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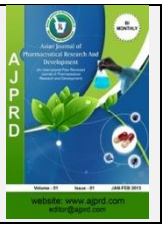

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Review Article

A Review on Algal Oil

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A B S T R A C T

Algal oil, obtained from algae, is well-known for its high concentration of omega-3 fatty acids, particularly DHA and EPA. This investigation aims to elucidate algal oil's components and its manifold benefits for human health. This article synthesizes pharmacology aspects including dosage, administration, and side effects, as well as pharmacognostic insights like extraction types and processes, and the composition of various forms of microalgae, which may inspire novel investigation approaches. The chemical features of algal oil have been employed effectively in significant health conditions such as preterm birth, coronary heart disease, and other health concerns.

Keywords: algal oil, pharmacology, pharmacognostic insights, health benefits

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INTRODUCTION

Algal oils are recognized as the botanical origin of the omega-3 (n-3) fatty acids known as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA)1. An excellent dietary option for vegetarians, algal oil, high in omega-3 fatty acids, offers both safety and effectiveness2. Since it is understood that the primary dietary supply of docosahexaenoic acid and eicosapentaenoic acid, namely fish oil, has likely reached its peak global production, efforts are presently directed towards finding a sustainable substitute. In this current century, a notable commercial advancement has been the manufacturing of oils abundant in docosahexaenoic acid and eicosapentaenoic acid extracted from microalgae. These oils derived from algae were previously known to be safe for use in newborn formula, and they are now being utilized more frequently in enriched foods and health supplements. These algal oils are made from micro-algae found in the oceans. Algal oils offer several advantages, including their production within controlled conditions, suitability for vegetarian diets, and strong sustainability credentials. Algae oil production is costly, although technological improvements and size-related economies of scale have reduced the overall price. Docosahexaenoic acid (C22:6 n-3) is a specific omega-3 long-chain fatty acid that plays a significant role in the physical body; it serves as a crucial structural component in the retina of the eye, and the brain plays a vital role in heart health. The presence of DHA and EPA in the bloodstream is a fundamental component of the body's protective mechanisms, actively contributing to the reduction of inflammation and the neutralization of reactive oxygen species (ROS) at the cellular level. EPA (C20:5 n-3) is another example of a long-chain omega-3 fatty acid. Its primary health advantage lies in its function as an eicosanoid, which plays a significant role in controlling inflammation and the immune response in the human body. Eicosanoids generated from EPA are well known for their ability to effectively control inflammatory and chronic conditions like heart disease3. A daily consumption of 250–500 milligrams of omega-3 fatty acids is recommended by the European Food Safety Authority (EFSA). Docosahexaenoic acid (DHA, C22:6n-3) and

eicosapentaenoic acid (EPA, C20:5n-3)-fortified functional foods are in high demand4.

DRUG PROFILE

Different Names of Algal Oil

Single cell oil,Microalgae Oil,High EPA Algal Oil,High DHA Algal Triacylglycerol,DHA-S Oil,DHASCO Oil,DHASCO-T,DHASCO-S, DHA-T Oil.

HISTORY

Algal oil is derived from marine algae, and it contains high levels of specific n-3 fatty acids such as DHA and EPA. Particular species of algae are intentionally cultivated in agriculture to create algal oil.

Algal oil can be derived from various species, like Nannochloropsis, Crypthecodinium, Prototheca, Schizochytrium, and Ulkenia.The fatty acids found in this oil could potentially relieve inflammation and support cognitive function.

It's important to differentiate algal oil from particular algae types, like brown algae, blue-green algae, laminaria, or chlorella. Additionally, make a clear distinction between algal oil and DHA or EPA obtained from alternative sources like krill oil, cod liver oil, or fish oil, as they are not identical products[5].

Algae: photosynthetic organisms characterized by their absence of real roots, stems, and leaves.

Algae are photosynthetic creatures with pigments like chlorophyll. They come in a variety of forms, with some being single-celled and others being multicells. They can also create colonies. The majority of algae live in water, but they are land-based and may be located on wet ground, plants, or rocks. Certain types of algae engage in symbiotic relationships with other organisms. One example is lichen, which represents a mutually beneficial partnership between green and fungi (or rarely blue-green) microalgae. Algae are part of a polyphyletic category; this indicates that the creatures in this group may have no close genetic connections and no common ancestry. Nevertheless, they have a common characteristic: they are eukaryotic organisms capable of photosynthesis using chlorophyll as their main pigment while simultaneously lacking the typical morphological and anatomical features found in vascular plants. The scientific field dedicated to the examination of algae is known as phycology. While certain sources include blue-green algae in this category, it's important to note that these organisms are prokaryotic in nature, and thus, some experts do not classify them as true algae.

ETYMOLOGY

The term "algae" comes from the Latin word "alga," which means "seaweed." The adjective "algal" is used to describe, represent, or refer to algae.

According to the five-kingdom classification system, algae and protozoa are categorized within the Kingdom Protista.

They differ from protozoa in that they perform photosynthesis.

Algae are additionally classified into different phyla, and the suffix "-photo" is employed in their categorization.

- Cyanophyta (blue-green algae)
- Euglenophyta (euglenids)
- Chrysophyta(diatoms)
- Chlorophyta(green algae)
- Rhodophyta (red algae)
- Pyrrophyta (dinoflagellates)
- Phaeophyta (brown algae)[6]

Table 1: Algal Composition Presented In Dry Matter (%) 7

Strain	Lipids	Protein	Nucleicacid	carbohydrate
Scenedesmusquadricauda	1.9	47		
Scenedesmus dimorphus	16-40	8-18		21-52
Chlorellavulgaris	14-22	51-58	4-5	12-17
Chlamydomonasrheinhardii	21	48		17
Spirogyrasp.	11-21	6-20		33-64
Dunaliellabioculata	8	49		4
Chlorellapyrenoidosa	2	57		26
Euglenagracilis	14-20	39-61		14-18
Prymnesiumparvum	22-38	28-45	1-2	25-33
Scenedesmusobliquus	12-14	50-56	12-14	10-17
Dunaliellasalina	6	57		32
Porphyridiumcruentum	9-14	28-39		40-57
Tetraselmismaculata	3	52		15
Synechoccus sp.	11	63	5	15
Spirulinamaxima	6-7	60-71	3-4.5	13-16
Spirulinaplatensis	4-9	46-63	2-5	8-14
Anabaena cylindrica	4-7	43-56		25-30

Table 2: Oil Content Found In Various Types of Microalgae[8]

Sl. No.	Tiny algae	Lipid content (% dry weight).
1	Tetraselmissueica	15-23
2	Schizochytrium sp.	50-77
3	Phaeodactylumtricornutum	20-30
4	Nitzschia sp.	45-47
5	Neochlorisoleoabundans	45-47
6	Nannochloropsis sp.	31-68
7	Nannochloris sp.	20-25
8	Monallanthus salina	>20
9	Isochrysis sp.	25-33
10	Dunaliellaprimolecta	23
11	Cylindrotheca sp.	16-37
12	Crypthecodiniumcohnii	20
13	Chlorella sp.	28-32
14	Botryococcusbraunii	25-75

EXTRACTION OF OIL

There are multiple techniques available for extracting oil from algae, with four particularly well-known methods: solvent extraction method, mechanical pressing method, ultrasonic-assisted extraction method, and supercritical fluid extraction method.

Solvent Extraction Method

Chemical methods can be employed to extract algal oil. It involves combining organic solvents like benzene, cyclohexane, hexane, acetone, and chloroform with microalgal biomass. These solvents break down the cell walls of microalgae and effectively extract the oil due to its high solubility in organic solvents. This method uses low-cost solvents, yields consistent results, and allows for solvent recycling. The oil yield through this method typically ranges from 60% to 70%.

Mechanical Press Method

This technique involves subjecting microalgal biomass to elevated pressure, causing cell walls to rupture and oil to be released. It is simple and does not necessitate the use of any solvents. Using this process, a significant amount of the oils (about 70–75%) may be recovered from the algal biomass.

Ultrasonic-Assisted Extraction Method

This technique depends on the phenomenon known as cavitation. Cavitation takes place when tiny, vapor-filled bubbles form within a region where the liquid's pressure is below the point at which it would normally turn into vapor. These bubbles expand when subjected to lower-than-normal pressure and shrink when exposed to higher pressure, resulting in a forceful implosion of the bubbles. When bubbles implode close to cell membranes, they can cause harm and lead to the release of cell contents. This method offers several benefits compared to other extraction techniques, including shorter extraction times, reduced solvent usage, enhanced solvent penetration into cellular materials, and improved release of cell contents into the bulk medium. It is capable of extracting approximately 76-77% of the oils independently.

Supercritical Fluid Extraction Method

This method is more effective than conventional solvent-based separation techniques. When exposed to pressures and temperatures above their critical points, supercritical fluids show improved solvating ability. This method produces very pure extracts free of possible solvent residues, ensuring rapid and safe extraction and separation, especially for heat-sensitive compounds. This method can independently extract nearly 100% of the oils. In the case of supercritical fluid carbon dioxide (CO2) extraction, CO2 is pressurized and heated until it exhibits characteristics of both a liquid and a gas. This transformed fluid then serves as the solvent for oil extraction.

Table 3: Comparing Different Extraction Methods

Extraction technique	Fundamental principle	benefits	Yields (%)	Drawbacks
Mechanical Press	In a mechanical press, high pressure is applied to microalgal biomass, causing cell walls to rupture and oil to be released	Simple to operate, no need for solvents	70-75	Significant sample quantitiesare required, and the recovery process is lengthy, but it is simple
Solvent extraction	When organic solvents like hexane, benzene, acetone cyclohexaneand chloroform are combined with tiny algae biomass, Because of the oil's high solubility in organic solvents, they break down the microalgal cell walls and extract the oil	The solvents employed are cost-effective, yielding consistent results, and can be reused, saving time in the process	60-70	Many organic solvents are very flammable and poisonous, and solvent recovery can be costly due to the huge volume needed
Supercritical fluid extraction	When supercritical fluids are elevated over their critical temperature and pressure thresholds, their solvating ability improves. This results in extraordinarily clean extracts free of potentially hazardous solvent residues, as well as rapid extraction and separation, which is especially safe for thermally sensitive products	Freefrom toxicity (with no traces of organic solvent in the extracts), environmentally friendly solvent, not-flammable, and easy to operate	100	Significant energy usage and currently challenging/expensive to expand in scale
Ultrasonic assisted	Theultrasonic-assisted extraction technique relies on cavitation, which occurs when vapor bubbles form within a liquid where the liquid's pressure is lower than its vapor pressure. These bubbles expand in negative pressure conditionsand when under additional pressure, the bubbles constrict and violently collapse. When these collapses occur in proximity to cell membranes, they can lead to harm and the discharge of cellular contents	Decreased extraction duration, lower solvent usage, enhanced solvent penetration into cellular substances, Enhanced discharge of cell components into the surrounding environment	76-77	Elevated energy usage, challenging to expand in size

According to the table above, solvent extraction and supercritical procedures are the most effective methodologies for oil extraction when considering parameters such as oil yield and other features[9].

UTILIZINGALGAL OIL FOR TREATING MAJOR HEALTH CONDITIONS

NON-INSULIN-DEPENDENT DIABETES:

N-3 fatty acids could perform a meaningful role as co-treatments in the effort to reduce triglyceride levels in individuals with early-stage diabetes and non-insulin-dependent diabetes mellitus (NIDDM). While omega-3 supplements may not have a direct impact on glucose regulation, these vital fatty acids provide protection against lipid oxidative stress in individuals with diabetes.

ARRHYTHMIAS:

Originally, it was believed that omega-3s provided their benefits primarily by preventing blood clot formation, but more recent research suggests that their main effect may actually be in preventing abnormal heart rhythms. Omega-3 supplementation led to a reduction in heart rate variability among patients who had experienced a heart attack, and this decrease in heart rate variability was connected with a lower chance of death and dangerous heart rhythm disturbances. Indeed, introducing EPA/DHA directly into the culture medium with cardiomyocytes in a laboratory setting can prevent or halt drug-induced or electrically controlled arrhythmias. EPA and DHA are proposed to have immediate protective effects on cardiac muscle cells by regulating the permeability of the plasma membrane and maintaining the stability of ion channel activities.

CORONARY HEART DISEASE:

Elevated levels of docosahexaenoic acid and eicosapentaenoic acid are believed to serve as a beneficial addition. Recent clinical investigations, such as the DART and GISSI-P trials involving the supplementation of fish oil, demonstrated a significant decrease in mortality (ranging from 15% to 45%) among individuals considered at risk for coronary heart disease. Significant decreases in sudden deaths were observed. However, a minor fish oil supplementation study conducted in Norway did not yield

substantial improvements, likely because participants habitually included cold-water fish as a regular component of their diet. The second outcome can be understood by considering that the initial omega-3 status was already optimal. This implies that in Norway, coronary heart diseases were probably influenced more by other factors like obesity or dominant genetic factors among the study participants, with the full necessity of EPA/DHA in the background. Nonetheless, the majority of worldwide risks for coronary heart disease are linked to dietary factors. Many countries, including India, exhibit a significant occurrence of coronary heart disease that can be attributed to dietary causes.

CANCER:

Boosting the intake of EPA and DHA through either dietary sources or supplements can naturally enhance cancer treatment. Nonetheless, human clinical research on this matter is still ongoing. Findings from animal studies have indicated that consuming DHA/EPA can decelerate the development of cancer xenografts, enhance the effectiveness of anticancer treatment, and mitigate chemotherapy-related adverse effects.

ATHEROSCLEROSIS AND INFLAMMATION:

N-3 fatty acids may have a role in the development of atherosclerosis. Once more, when it comes to individuals with coronary heart disease, providing them with DHA/EPA supplements or a placebo over a two-year period led to slight enhancements in atherosclerosis, as determined through angiography. Within the fish oil category, atherosclerotic plaques showed the integration of Omega-3 fatty acids, and these plaques were more likely to exhibit decreased mass, lower levels of inflammatory infiltrate, and thicker fibrous caps due to protective responses. These characteristics suggest a plaque that is less prone to breaking, suggesting that DHA/EPA may contribute to the promotion of plaque stability. Furthermore, there have been observed enhancements in overall endothelial function and reductions in inflammatory mediators[10].

DEVELOPMENT OF BRAIN AND VISION IN INFANTS:

A nutritionally balanced diethigh in omega-3 fatty acids can help to avoid cognitive issues and promote eyesight development in newborns.As a developing brain matures, it tends to accumulate significant quantities of DHA. In comparison to other parts of the body, the brain and nervous system contain notably elevated levels of DHA; however, its specific function within the brain remains not completely understood.At present, EPA and DHA may be found in a broad range of newborn food products.

CARDIOVASCULAR:

Diets that are high in DHA and EPA have indicated protective benefits against cardiovascular risk factors and hypertension. These benefits include a notable reduction in blood triglyceride levels and decreased inflammation following cardiovascular events. Furthermore, studies revealed positive effects in relation to various conditions such as arrhythmias, atherosclerosis, Alzheimer's, and other coronary, circulatory, or neurological diseases[11].

SIGNIFICANT ADVANTAGES

Lowered triglyceride levels

Both EPA and DHA are highly efficient at decreasing triglyceride levels, typically resulting in reductions ranging from 15% to 30%. Individuals with initially elevated triglyceride levels often experience the most significant improvements.

Alleviated signs of depression

Omega-3 supplements like algae oil can be equally effective as pharmaceuticals such as fluoxetine in significantly improving the condition of individuals suffering from major depression.

Decreased lupus symptoms

The supplement can alleviate symptoms of systemic lupus erythematosus by up to 50%, with most research indicating an improvement of approximately 30%. Notably, doses containing 160mg of EPA and 140mg of DHA are more effective in this context than higher doses.

DOSAGE INSTRUCTIONS AND HOW TO PROPERLY ADMINISTER IT

The quantity of omega-3 in algae oil may vary between different brands, but fortunately, they typically provide specific information regarding their EPA and DHA content.

The suitable and safe dosage range for a combination of EPA and DHA varies, with doses ranging from 300 milligrams to 3 grams, depending on your objectives.

A daily dose of 2 grams of combined EPA and DHA appears to provide maximum benefits with a minimum risk of serious adverse effects for the vast majority of people.

POSSIBLE ADVERSE EFFECTS

- Unpleasant Stomach Discomfort
- Abdominal pains
- Frequent and loose bowel movements
- Fishy burbs12

CONCLUSION

Algal oil represents a significant supplier of N-3 fatty acids, especially docosahexaenoic acid and eicosapentaenoic acid, which are essential for human health. It provides a sustainable and plant-based alternative to traditional sources like fish oil. Algal oil supplements are widely available and recognized as safe for consumption, making them a valuable option for individuals looking to incorporate omega-3s into their diets.

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