

# Cataract and Healthy Diet, an Ounce of Prevention is Worth a Pound of Cure - A Mini-review

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## Abstract

A cataract is a major cause of reversible blindness worldwide. Nowadays, the only available treatment is the surgical removal of the cataractous lens. Several studies have found that oxidative stress has a significant role in reducing lenticular transparency by damaging certain proteins and enzymes inside the lens. Oxidative stress reflects an imbalance between free radicals and antioxidants in the body. It occurs naturally as a part of the aging process resulting in structural and optical changes in the lens. Free radicals result from converting food into energy or exposure to environmental factors such as ultraviolet light, cigarette smoking, unhealthy diet, and certain chemicals. Healthy food contains several nutrients with an antioxidant effect that protects the eye from these harmful and unstable molecules.

**Keywords:** Cataract; Cataractogenesis; Oxidative stress; Free radicals; Healthy diet; Antioxidants; Vitamins

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## Oxidative Stress and Cataractogenesis

Cataract, the complete or partial opacification of the eye's natural lens, is a leading cause of visual impairment and reversible blindness worldwide. Aging is the principal cause of cataract besides environmental factors (ultraviolet irradiation, oxidative damage, trauma, etc.), genetic predisposition, and ocular diseases [1]. Among all types of cataracts, Age-related cataract is the most common type, which is classified according to the opacity location to cortical, nuclear, and posterior sub capsular. The pathophysiology behind this type of cataract is not fully understood and still an interesting subject for current research. The oxidative stress, caused by the accumulation of free radicals, is believed to be the initial event in the cataract formation process [2]. The aging eyes are at high risk from oxidative stress and more vulnerable to damage by ultraviolet irradiation and free radicals that considered the major contributors for cataract formation [3].

The natural lens consists of alpha, beta, and gamma crystalline proteins, which can be affected by oxidative stress leading to aggregation, clustering, and clumping of these proteins. With aging, this results in a loss of clarity and transparency of the lens and leads to cataract formation. Membrane lipid peroxidation, DNA damage, and calcium homeostasis imbalance have a role in oxidative stress. Diabetic patients have a high level of superoxide in the mitochondria of their lens due to hyperglycemia, which makes them at greater risk of cataract formation [4].

Factors implicated in the onset of cataractogenesis are high lipid peroxidation, weak antioxidant capability, increased nonenzymatic

glycosylation, excessive permeability of the lens membrane, and reduced alpha-crystallin chaperone-like function that is essential to prevent the insolubilization and aggregation of crystalline proteins occurring in cataractogenesis [5,6].

The lipid peroxidation describes the damage induced by hydrogen peroxide, hydroxyl radicals, and superoxide anions. This reaction results in structural changes and an increase in cell membrane permeability. The alteration in cell membrane structure leads to loss of the essential fatty acids and releases of the contents of cell and organelle along with the formation of peroxide and cytosolic aldehyde products [7].

Superoxide dismutase (SOD) is an enzyme that protects the cell membrane from antioxidants by converting  $O_2$  into  $H_2O_2$  to prevent the formation of the Reactive Oxygen Species (ROS) [8]. Glutathione Peroxidase (GPX) is another antioxidant enzyme that acts by scavenging the highly reactive lipid hydro peroxide to prevent its potential damage to the cell membrane. Unfortunately, the lens loses its antioxidant capacity with aging due to the reduction in antioxidants expression and low levels of glutathione [9].

## Role of Healthy Food in Cataract Prevention

The consumption of a proper amount of healthy diet rich in fruits, vegetables, and whole grains is essential because it contains a significant amount of phytochemicals and antioxidants that may reduce the risk of cataract formation. These include vitamins (A, C, and E), beta-carotene, lutein, zeaxanthin, and zinc [10,11]. Also, food rich in omega-3 fatty acids such as oily fish helps in cataract prevention due



to the antioxidant properties of these fatty acids [12]. Multiple studies were conducted in several countries of which, many failed to show an association between decreased risk of cataract and some of these nutritional supplements, while others confirm its role.

Recently in 2019, Jiang H, et al. (2019) conducted a study showed that the consumption of supplements containing these antioxidants was significantly associated with a decreased risk of age-related cataract [10]. In 2007, a study carried out by Townend BS, et al. (2007) revealed that dietary intakes of Omega-3 polyunsaturated fatty acids (n-3 PUFA) reduced the risk of nuclear cataract, while higher dietary intakes of protein were associated with a reduced risk of posterior sub capsular cataract [12].

Avoid eating large amounts of carbohydrates is crucial to decrease the risk of progression or formation of cataracts. In 2010, an Australian study showed an increased risk of nuclear cataract and a significant association between total carbohydrate intake and pure cortical cataract [13]. In another study, it was revealed that the higher consumption of sodium was associated with a higher risk of posterior sub capsular cataract [14]. In 2012, a meta-analysis was conducted by Ye J, et al. (2012) revealed that smoking was associated with an increased risk of nuclear sclerosis [15].

### Nutrients Functions and Food Sources

A healthy diet provides the body with various nutrients that are crucial to maintaining organ function and metabolism. In addition to its role as antioxidants, the following nutrients play many critical roles:

Vitamin A is a fat-soluble vitamin that presents naturally in the diet. It is crucial for vision, maintenance of immunity, reproduction, and the function of body organs. It is obtained from the diet as preformed vitamin A (retinyl palmitate or retinyl acetate), or provitamin A (beta-carotene), or combination of both. Preformed vitamin A is available in red meat, dairy products, poultry, and fish, while provitamin A is found mainly in fruits and vegetables. Carotenoids are fat-soluble pigments obtained from plant sources. The human body converts some of these plant pigments (alpha-carotene, beta-carotene, and beta-cryptoxanthin) into vitamin A, while other carotenoids (lycopene, lutein, and zeaxanthin) remain unaltered [16].

Vitamin C (Ascorbic acid) is a water-soluble vitamin, which has an important role in body collagen formation, wounds healing, enhance the functions of the immune system and iron absorption from plant-based foods. Cooking and prolonged storage of food may lead to a reduction in vitamin C contents. Thus, it is better to eat raw fruits and vegetables [16].

Vitamin E is a fat-soluble vitamin. It has a significant role in immunity against bacteria and viruses. Moreover, it helps in the widening of blood vessels and prevents blood clotting. There are eight forms of vitamin E, which have different levels of activity or potency. Alpha-tocopherol is the most active and available form in humans [16].

Zinc is an important mineral for the body that plays a role in enhancing body immunity against pathogens, the formation of proteins and DNA, wound healing, smell, and taste [16].

There are three main types of fatty acids, saturated, monounsaturated, and polyunsaturated fatty acids (PUFAs). Omega-3 and Omega-6 are the two major classes of PUFAs. As a component of phospholipids, the body needs Omega-3 fatty acids to maintain the structure of the cell membrane. Besides, Omega-3 fatty acids have antioxidant properties and are essential for eicosanoids formation,

which are signaling molecules with a wide range of vital functions [16].

The following table presents the most common dietary sources of these nutrients and the average daily-recommended amounts for adults.

Nutrient	Food sources	Average daily-recommended amounts for adults aged above 18 years (male/ female).
Vitamin A	Beef liver, red meat, fish, green leafy vegetables, carrots, squash, broccoli, apricots, cantaloupe, mangos, and dairy products.	900 mcg RAE / 700 mcg RAE
Vitamin C	Citrus fruits (oranges, grapefruit, lemon, etc.), kiwifruit, strawberries, cantaloupe, broccoli, tomatoes, baked potatoes, and pepper.	90 mg/75 mg
Vitamin E	Vegetable oils (wheat germ, safflower, sunflower, and soybean oils), sunflower seeds, almonds, peanuts, hazelnuts, broccoli, and spinach.	15 mg/15 mg
Zinc	Oysters (the best source), poultry, red meat, seafood, dairy products, nuts, beans, and whole grains.	11 mg/8 mg
Omega-3 fatty acids	Oily fish (salmon, herring, sardines, salmon, mackerel, trout, and pilchards), chia seeds, flaxseed, walnuts, soybean oil, and canola oil.	1.6 g/1.1 g

<sup>\*</sup>Micrograms (mcg) of retinol activity equivalents (RAE)  
From the National Institutes of Health/ Office of Dietary Supplements.

Although the nutrients known to reduce the risk of cataract are available in nutritional supplements, many experts believe that it should be acquired from a healthy diet rather than from synthetic sources. However, experts encourage people who lack important nutrients due to the low intake of fruits and vegetables, to have sufficient daily nutritional supplements. Specialist consultation is required because high amounts of these supplements are harmful.

### Conclusion

Cataract surgery is the only available treatment for cataracts with a high success rate. Nevertheless, it still exposes patients to ocular complications that carry a great risk of irreversible blindness. Therefore, it is important to apply precautionary strategies and encourage the consumption of antioxidants that would reduce the risk or prevent the formation of cataracts.

Vitamin A, vitamin C, vitamin E, beta-carotene, lutein, zeaxanthin, zinc, and Omega-3 fatty acids are effective against harmful free radicals. Low carbohydrate and sodium intake, as well as smoking cessation, are useful for lenticular health and delay the progression of opacifications.

Normal daily metabolism produces some free radicals. Thus, obtaining antioxidants from the diet is very important even in people who have no risk factors for cataract.

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