

Squalene- A Miraculous Oil

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ABSTRACT

Squalene is natural potent antioxidant present in vegetable oil, fish liver oil, palm oil, grain amaranth, buckwheat etc. It is mainly used in skin care products due to photoprotective agent and strongly quenches free radicals. Commercially squalene is derived from deodorized distillate from the refining of vegetable oil followed by extraction either by solvent or super critical fluid extraction method. Micronized squalene emulsions are being used as immune adjuvant, treat the COVID 19. Natural source of squalene served the functions of nutraceuticals i.e. prevention and treatment of CVD, improves the immunity, increase the GSH, CAT, SOD hormones to quenches the free radicals in cellular level. Squalene's potential health benefits are attributed to its antioxidant, anti-inflammatory and cardio protective properties, among others. Hence, the consumption of squalene rich foods can boost immunity, improve skin health and also maintain healthy life style.

INTRODUCTION

Squalene is a nonsaponifiable unsaturated triterpene with all six double bonds having isoprene units. Interestingly all six bonds are trans structure which causes rapid oxidation and unstable for

long time. It is natural potent antioxidant and commonly found in animal and plant source namely shark fish liver oil, soybean oil, olive oil, palm oil, rice bran oil, millet ban oil. Generally, shark fish liver oil is abundant

source of squalene and it was first identified in the fish liver oil by Japanese scholar during 1906. Squalene can be produced through the 2-C-methyl-D-erythritol 4-phosphate (MEP) or mevalonate (MVA) pathway. Further, β -Carotene, Coenzyme Q10, vitamin E, A, and Vitamin K1 have similar structure of squalene and play a significant role in scavenging free radicals and also inhibit the reactive oxygen species. Therefore, it act as strong natural antioxidant and also used to prevent CVD, colon cancer, inflammation, improve immunity, and detoxify the body.

Naturally, squalene is abundant in shark fish liver oil but grain amaranth oil has rich source of squalene. The other sources are buckwheat, rice bran oil, olive oil. But, commercially squalene is obtained from refining of vegetable oil because oil deodorized distillate has concentrated source of squalene. Among all vegetable oil distillate, olive oil distillate has highest concentration followed by palm oil distillate (O.Popa *et al* 2015). The human body can produce approximately 125–475 mg of squalene daily; however, squalene contents decrease in sebum with age. Therefore, supplementing squalene through diets is necessary but it is easily degraded by oxygen, temperature, water, metal, light, and other factors due to its high degree of unsaturation, which reduces its nutritional value and bioavailability. Hence suitable green technology and drug delivery system technology is essential (L Cheng *et al* 2024). Squalene content in edible oil varies from 0.7 % in olive oil to 7.12% in amaranth oil. In addition, White grain amaranth found less squalene than brown amaranth i.e. 327.54 and 340.81 mg/100g dry matter respectively. The teff grain found 0.85 to 2.33 mg/100g dry matter.

According to estimates, approximately 3000 sharks must be killed to produce 1 ton of squalene. Production from natural process is cost effective and content of SQ is low and

also availability of raw material for large production may not be sufficient. Hence, microorganisms are a prominent natural source of squalene due to their rapid growth and amenability to genetic engineering render them an alternative source of squalene. The examples of microorganisms that produce squalene are archaea *Halobacterium cutirubrum*; *Methylomonas methanica*; *Methylococcus capsulatus*, Euglena, *Saccharomyces cerevisiae* (yeast); fungi, such as *Torulaspora delbrueckii*. *Aspergillus nidulans*, and *Kluyveromyces lactis*, and the industrial yeast *Saccharomyces uvarum*. *Pseudozyma sp.* produces over 2 g/L squalene without having to undergo any strain engineering (S Shalu *et al* 2024). The details of sources of squalene are presented in table 1.

Table 1. Squalene sources (plant, animal and microbial)

Name of the food/organisms	Squalene yield (mg/100g)	References
White grain amaranth	327.54 mg/100g dry matter	(He <i>et al.</i> , 2002)
Brown amaranth	340.81 mg/100g dry matter	(He <i>et al.</i> , 2002)
Teff grain	0.85 to 2.33 mg/100g dry matter	(He <i>et al.</i> , 2002)
Olive Oil Distillate (ODD)	95 g squalene/kg ODD (99% pure)	Bouriakova <i>et al.</i> , 2019
Soybean ODD	31 g squalene/kg ODD (98% pure)	Bouriakova <i>et al.</i> , 2019
Rice bran oil	Not directly stated but mentioned as a source of squalene.	Y Shi <i>et al.</i> , 2015 (discusses supercritical fluid extraction from foxtail millet bran oil and oil distillates like rice bran).
Olive oil	Squalene content ranges from 0.7% to 7.12% (combined with amaranth oil details).	O. Popa <i>et al.</i> , 2015.
Palm oil	Not quantified but included in the list of oils	O. Popa <i>et al.</i> , 2015 (covers vegetable oils,

	with squalene.	including palm oil).
Soybean oil	Included as a source, but no specific concentration provided.	O. Popa <i>et al.</i> , 2015
Squalene yield	24 g squalene/kg ODD (98% pure)	Bouriakova <i>et al.</i> , 2019
Palm oil ODD	Discussed along with olive and soybean ODDs but not quantified.	Bouriakova <i>et al.</i> , 2019.
E Coli	Microbial sources of squalene mentioned without specific yields.	S. Shalu <i>et al.</i> , 2024
Pseudomonas	Microbial sources of squalene mentioned without specific yields.	S. Shalu <i>et al.</i> , 2024

Pharmacological Properties

Antioxidant and Anti-inflammatory Effects:

Squalene is known for its potent antioxidant properties, which help in maintaining the oxidation/antioxidation balance in the body. This capability is crucial in protecting cells from oxidative stress, which is linked to aging and various diseases (Ronco & Stefani, 2013) (Lou-Bonafonte *et al.*, 2018).

Cardioprotective Effects: Squalene has been shown to have hypolipidemic effects, potentially reducing the risk of cardiovascular diseases (CVD) by inhibiting HMG-CoA reductase, similar to statins. However, while animal studies have shown promising results, human studies have been inconsistent, indicating the need for further research (Muzalevskaya *et al.*, 2015) (Ibrahim *et al.*, 2020).

Anticancer Properties: Squalene exhibits antitumor activities, particularly against cancers such as ovarian, breast, lung, and colon cancer. It can potentiate the effects of certain antitumor drugs while reducing their

side effects (Muzalevskaya *et al.*, 2015) (Lozano-Grande *et al.*, 2018).

Sources and Extraction

Animal and Plant Sources: Squalene is abundantly found in deep-sea fish, especially sharks, and in plant oils such as olive, amaranth, and palm oil. Amaranth seed oil is particularly rich in squalene, containing 5-8% of the compound (Zhen, 2004).

Extraction Challenges: Despite its benefits, the commercial production of squalene is limited by the availability of natural sources and efficient extraction methods. Advances in biotechnology have led to synthetic production, but yields remain insufficient to meet global demand (Lozano-Grande *et al.*, 2018).

Extraction methods

Traditional solvent extraction process was used for squalene production. However, recently super critical fluid extraction and super critical propane extraction techniques was used for extraction oil from foxtail millet bran and found higher oil yield (17.5% to 21%), higher carotene content as compared to the solvent extraction (Y Shi *et al* 2015).Supercritical fluid extraction (ScCO₂) facilitates separation of squalene at low temperatures without leaving traces of organic solvents. Generally, ScCO₂ is a recommended technique for nonpolar compound extraction with molecular weights less than 500 g/mol soluble in CO₂, such as SQ (Lozano-Grande).In addition to grain amaranth, Bouriakova, used the deodorized distillery oil namely olive, soybean and sunflower ODD was subjected to SCF and found the highest squalene yield and purity i.e., from olive ODD (95 g squalene kg-1 ODD, 99wt% pure), followed by soybean ODD (31 g squalene kg-1 ODD, 98wt% pure) and sunflower ODD (24 g squalene kg-1 ODD, 98wt% pure).

Applications of squalene

Squalene is used in food, agriculture, and medical, nutraceutical application due to its miraculous and nature gift. As above mentioned it has potent antioxidant, photo protective agent and used to treat many disorders, disease.

Applications in Cosmetics and Nutrition

Cosmetic Uses: Squalene is widely used in cosmetic dermatology due to its emollient and hydrating properties. It is a key component in skin care products, providing protection against UV radiation and supporting skin health (Huang *et al.*, 2009).

Nutritional Benefits: As a dietary supplement, squalene is recommended for its potential to lower LDL cholesterol and support overall cardiovascular health. However, its intake is limited by the scarcity of natural sources (Lozano-Grande *et al.*, 2018) (Sumi *et al.*, 2018).

CONCLUSION

Squalene is valuable compound present in food but refining of oil reduces its content and currently consuming as a supplement. It is a potent antioxidant, anticarcinogenic, anti-aging agent and is used in skin care products and has vast application in the field of biomedical. Hence, the natural source of cereals, pseudo cereals, millets with bran and, GMO's are alternative source for rich source of squalene. The awareness of squalene content in the natural food source is essential to lead healthy life style and also cut down the consumption of refined and ultra processed foods among the population is essential.

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