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REVIEW ARTICLE

SHARK LIVER OIL: A REVIEW

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Abstract:

Shark liver oil is the fixed oil obtained from the fresh and carefully preserved livers of various species of sharks, mainly Hypoprion brevirostris (lemon shark) and Galeorhinus zyopterus, family-Pleuonectidae, order-Selachii. Shark liver oil is rich in alkylglycerols, which are naturally found in mother's milk and in bone marrow. It also contains pristane, squalene, vitamins A(whose concentration varies from 15000 to 30000 International units per g), vitamin D, omega-3 fatty acids[Eciosapentaenoic acid (EPA), Docasahexaenoic acid (DHA)], triglycerides, glycerol ethers, and fatty alcohols. Shark liver oil is promoted as a dietary supplement used to boost the immune system, fight off infections and heal wounds. It has been suggested that their alkylglycerol component fight cancer by killing tumor cells indirectly, squalene has been promoted as having cell-protecting abilities, which may reduce the side effects of chemotherapy, omega-3 fatty acids and vitamin A are used in the treatment of Xeropthalmia (abnormal dryness of the surface of conjuctiva). Many parts of the shark can be valorized: Meat, for human consumption, Skin, in tanning industries. Fins, for soups, Cartilage, for production of Condroitin and Condroitin Sulfate (used as a cosmetic ingredient). Various studies have been conducted which explores Shark liver oil's anti cancerous, cardiac stimulant, anti psychotic, anti depressive, anti alzheimeric and anti parkinsonic effect. The recent use of Shark liver oil for the development of Swine flu vaccines and in certain cosmetics soaps and lotions adds to their invaluable use.

Keywords: Shark liver oil, squalene, anti cancerous, cardiac stimulant, anti psychotic, Swine flu vaccines.

Introduction

Sharks are among the most important commercial fish stocks in Cuban waters nowadays and there are 23 commercial species which have been caught for the past 100 years.[1] Levels of shark catches in Cuban waters have varied during the years in terms of fishing effort. Catch levels are already around 1500 or 2000 tons per year.

Shark liver oil (also known as shark oil) is extracted from the livers of various species of sharks. Studies have been conducted on oil extracted from shark livers from Cuban waters since the 1940s. Some exports of the product were carried out and its physical, chemical and microbiological properties were studied. It is known that comparative studies were made between shark oil and Atlantic cod liver oil, showing the similarity between them in terms of their properties. However, after 1959 investigations concerning Cuban sharks were reopened and there are some studies on their population, taxonomic characterization, status of exploitation of the species, representative species and general characteristics of each one.

Historical Background:

Shark liver oil has been used as a folk remedy by people on the coasts of Norway and Sweden for hundreds of years. It was mainly used to promote wound healing and as a general remedy for conditions of the respiratory tract and the digestive system.

In the 1950s, a young Swedish doctor suggested that extracts of bone marrow helped boost the recovery of white blood cells in children undergoing radiation therapy and chemotherapy for leukemia [2]. The active ingredient in the bone marrow extract was identified as alkylglycerols. Shark liver oil was found to be one of the richest sources of alkylglycerols. Around 1986, the first commercially purified shark liver oil with a "standard dose" of alkylglycerols was marketed. It is still widely used in many northern European countries.

Synonym: Oleum Selachoide.

Biological source:

Shark liver oil is extracted from the livers of deep-water sharks which typically inhabit the cold, non-polluted waters of the sea. Shark liver oil is typically obtained from sharks that are caught as a by-product of deep-sea fishing, making a valuable remedy from a natural resource that would have otherwise gone to waste.

Shark liver oil is the fixed oil obtained from the fresh and carefully preserved livers of various species of shark, mainly Hypoprion brevirostris (lemon shark), family- Pleuonectidae, order- Selachii and Galeorhinus zyopterus.

In India, Scoliodon, Carcharias, and Sphyrna are abundant among the species, and are generally utilize for the extraction purpose.

Geographical Source:

The oil is produced mainly on large scales in many European countries. In India, it is produced in Tamil Nadu, Maharashtra and Kerala states.

Ultramarine Shark Liver Oil [3]:

Ultramarine Shark Liver Oil is extracted from the liver of deep-water Etmopterus sharks, which inhabit the cold, non- polluted waters of New Zealand at depths of 3,000 to 5,000 feet. this superior all natural, whole shark liver oil is minimally processed to ensure that the active ingredients and the natural trace elements are maintained. Harsh processing and heat are avoided which would strip the shark liver oil of many of its valuable natural components. It is 100% pure, with no artificial coloring, preservatives or additives.

Preparation:

Livers removed from the shark are thoroughly cleaned, freed from fatty material and adhering tissues. The cleaned livers are minced and heated in a boiling pot at a temperature not exceeding 80 C. The oil thus extracted is kept in contact with dehydrating agent to eliminate water. The oil freed from water is chilled to separate stearin. It is then centrifuged to get clear oil after removing the suspended material. The oil may further be manipulated to adjust vitamin strength as per requirement and sometimes it is fortified with vitamin D, if so desired.

With a little variation, the principle involved in extraction of oil from livers is uniform in almost all the cases. Government factories in Tamil Nadu and Maharashtra are processing livers for extracting oil.

Description:

Description	Properties
Color	Pale yellow to brownish or yellow
Odor	Characteristic fishy, but not rancid
Taste	Bland or fishy

Solubility:

Shark liver oil is soluble in solvent ether, chloroform, and light petroleum ether. However, it is insoluble in water and slightly soluble in ethyl alcohol.

Standards:

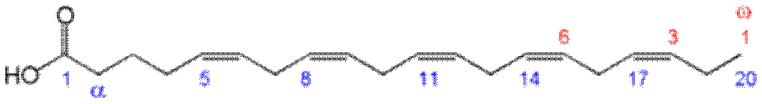
The shark liver oil complies with following standards:

Specific Gravity	0.912 to 0.916.
Refractive Index	1.459 to 1.477 at 40 C.
Acid Value	not more than 2.
Iodine Value	not less than 90.
Saponification Value	175 to 200.
Moisture Content	less than 1%
Impurities	less than 1%

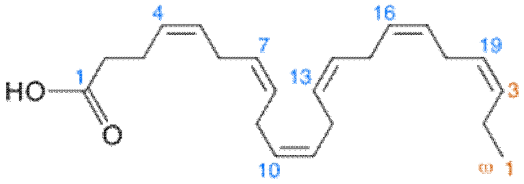
Chemical constituents:

Shark liver oil is rich in alkylglycerols, which are naturally found in mother's milk and in bone marrow. It also contains pristane, squalene, vitamins A(whose concentration varies from 15000 to 30000 International units per g), D, omega-3 fatty acids[Eciosapentaenoic acid (EPA), Docasahexaenoic acid (DHA)], triglycerides, glycerol ethers, and fatty alcohols.

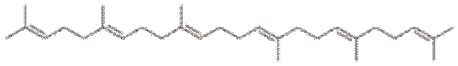
Structure of EPA-



Structure of DHA-



Structure of Squalene-



Structure of Vitamin A-

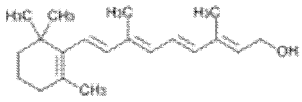


Table 1: Fatty Acids Concentration

Grams of omega-3 fatty acids per 3oz (85g) serving of popular fish

Common name	Grams
Tuna	0.21–1.1
Tuna (canned, light)	0.17-0.24
Pollock	0.45
Salmon	1.1–1.9
Cod	0.15–0.24
Catfish	0.22–0.3
Flounder	0.48
Grouper	0.23
Halibut	0.60–1.12
Mahi mahi	0.13
Orange roughy	0.028
Red snapper	0.29
Shark	0.83
Swordfish	0.97
Tilefish	0.90
King mackerel	0.36

Table 2: Quality Properties [1]:

Property	Value
Squalene (%)	0.03
Vitamin A (mgg-1)	439.5
Vitamin E (mgg-1)	0.76
Vitamin D (mgg-1)	Not detected
FFA(free fatty acids) %)	0.428

Identification Test:

(1) Dissolve one or two drops of shark liver oil in 1ml of chloroform in a dry test tube. Add a drop of concentrated sulphuric acid, a violet color which changes to purple or brownish is obtained. this is due to the presence of vitamin A.

(2) One ml of the oil is dissolved in 10 ml of chloroform in a dry test tube. On addition of few drops of saturated solution of antimony trichloride in the chloroform solution a blue colour is formed. This is also due to the presence of vitamin A.

Uses [4]:

Shark liver oil is promoted as a dietary supplement used to boost the immune system, fight off infections, heal wounds, and to treat cancer and lessen the side effects of conventional cancer treatment. Alkylglycerols, one of the components found in shark liver oil, are thought to be helpful in several ways. It has been suggested that they fight cancer by killing tumor cells indirectly. Proponents claim they activate the immune system in two ways: by stimulating immune system cells called macrophages, which consume invading germs and damaged cells; and by inhibiting protein kinase C, which is a key regulator of cell growth. Proponents also claim that alkylglycerols reduce the side effects of chemotherapy and radiation treatment, supposedly because of their ability to protect cell membranes.

Because of their supposed immune-boosting effects, alkylglycerols are also claimed to help against colds, flu, chronic infections, asthma, psoriasis, arthritis, and AIDS. Since macrophages are also important in wound healing, alkylglycerols are said to have healing effects.

Other compounds in shark liver oil, such as squalamine and squalene, have also been promoted to have anti-cancer effects. It is also being studied for use against macular degeneration, an eye condition that results in loss of vision. . Squalene has been promoted as having cell-protecting abilities, which may reduce the side effects of chemotherapy.

These claims are currently being studied. Depending on the commercial preparation, shark liver oil may also be rich in omega-3 fatty acids and vitamin A [which is used in the treatment of Xerophthalmia (abnormal dryness of the surface of conjunctiva)]. Shark liver oil has also been used in some moisturizing skin creams and lotions, although several cosmetics companies have recently removed this ingredient because of concern regarding the decline of some shark species.

Deep-sea shark are often caught as a by catch. Sharks are mainly caught for food purpose. Many parts of the shark can be valorized [5]:

- **Meat**: for human consumption. In Asia it's often salted and dried and in Europe it's widely used in the fish and chips trade.
- **Skin**: in tanning industries. The resultant leather is durable and has a texture resembling crocodile skin.
- **Fins**: for soups. Shark fin soup is very popular in Asia, especially in China.
- **Cartilage**: for production of Condroitin and Condroitin Sulfate. Condroitin Sulfate is a cosmetic ingredient.
- **Liver oil: for production of Squalene** and alkylglycerols. After being hydrogenated Squalene becomes Squalane. Squalane is a cosmetic base.

Shark liver oil is effective for the following medical conditions [5]:

- Ataxia
- Ataxia associated with a vitamin E deficiency : Vitamin A deficiency, VitaminC deficiency, VitaminE deficiency.

May be effective for the following conditions, though further research is needed:

- Age-related maculopathy
- Age-related macular degeneration
- Alzheimer’s disease
- Vascular dementia
- Anemia
- Arthritis
- Cancer
- Bladder Cancer
- Beta-thalassemia
- Cancer-related fatigue
- Cancer chemotherapy side effects
- Cancer associated anorexia
- Chemotherapy

- Cisplatin-induced neurotoxicity
- Connective tissue diseases and disorders
- Dysmenorrhea (painful menstruation)
- Eclampsia
- Huntington's disease
- Dyspraxia (a wide range of developmental disorders)
- Granuloma annulare (chronic skin condition)
- Infertility
- Intracranial hemorrhage (brain bleeding)
- Leukemia
- Malignant melanoma
- Melanoma
- Parkinson's disease
- Pre-eclampsia
- Physical performance
- Premenstrual syndrome (PMS)
- Sunburn
- Radiation-induced fibrosis
- Radiation
- Sun exposure
- Skin cancer
- Thalassemia
- Sunburn
- Retrolental Fibroplasia

CANCER:

In a recent study of 35,000 middle-aged women published in the journal Cancer Epidemiology, those that took fish oil supplements were found to have a 32% lower risk of breast cancer. Omega-3 fatty acids reduced prostate cancer growth, slowed histopathological progression, and increased survival in genetically engineered mice [7]. High levels of docosahexaenoic acid, however, the most abundant n-3 polyunsaturated fatty acid (omega-3) in erythrocyte membranes, were associated with a reduced risk of breast cancer [8].

Cardiovascular:

1. The American Heart Association recommends the consumption of 1g of fish oil daily, preferably by eating fish, for patients with coronary heart disease although pregnant and nursing women are advised to avoiding eating fish with high potential for mercury contaminants including mackerel, shark, or swordfish [9].
2. The US National Institutes of Health lists three conditions for which fish oil and other omega-3 sources are most highly recommended: hypertriglyceridemia, secondary cardiovascular disease prevention and high blood pressure.
3. There is also some evidence that fish oil may have a beneficial effect on some forms of cardiac dysrhythmia.[10] [11]

Mental Health:

1. Studies published in 2004 and 2009 have suggested that fish oil may reduce the risk of depression and suicide. One such study took blood samples of 100 suicide-attempt patients and compared the blood samples to those of controls and found that levels of Eicosapentaenoic acid were significantly lower in the washed red blood cells of the suicide-attempt patients [12].
2. A small American trial, published in 2009, suggests that E-EPA, as monotherapy, might treat major depressive disorder, however the study achieved no statistical significance [13].
3. Studies[14][15] were conducted on prisoners in England where the inmates were fed seafood which contains omega-3 fatty acids. The higher consumption of these fatty acids corresponded with a drop in the assault rates. It was suggested that these kinds of fatty acids are responsible for the neuronal growth of the frontal cortex of the brain which, it is further alleged, is the seat of personal behavior.
4. A study from the Orygen Research Centre in Melbourne suggests that omega-3 fatty acids could also help delay or prevent the onset of schizophrenia. The researchers enlisted 81 'high risk' young people aged 13 to 24 who had previously suffered brief hallucinations or delusions and gave half of them capsules of fish oil while the other half received fish-tasting dummy substitute. One year on, only three percent of those on fish oil had developed schizophrenia compared to 28 percent from those on the substitute [16].
5. A study conducted at Sheffield University in England reported positive results with fish oil on patients suffering from schizophrenia. Dr. Malcolm Peet, Professor of Psychiatry at Sheffield University organized the study and followed the progress of the participants.

Participants of the study were previously taking anti-psychotic prescription drugs but after some time were no longer effective on patients. After taking fish oil supplements, participants in the study experienced progress compared to others who were given a placebo [17].

ALZHEIMER's (Neuro degenerative disorder):

According to a study from Louisiana State University in September 2005, fish oil may help protect the brain from cognitive problems associated with Alzheimer's disease [18].

PARKINSON's:

A study examining whether omega-3 exerts neuroprotective action in Parkinson's disease found that it did, using an experimental model, exhibit a protective effect (much like it did for Alzheimer's disease as well). The scientists exposed mice to either a control or a high omega-3 diet from two to twelve months of age and then treated them with a neurotoxin commonly used as an experimental model for Parkinson's. The scientists found that high doses of omega-3 given to the experimental group completely prevented the neurotoxin-induced decrease of dopamine that ordinarily occurs. Since Parkinson's is a disease caused by disruption of the dopamine system, this protective effect exhibited could show promise for future research in the prevention of Parkinson's disease [19].

DEPRESSION:

An August 2003 double-blind placebo-controlled study published in the journal European Neuropsychopharmacology found that among 28 patients with major depressive disorder, "patients in the omega-3 PUFA group had a significantly decreased score on the 21-item Hamilton Rating Scale for Depression than those in the placebo group [20].

Side effects/ Dangers:

Although many people have taken shark liver oil, the issue of potential toxicity at the usual doses has not been well studied. Some mild digestive problems such as nausea, upset stomach, and diarrhea have been reported. Some animal studies have found that shark liver oil and its components may raise blood cholesterol levels.

Vitamins:

The preferred source of omega-3 should be from the fish's body, not the liver. The liver and liver products of fish and many animals (such as sharks) contain omega-3, but also the active form of vitamin A. At high levels, this form of the vitamin can be dangerous (Hypervitaminosis A). The FDA says it is safe to take up to 3000 mg of omega-3 per day [21].

TOXIC POLLUTANTS:

In early 2006, government agencies such as the Food Standards Agency in the UK and the Food Safety Authority of Ireland reported PCB levels that exceeded the strict new European maximum limits in several fish oil brands, which required temporary withdrawal of these brands [22]. A March 2010 lawsuit filed by a California environmental group claims that eight popular brands of fish oil supplements contained excessive levels of PCBs, including CVS/pharmacy, Nature Made, Rite Aid, GNC, Solgar, Twinlab, Now Health, Omega Protein and Pharmavite. It should be noted, however, that the majority of these products were either cod liver or shark liver oils. Because the liver is the major filtering and detoxifying organ.

Dosage: As a complement for cancer treatment, take 1 to 2 capsules (providing 100 mg alkylglycerols) 3 times per day with meals. For fighting infections take 1 to 2 capsules a day with meals, for one week do not exceed manufacturer's recommended dosage.

Substitutes: Due to the ever increasing threats on the species of shark for the extraction of their oil, the non-animal sources of squalene are being looked for. Olive oil is found to be an excellent substitute to the shark liver oil in this context.

It is important to know that shark liver oil is substantially different from shark cartilage supplements, even though both come from the same fish. Shark liver oil contains potentially therapeutic substances unlike those found in the cartilage.

Some Unexplored Facts on the Shark Liver Oil:

1. **Swine Flu Vaccines and Shark Liver Oil:**

   Vaccines being made to protect people from swine flu may not be so healthy for threatened species of sharks.That's because millions of doses of the pandemic H1N1/09 vaccine contain a substance called squalene, which is extracted from shark livers. More commonly found in beauty products such as skin creams, squalene can be used to make an adjuvant, a

compound that boosts the body's immune response. The World Health Organization recommends adjuvant-based vaccines, because they allow drug makers to create doses that use less of the active component, increasing available supplies. Olive oil, wheat germ oil, and rice bran oil also naturally contain squalene, albeit in smaller amounts. But for now squalene is primarily harvested from sharks caught by commercial fishers, especially deepwater species.

GlaxoSmithKline (GSK), a major swine-flu vaccine producer, announced in October that it had received orders for 440 million doses of vaccine containing adjuvant. And the adjuvant in GSK's vaccines, which have been administered in 26 countries so far contains shark-liver squalene, company spokesperson Clare Eldred confirmed in a statement [23].

2. Cosmetic Soaps and Shark Liver Oil:

It will no doubt come as a shock to many of us that shark liver oil (or squalene) is used in cosmetic products. The campaign group Oceana is fighting to stop its use, and announced on January 2008 that, Hindustan lever has agreed to remove squalene from 'Pond's' and 'Dove'.

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