.19	
	C16:0 Palmitic acid	8.80	
	C18:0 Stearic acid	3.03	
	C18:1 Oleic acid	6.45	
	C18:2 Linoleic acid	1.45	
	C18:3 Linolenic acid	0.27	
2	Sterols		Anti-cancer and hypocholesterolemic effects [8]
	Campesterol	7.20	
	Stigmasterol	12.30	
	β -sitosterol	38.97	
3	Tocols (tocopherols and tocotrienols)		Natural anti-oxidants, components of cell membranes and anti-ageing properties [9]
	α -tocopherols	1.01	
	β -tocopherols	0.13	
	γ -tocopherols	0.06	
	Δ -tocopherols	0.20	
	α -tocotrienols	2.05	
	β -tocotrienols	0.09	
	γ -tocotrienols	0.49	
Δ -tocotrienols	0.05		
4	Phenolic acids (mg/ Kg of oil)		Natural anti-oxidants scavenging reactive oxygen species, anti-inflammatory, anti-allergic, anti-cancer properties, and prevents cardio-vascular diseases [10]
	Protocatechuic acid	0.03	
	Vanillic acid	0.82	
	Caffeic acid	1.05	
	Syringic acid	1.87	
	Ferulic acid	7.30	
	p-Coumaric acid	0.49	
	Gallic acid	15.27	
	p-Hydroxybenzoic acid	0.80	

monolaurin has been attributed to its role in disrupting the phospholipid layers in the membranes of the enveloped viruses. Monolaurin has adverse effects on the virus assembly and maturation phases of the infection cycle even though the viral RNA and protein synthesis remain unimpeded [15]. Lauric acid also compromises the binding of viral M protein (membrane) to the host cells [15]. Supplementation of MCTs (e.g., lauric acid) induces cellular biosynthesis of triacylglycerols (TAG) in the infected cells [15, 16]. This spurt in the biosynthesis of TAGs deprives the viruses of its crucial process-glycoprotein insertion in the plasma membrane-consequently affecting the virus maturation process [15, 16]. However, direct inactivation of virion particles of enveloped viruses such as HIV and HSV due to physical contact with MCFAs is also not uncommon [19, 20]. Antiviral properties of coconut oil-derived lauric acid or direct application of coconut oil have been established in animal studies. Administration of virgin coconut oil (VCO) through feed has enhanced the immunity parameters of chickens following challenge tests with Avian influenza A virus subtype H5N1 [21, 22]. Philippine Council for Health Research and Development (PCHRD) and Department of Science and Technology (DOST) has announced a hospital-based project entitled “Virgin Coconut Oil and Omega-3a Adjunctive Therapy for Hospitalized Patients with COVID-19” (<https://www.covid19.gov.ph/dost-to-study-benefits-of-virgin-coconut-oil-on-covid-19-patients>). In this context, this communication addresses the prospects and limitations of coconut oil-based treatment of COVID-19.

3. COCONUT OIL VS. SARS-COV-2

3. COCONUT OIL VS. SARS-COV-2

Coconut oil-derived lauric acid could be an effective antiviral treatment for COVID 19. The potential positives for this proposition are SARS-CoV-2, which is an enveloped virus with a characteristic lipid membrane having S-glycoproteins (spike proteins) over its surface. Considering the significance of the early viral infection phase, wherein the virus-encoded S-protein effectively binds the human receptor protein angiotensin converter enzyme 2 (hACE2), any disruption of viral membrane lipids could be detrimental to the entry of the virus into human cells. In this context, the development of coconut oil-based nasal or throat spray shows great potential. The spray could be prepared in combination with other plant-derived essential oils, or the spray composition could have anti-microbial, anti-inflammatory and decongestant attributes [22, 23]. Fatty acids, preferably lauric acid and capric acid (both of which accounts for >60% of total fatty acids in coconut oil), have been developed into pharmaceutical formulations as mouth and throat rinse, nose

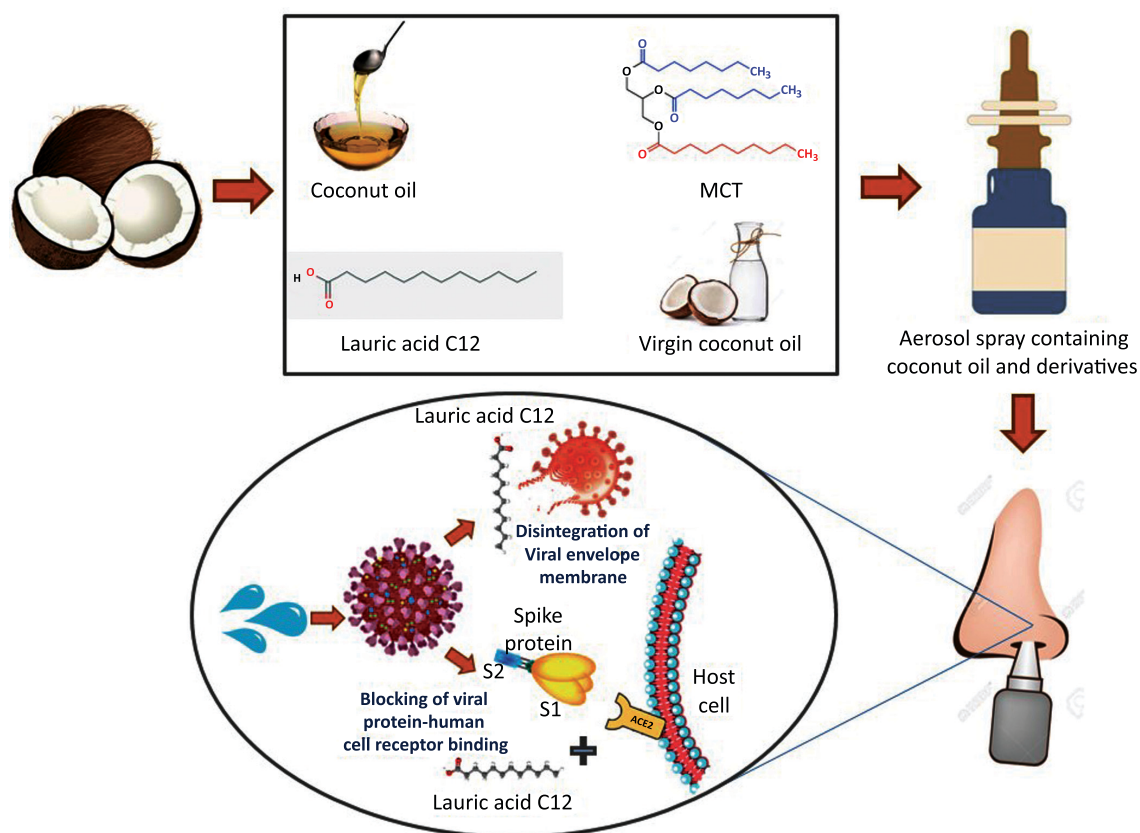


Fig. 1. Therapeutic potential of coconut oil and its products in fighting COVID-19 caused by SARS-CoV-2. The scheme depicts the utility of various coconut oil products in the development of an aerosol spray for use against SARS-CoV-2. The possible mode of action of lauric acid in disrupting the lipid membrane envelope of the virus and in blocking the interaction between viral Spike protein and human angiotensin-converting enzyme (hACE) receptors is also presented. (A higher resolution / colour version of this figure is available in the electronic copy of the article).

and throat spray or nasal drops suitable for the treatment of respiratory syncytial virus (RSV). The efficacy of these virucidal formulations in decreasing the nasal viral load was demonstrated in mouse models without any off-target effects [24]. In the absence of clinical trials supporting the antiviral potential of lauric acid against SARS-CoV-2 or otherwise, authors suggest that the development of lauric acid-based novel prophylactic or therapeutic measures would be of value to block respiratory infections such as COVID-19 (Fig. 1).

Lauric acid, as a food supplement, has demonstrated no signs of toxicity on biochemical, histopathological profiles of animal models even at the dosage of 2,000 mg/kg body weight [25]. Hence, considering the safety profile of lauric acid and coconut oil, they can be recommended for acceptable antiviral therapeutic purposes. It is further corroborated by the development of a proprietary antiviral formulation based on a short-chain fatty acid (SCFA) (caprylic acid), ViraSAL. Its efficacy in treating the enveloped viruses such as Epstein-Barr, measles, herpes simplex, Zika, and orf parapoxvirus, together with Ebola, Lassa, vesicular stomatitis and SARS-CoV-1 pseudoviruses, was proven *in vitro* and *in vivo* studies [26]. These investigations further underscore the importance of SCFAs and MCFAs in the treatment of enveloped viruses due to its surfactant activity on the virus envelopes. Although monolaurin is widely available and generally recognized as safe (GRAS) by US-FDA, the chemical synthesis of coconut lauric acid-based monosaccharide esters and its anti-microbial properties are encouraging. Monosaccharide lauric acid esters are biodegradable, non-toxic and have wide medical applications, yet antiviral properties are not proven [27]. Sodium lauryl sulfate (SLS) – a tensoactive agent which has detergent properties, is made from lauric acid. The broad spectrum surfactant activity of SLS has been instrumental in inactivating the human and animal infecting viruses such as human immunodeficiency virus (HIV), human papillomavirus (HPV) and herpes simplex virus (HSV) [28] and in demonstrating microbiocidal activities against the viruses infecting small ruminants [29]. Esterification of lauric acid yields a functional monoglyceride (MAG) with anti-microbial activity while using it as a food preservative [30].

Investigations prove that monolaurin evinces anti-inflammatory effects in response to HIV-1 and SIV infections in rhesus monkey models [18]. Monolaurin suppresses inflammatory immune responses, including the repression of IL-6 (Interleukin -6) production. Zhang *et al.* (2017) [31] attributed this effect to the disrupted lipid dynamics in the T-lymphocytes. The effect of monolaurin in lowering the levels of IL-6 in COVID-19 patients opens a new avenue for designing a novel therapeutics to block SARS-CoV-2 since the production of pro-inflammatory cytokines such as IL-6 leads to extreme inflammation of bodily parts resulting in acute respiratory distress syndrome (ARDS) associated with the disease [32]. Inhalation of virgin coconut oil (VCO) reduces the inflammatory responses and relieves asthma-related symptoms in rabbit models of allergic asthma [33], further substantiates its therapeutic potential.

In HIV-infected human subjects, dietary supplementation of VCO for 6 weeks has improved the CD4+ T lymphocyte

counts suggesting the immune-modulatory role of VCO and disrupting HIV disease progression [7]. Though WHO is wary of the antiviral therapeutic potential of VCO in the absence of scientific evidence, Philippines's DOST is conducting two clinical trials on COVID-19 positive patients and COVID-19 persons under investigations (PUIs) by incorporating VCO as a dietary supplement in addition to the current drug regimen (<https://www.pna.gov.ph/articles/1098482>).

Even though most of the beneficial effects of coconut oil are attributed to its unique fatty acids composition, several bioactive properties of coconut oil, especially VCO are due to its phenolic components [10, 34, 35]. Coconut-derived polyphenols have been demonstrated to reduce the risk of cardiovascular disease and oxidative stresses [36]. Hence, coconut oil-derived polyphenolic fraction also evinces a positive role in the treatment of COVID-19.

4. CHALLENGES

There are some challenges for coconut oil to function as a therapeutic agent against COVID-19. Cellular pH is an important factor to be considered while using lauric acid as a therapeutic agent. It has been revealed that acidic condition (pH 4.2) was effective than pH 7.0 when MCFAs and long-chain fatty acids (LCFAs) were evaluated for antiviral activities against RSV and Parainfluenza virus type 2, as well as on HSV types 1 and 2 [37]. Nonetheless, the efficacy of the chemical drug chloroquine and its derivatives, currently being widely used for the treatment of COVID-19, works by increasing the endosomal pH and disrupts the glycosylation of cellular receptor of the virus [38]. Hence, the compatibility and efficacy of coconut oil-and /or its derivative-based treatment in the current standard drug regimen are researchable concerns. Multi-targeted interventions to treat COVID-19 are gaining momentum so as to harvest the potential synergies of various drug molecules [39]. Hence, the optimal temporal administration of coconut oil and its products requires to be explored so that combination therapy is designed to treat the COVID-19.

Recent evidences highlight the fact that cardiovascular co-morbidities associated with the COVID-19 are due to the SARS-CoV-2 infection of human endothelial cells and the resultant endotheliitis [40]. This study thus corroborates the rationale for stabilizing the endothelial tissues while administering antiviral drugs for COVID-19, more so for the vulnerable patients with endothelial dysfunction. In this framework, it is relevant to acknowledge that lauric acid or coconut oil has an inherent positive impact by ameliorating cardiovascular diseases and in fighting obesity [3, 41]. Hence, the need for supplementary designer therapies to stabilize the endothelial tissues would become redundant when lauric acid or coconut oil is used in COVID-19 treatment.

Given the crucial role of coconut oil-derived diacylglycerol (DAG)-induced insulin resistance in the pathogenesis of type II diabetes mellitus-one of the co-morbid conditions of COVID-19 [42], administration of coconut oil might pose serious adverse health impact. Nevertheless, recent reports highlight that DAG of coconut oil significantly reduces serum triglyceride (TG) content, thereby improve lipid metabolism and reduce obesity, owing to its unique medium-chain fatty acids content [43].

CONCLUDING REMARKS

To conclude, research evidences are abounded, proving the antiviral effects of coconut oil and monolaurin in animal and human subjects. However, large scale human trials to treat COVID-19 followed by rigorous analysis are mandatory to ascertain the therapeutic potential of the coconut oil and its products. Providing due credits to the virus containment and other socio-economic measures of the local government, the successful turnaround in the containment of COVID19 in the Indian state of Kerala is tempting us to correlate it with the consumption of lauric acid by the population. Coconut oil is a major dietary component in this part of the world. It would be premature to conclude thus until thorough epidemiological research investigating the effects of coconut oil-derived lauric acid and reduction of viral load in human subjects of Kerala proves it so. Furthermore, available evidences and proven food safety of coconut oil and its derivatives convinces us to safely conclude that the products of *Cocos nucifera* L. could be a supplemental therapeutics candidate, if not principal antiviral agent, for COVID-19.

CONSENT FOR PUBLICATION

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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