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Review article

Caprylic acid: An overview on biological importance

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Abstract

Fatty acids are essential bioactive compounds that take part in various complex metabolic pathways and thus play a very important role in normal growth and development of humans by regulating structure and functions of membranes, intracellular signaling pathways, gene expression and production of bioactive lipid mediators. Depending upon their dietary source, the type of fat consumed and its health consequences can be determined. Saturated fatty acids like caprylic acid, myristic acid, arachidic acid is obtained from butter, palm and coconut oil, lard etc. whereas unsaturated fatty acids are present in vegetable oils and marine products like algae and fish. Fatty acids are also reported to possess anti-inflammatory, antithrombotic, anti-arrhythmic, hypolipidemic, antimicrobial, anticancer and vasodilatory properties. This review highlights the biological importance of caprylic acid, one of the important medium chain saturated fatty acid.

Key words: Caprylic acid, Fatty acid, Source, Biological Importance

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1. Introduction

Caprylic acid ($CH_3(CH_2)_6COOH$) is a naturally occuring medium chain fatty acid containing eight carbon atoms which is found in triglycerides of butter [1], coconut oil [2, 3], bovina and human milk [4], palm hemp [5]. Fatty acids play a vital role in controlling insulin release [6] and lipid levels in artherosclerosis [7], in myocardial infarction [8], in inflammatory disorders [9] and mood disorders [10], as antimicrobial against *Candida albicans* [11], *Helicobacter pylori* [12], *Escherichia coli* [13].

Caprylic acid is also used commercially in perfume industries for production of esters and also in the manufacture of dyes [14].

Biological activities of caprylic acid

a) As antibacterial

In susceptibility study of *Clostridium perfringes* to C_2–C_{18} fatty acids by Skrivanova *et al.*, 2005 [15], it was observed that lauric acid showed the highest antimicrobial activity, followed by myristic, capric, oleic and caprylic acid.

Skrivanova *et al.*, 2006 [16] determined antimicrobial activity of fatty acids viz monolaurin, citric, succinic, fumaric, maleic caprylic and lactic acid in culture of two strains of *Escherichia.coli* (CCM 3954, CCM 4225), three strains of *Salmonella species* (ATCC 13076, K_2 and K_3) and two strains of *Clostridium perfringes* (CCM 4435, CNCTC 5459) and observed that among all the tested acids, caprylic acid was the only acid capable of inhibiting all the tested strains with the MIC value ranging from 1 to 3 mg/ml.

Shipar, 2007 [17], in his study reported that brain lipid of *Metapenaeus brevicornis* has antimicrobial activity against disease causing bacteria *Shigella dysenterial*, *Salmonella typhi*, *Staphylococcus aureus* and fungal pathogens *Macrophomia phascolma*, *Alternaria alternate* and *Curvularia lunata*. Further GLC analysis confirmed that caprylic, myristic, palmitic, stearic and oleic acid are key components of brain lipid responsible for its antimicrobial effects.

Shipar, 2014 [18] reported that lipid obtained from body of red shrimp (*Metapenaeus brevicornis*) also possess antimicrobial activity against many bacteria like *Staphylococcuss dysenterial*, *Bacillus subtilis*, *Salmonella typhi* and *Escherichia coli* and fungal pathogens like *Alternaria alternate* and *Curvularia* *lunata* which is due to the presence of fatty acids viz. caprylic, myristic, palmitic, stearic, arachidic and oleic acid.

b) As antifungal

In a review on antifungal activities of free fatty acids, Carolina *et al.,* 2011 [19] reported the antifungal activity of caprylic acid against *Alernaria solani, Cucumerinum lagenarium, Fusarium oxysporum, Kluyveromyces marxianus, Myrothecium verrucaria, Saccharomyces cerevisiae, Trichoderma viride* etc.

Elmore *et al.,* 2014 [20] reported the antifungal activity of coconut oil obtained from *Cocos nucifera L* against *Candida albicans* is due to presence of fatty acids like lauric acid, capric acid, caprylic acid etc. He also observed the antibacterial effects of these acids against certain gram-negative organisms (*Proteus vulgaris, P. mirabilis, P. rettgeri, Escherichia coli, Serratia marcescens, Pseudomonas aeruginosa,* and *Salmonella typhimurium*), gram-positive organisms (*S. aureus, S. epidermidis,* beta-hemolytic streptococci, group D streptococcus, *Bacillus subtilis, Sarcina lutea, Micrococcus, Nocardia asteroids, Corynebacterium* and pneumococcus).

c) In Dermatophilosis

Valipe, 2011 [21] reported the activity of caprylic acid in dermatophilosis (rain rot), a skin infection, caused by *Dermatophilus congolensis*, a gram positive bacterium which causes heavy loss in animal industry by causing fall in milk yield, and deterioration of hide and meat quality. Further electron microscopy results reveal that caprylic acid disrupts plasma membrane of bacteria which is thus responsible for its action.

d) In Bovine mastitis

Bovine mastitis is the single most important cause of economic loss to the dietary industry, and is characterized by inflammation of the mammary gland, usually caused by microbial infection. Mastitis can lead to increased production costs due to culling, medication, disordered milk, delayed genetic progress, and reduced milk yield and milk quality, which combined lead to a huge economic drain on the industry. Nair *et al.,* 2005 [22] tested caprylic acid and monocaprylin for their bactericidal activity against the major bovine mastistis pathogens *Streptococcus agalactiae, Streptococcus dysgalactiae, Streptococcus suberis, Staphylococcus aureus,* and *Escherichia coli* in milk and caprylic acid was found active against all tested strains and thus has the potential to be used as an alternative or adjunct to antibiotics for treatment of bovine mastitis.

e) Against intestinal pathogens

Santos *et al.,* 2008 [23] in a study on ten day old broiler chickens reported that caprylic acid supplemented in feed is active against *Campylobacter jejuni* which is one of the leading cause of human foodborne illness (mainly poultry products) in United States so reducing *Campylobacter jejuni* in intestinal tract will reduce contamination of poultry products and eggs.

Skrivanova *et al.,* 2008 [24], found caprylic acid to be effective in the reduction of enteropathogenic *Escherichia coli* in caecum and faeces of rabbits infected with EPEC O103 or O128.

Hanczakowska *et al.,* 2011 [25] reported that caprylic, capric and fumaric acids when given in piglet feed decreased the amount of *Escherichia coli* in small intestine and thus work as antibiotic replacement.

Kollanoor *et al.,* 2012 [26] investigated efficacy of feed supplemented with caprylic acid for reducing *Salmonella enterica serovar* enteritidis colonization in commercial broiler chickens and observed that caprylic acid potentially reduces the pathogen's ability to invade intestinal epithelial cells by downregulating key invasion genes, hilA and hilD.

Begum *et al.,* 2015 [27] observed that caprylic acid extract-supplemented diet improved growth performance, relative weight of bursa of Fabricius and reduced mortality rate, breast muscle and caecal E. coli counts in broiler chickens.

f) As Antiparasitic

The *in vitro* antiparasitic effect of caprylic acid was studied by Hirazawa *et al.,* 2001 [28] against several fish parasites i.e. *Cyrptocaryon irritans* (theronts), monogenean *Benedenia seriolae* (oncomiracidia and adults), copepod *Pseudocaligus fugu* (copepodids and adults) and myxosporean *Kudoa shiomitsui* (spores). It was observed that caprylic acid at a concentration of 1mM had a parasiticidal effect against *C. irritans* theronts, *B. seriolae* oncomiracidia and *K. shiomitsui* spores and a contractile effect against *B. seriolae* adults, but had no clear effect against *P. fugu* copepodids and adults.

g) In Crohn's disease

Hoshimoto *et al*., 2002 [29] revealed the inhibitory effect of caprylic acid on IL-8 gene transcription in differentiated Caco-2 cells and thus has potential in treatment of Crohn's disease. Further, they suggested that inhibition of IL-8 gene transcription by caprylic acid is not dependent on transcription factor inhibition or the induction of H_4 acetylation in its promoter.

h) As preservative

Chauhary *et al.,* 2008 [30] reported preservative effectiveness of caprylic acid derivatives (mainly capryl hydrazides) against *Staphylococcus aureus* MTCC 2901, *Bacillus subtilis* MTCC 2063, and *Escherichia coli* MTCC 1652 in Aluminium Hydroxide Gel–USP.

i) Decreased mortality in rabbits

Skrivanova and Marounek, 2002 [31] studied the effects of an oil containing triglycerols of caprylic and capric acid on growth, mortality, and digestibility of nutrients in growing rabbits. From their study, they concluded that medium chain fatty acids supplied as triacylglycerols decreased high mortality of growing rabbits under practical conditions but had no effect on the rate of growth.

j) Antioxidants

Kidwai *et al.,* 2011 [32] synthesized acyl derivatives of coumarins using different acids viz. acetic acid, caprylic acid, myristic acid, capric acid, palmitic acid etc. and reported the antioxidant potential of these compounds using DPPH radical scavenging activity and ABTS radical cation activity method.

k) **Role on food consumption or body weight**

de Sousa *et al*., 2006 [33] found that caprylic acid is capable of producing a signal that inhibits feeding (decreased food intake) in rats which may be due to increase in hepatic fatty acid oxidation by the caprylic acid.

Further Lemarie *et al.,* 2015 [34] observed the effect of dietery caprylic acid on food consumption and found that dietary caprylic acid decreases plasma unacylated ghrelin in rats without increasing plasma acylated ghrelin, thus having no role on body weight or food consumption and therefore dietery limit of caprylic acid need not to be changed.

l) In enterocolitis

Skrivanova *et al.,* 2008 [35] found caprylic acid to be active against coliform bacteria by improving the resistance of weaned rabbits to enterocolitis.

m) Production and purification of immunoglobulin

Caprylic acid is also reported to be used in production [36] and purification [37] of human immunoglobulin.

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