

# Preventing Cataracts with a Plant-Based Diet



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## Abstract

The percentage of complications in cataract surgery, even if only 5%, the cost of surgery, whether borne by the patient or insurance, and the stress that any surgical procedure causes, makes prevention of primary importance. A plant-based diet reduces the risk of cataracts. In a British study risk reduction for cataract for low meat eaters was 15%, 21% for fish eaters, 30% for vegetarians and 40% for vegans. In a Taiwanese study, a vegetarian diet reduced the risk of cataract by 30%. This may be partly explained by the greatly reduced risk of type 2 diabetes in vegans. Diabetes is a risk factor for cataracts. Vegans also have a much lower risk of hypercholesterolemia, another risk factor for cataracts. Contributing to the reduced risk of cataracts in vegans is the increased intake of antioxidants including lutein and zeaxanthin, which some studies show reduces the risk of cataracts. On average, plant foods provide 11.57 mmol/100gm antioxidant content, while animal foods provide only on average 0.18mmol/100gm. Prophylaxis with a vegan diet has no adverse effects or contraindications and treats common comorbidities including type 2 diabetes and hypercholesterolemia.

**Keywords:** Antioxidants; Eye; Lens; Lifestyle; Lutein; Plant-based diet; Vegan; Vegetarian; Vitamin C; Zeaxanthin

**Abbreviations:** ARC: Age-Related Cataracts; DM: Diabetes Mellitus; HDL: High-Density Lipoprotein; L: Lutein; LDL: Low-Density Lipoprotein, T2DM: Type 2 Diabetes; Z: Zeaxanthin

## Introduction

Cross sectional studies place the prevalence of cataracts at 50% in individuals aged 65-74. The prevalence increases to about 70% for those over 75 [1]. While some cataracts may be congenital, secondary to trauma, or drug-induced, most cataracts are age-related. Age-related cataracts are due to the opacification of the lens [2]. Research has established smoking, diabetes, and ultraviolet (UV) light exposure as the etiologic factors for age-related cataract, while recent studies have identified other potential risk factors like corticosteroids, exogenous estrogen, [3,4] nutrition, [5,6] dietary fat and serum lipids, [7,8] and genetics, [9,10] all of which might play a role in the development and progression of cataract. Cataract surgery is the commonest single surgical procedure carried out in the developed world. In the developing world, cataract remains the commonest cause of blindness [11]. In 2015, 3.7 million cataract surgeries were performed in the United States [12].

Presently, cataract surgery is the only treatment for cataract, with high success rates in restoring sight. The opaque lens of the eye is removed and replaced by an artificial intraocular lens [11]. With newer and well-developed techniques, cataract surgery is

one of the most successful clinical managements in medicine, with direct improvements in visual acuity as well as large improvements in activities of daily living and decreased mortality [13]. However, while as many as 95% of patients will have improved visual acuity, cataract surgery does have infrequent complications. The most common include posterior capsule opacification and cystoid macular edema. Rare but serious complications include endophthalmitis and retinal detachment [13]. Contraindications to surgery include cataracts without visual impairment or medical/ophthalmic conditions that do not allow for safe surgical outcomes [13]. The percentage of complications, even if only 5%, the cost of surgery, whether borne by the patient or insurance, and the stress that any surgical procedure causes, makes clear that prevention is still of primary importance. The plant based diet can reduce the risk of cataracts and has the advantage of no adverse reactions or contraindications.

## Epidemiology

In a British study, there was a strong relationship between cataract risk and diet group, with a progressive decrease in risk of cataract when comparing high meat eaters to low meat eaters,

fish eaters (participants who ate fish but not meat), vegetarians, and vegans respectively. The risk reduction for low meat eaters was 15%, 21% for fish eaters, 30% for vegetarians and 40% for vegans, [14] so there is a clear decline in the risk of cataracts with the decline in the consumption of animal products. This study focused on the overall dietary pattern instead of specific nutrients and is notable for the large number of cases examined, and that the conclusion was based on a cohort of health-conscious British residents [14]. It is interesting to note that alcohol intake, body mass index, physical activity, education, socioeconomic status, and dietary supplement use were not associated with cataract risk. Studies such as this one examining overall dietary patterns may be more clinically relevant since they can help determine the effects of numerous dietary factors in concert.

In a study of Taiwanese, a vegetarian diet reduced the risk of cataract by 30%. Vegetarians in this study had higher intakes of soy, vegetables, nuts, whole grains, dietary fiber, vitamin C, folate, and beta carotene than meat eaters. However, it may be that the overall dietary pattern was the critical factor in this study [15].

A study conducted in Greece showed that those consuming the most meat raised their risk of cataract by 46%, while consumption of vegetables decreased the risk 53% and fruit decreased the risk by 47%. It also showed that diets high in vitamin C and vitamin E both reduced the risk of cataracts by 50% [16].

### Lutein and zeaxanthin intake

Several epidemiologic studies show a negative association of cataract with lutein and zeaxanthin (L+Z) status, [17-20] although not all [21]. In a recent study, diets high in lutein and zeaxanthin were also inversely associated with the prevalence of nuclear cataracts or the percentage of patients requiring cataract extraction [22]. The same results were found in several previous studies (reviewed by Moeller et al. [23]. and Mares [24]. In one study, those in the high dietary L+Z group had a 23% lower prevalence of nuclear cataract compared to those in the low group [25]. Looking at plasma levels, a study showed that compared with subjects with low plasma zeaxanthin, those with high plasma zeaxanthin had a 75% decreased risk of nuclear cataract [26].

### Hypercholesterolemia

Looking more specifically at the association of cholesterol levels with risk of cataract development, a Chinese study showed that serum LDL-C and TG (triglyceride) levels were found to be independent risk factors for age-related cataracts (ARC) [27]. In a randomized study of patients with asymptomatic aortic stenosis, those who were treated with 40mg simvastatin plus 10mg ezetimibe were associated with 44% lower risk of cataract development, compared to those who received placebos [28]. Hiller et al. [7] reported that fasting hypertriglyceridaemia ( $\geq 250$ mg/dL) is associated with an increased risk of cataract in men. In a population-based, cross-sectional study, Tang et al. [29] found that high LDL (low-density lipoprotein) and low

HDL (high-density lipoprotein) were independent risk factors for ARC. However, Marks et al. [30] found contrasting results. Vegetarians, and most especially vegans, have a much lower risk of hypercholesterolemia (for both total cholesterol and LDL) and a less atherogenic profile [31,32]. Vegans, or total vegetarians, have the lowest levels. Vegetarian and vegan diets can be very efficacious in reducing serum cholesterol. For instance, patients in a 4-week plant-based diet program had significant reductions in total cholesterol (34mg/dl), LDL-C (25mg/dl) [33]. The lower risk of hypercholesterolemia in vegetarians, and especially vegans, could be one of the factors giving them a lower risk of cataracts.

### Diabetes mellitus

Diabetes Mellitus (DM) is another risk factor for cataracts, with diabetic patients 2–5 times more at risk for developing cataracts and at an earlier age [34] DM can affect all ocular structures, with cataract being the most common ocular complication [35]. In one study of an older population, high baseline fasting blood glucose was associated with the long-term incidence of cortical cataract and long-term progression of all three cataract subtypes [36].

DM can lead to pathologies in many tissues in the eye structure, with both a systemic chronic metabolic disease and a microangiopathic character [37]. Cataract is one of the major causes of visual impairment in diabetic patients [38]. Patients with DM are reported to be up to five times more likely to develop cataract, at an early age [34,36,39,40].

Those following a plant-based diet have a 78% reduction risk of Type II diabetes mellitus (T2DM), as well as a 56% reduced risk of metabolic syndrome. [41]. One study showed that in patients treated with a plant-based diet, the mean HbA1C dropped from 8.2% to 5.8%, with sixty-two percent of participants reaching normoglycemic levels (HbA1C < 6.0%) [42]. Compare this to a meta-analysis study of Metformin, where the average change of glycosylated hemoglobin was only 0.9%, [43] so, the effects of a plant-based diet rival, and in some cases, exceed the average effects of Metformin. The lower risk of type 2 diabetes may be another reason that vegetarians, and especially vegans, have a lower risk of cataracts.

### Pathophysiology and intervention

Cataract genesis involves the misfolding and aggregation of lens crystalline protein, leading to loss of lens transparency [44]. Oxidative stress and the subsequent oxidative damage to lens proteins is a known etiologic factor in the initiation and progression of cataract formation [45]. Factors contributing to oxidative stress, such as aging; cigarette smoking; exposure to ultraviolet B light; and diabetes, are well known risk factors for cataracts [46].

Antioxidants, available from dietary sources (predominantly plant-foods) help reduce oxidative stress. The antioxidants active in the lens include lutein, zeaxanthin, vitamin C and

glutathione. The lens acts as an oxygen sink with some of the highest concentrations of the antioxidant glutathione in the body. Glutathione scavenges reactive oxygen species, is a cofactor for repair enzymes, and is thought to be released into the aqueous humor to be used by the avascular tissues such as the cornea and trabecular network. With age, the supply of glutathione diminishes, and oxidative damage can accumulate, causing an opacification of the lens [47,48]. Glutathione levels were significantly lower in lenses with cataracts compared to healthy lenses [49].

Vitamin C (L-ascorbate or L-ascorbic acid) is present in the lens and surrounding ocular humors, which bathe the lens at a concentration 50-fold higher than that found in plasma [50,51]. It acts as a physiological “sunscreen” to protect the lens from UV (ultraviolet light) induced oxidative damage, and to regenerate vitamin E and glutathione to further increase antioxidant capacity. With advancing age, vitamin C levels in the lens decrease, and a decrease in vitamin C in the lens is associated with increasing cataract severity [52]. Consumption of additional dietary vitamin C can increase the concentration of vitamin C in the lens [53]. There is evidence that the incidence of cataract may be higher in persons who have a low plasma concentration of vitamin C [53].

The use of antioxidant vitamins for cataract prevention has long been investigated. However, a Cochrane review of randomized controlled trials revealed no benefit of supplementing vitamin C, vitamin E, or  $\beta$ -carotene, [54]. whereas most observational studies show a protective association between cataracts and dietary surrogates and biomarkers of fruits and vegetables [16,53,55].

A plant-based diet protects against chronic oxidative-stress-related diseases. Dietary plants contain variable chemical families and amounts of antioxidants. Plant antioxidants may contribute to the beneficial health effects of dietary plant foods [57]. On average, plant foods provide 11.57 mmol/100gm antioxidant content, while animal foods provide only on average 0.18mmol/100gm [57]. It is therefore to be expected that a plant-based diet could decrease the risk of cataracts through reducing oxidative stress.

## Lutein and zeaxanthin

Lutein and zeaxanthin are structural isomers that belong to a class of molecules called carotenoids. Carotenoids, which are primarily plant-derived lipophilic pigments, are essential factors in human health and development. It has been shown that lutein and zeaxanthin are entirely of dietary origin, humans cannot synthesize lutein and zeaxanthin *de novo* [58,59]. Carotenoids may be divided into two general classes: carotenes and xanthophylls [60]. Lutein and zeaxanthin are xanthophylls biochemically distinct from other carotenoids due to the presence of hydroxyl groups located at each end of these molecules. Lutein and zeaxanthin are the only carotenoids present in the lens [61], where they filter blue light and neutralize reactive oxygen species [62], scavenge superoxide and hydroxyl radicals [63], protect against ultraviolet-B-induced lipid peroxidation in cultured lens

epithelial cells [64], and may further play a role in membrane stability [65].

Meso-zeaxanthin is a relatively recently discovered structural isomer of zeaxanthin and appears to be a metabolite of lutein or zeaxanthin. It also has both light filtering and antioxidant properties [66].

## Clinical considerations

The U.S. Department of Agriculture reported that the average daily intake of lutein by Americans is about 1.7 mg per day, and in Europe, it is 2.3 mg per day. These values are far below the recommended dietary intake level of 6 to 14 mg per day to reduce the risk of cataract [67]. Prescribing these phytonutrients may be efficacious for the prevention of cataracts. Several studies reported that the administration of lutein and zeaxanthin supplements was associated with a reduced risk of cataract. [17-19,68,69,70]. These supplements are widely available. However, a plant-based diet can supply the necessary amounts of these phytonutrients. Patients should be encouraged to eat plenty of foods containing lutein and zeaxanthin along with other plant foods containing antioxidants, as a part of a healthy plant-based diet. Lutein can be found in several vegetables such as kale, spinach, romaine lettuce, broccoli, and some nuts such as pistachio nuts. Zeaxanthin can be found in foods such as corn, orange peppers, mango, and orange juice [71,72]. Foods that are rich in sulfur, including cruciferous vegetables and allium vegetables, also support the production of glutathione [73,74].

While vitamin supplementation in the absence of deficiency is not indicated for the prevention of cataracts, when prescribing a plant-based diet as prophylaxis, supplementation with vitamin B12 is necessary. Vegetarians with limited or no vitamin B12 intake are at risk for elevated homocysteine levels [75]. Hyperhomocysteinemia has been associated with a higher risk of cortical cataract in the Blue Mountains Eye Study [76]. Therefore, vitamin B12 supplements, necessary for all patients on a plant-based diet anyway, should be prescribed. Vitamin B12 has been demonstrated to be safe in doses up to 1,000 times the recommended dietary allowance and is safe in pregnancy [77]. After the age of 50, the amount of intrinsic factor available is reduced, leading to malabsorption of B12 in many seniors. However, approximately 1% of oral vitamin B12 can be absorbed passively in the absence of intrinsic factor [78,79]. Therefore, even senior patients can obtain sufficient B12 through large oral doses.

A plant-based diet can be very efficacious in the prevention and treatment of comorbidities such as hypercholesterolemia and type 2 diabetes. For instance, the plant-based diet is as efficacious as Lovastatin and is more efficacious than Metformin in treating type 2 diabetes [80,41]. It also reduces the risk of several other pathologies such as coronary artery disease [80] stroke [81] osteoarthritis [82] prostate and colon cancer, [83,84] diverticular disease [85] ulcerative colitis [86]. Crohn's disease [87].

Grave's disease, Hashimoto's thyroiditis [88]. and rheumatoid arthritis [89] just to name a few. When treating comorbidities, it is important to titrate relevant medications as the effect of the plant-based diet become evident. Lab work should be done before starting treatment with a plant-based diet and then 6 to 8 weeks afterwards. Of course, other pathogenic factors besides food, such as exposure to UV radiation, need to be kept in mind and addressed with any patient.

**Discussion**

Epidemiological studies show a decreased risk of cataracts in vegetarians and an even greater risk reduction in vegans. This may be due to the antioxidants found in plant foods, but there may be other active substances in plant foods that help lower the risk as well. The avoidance of animal-derived foods may also contribute to the reduced risk. While surgical treatments are available, it's in the best interest of the patient not to need it. There's no doubt that technology has revolutionized medicine with widespread benefit to humanity. However, it should be remembered that methods of prevention requiring little technology, such as the plant-based diet, can be very efficacious.

Cataracts are the leading cause of preventable blindness in the developing world. In these regions limited access to surgery makes prevention, always of prime importance, even more valuable. Plant-based diets offer an affordable and accessible prophylaxis. Cataract patients tend to be older and often present with common comorbidities that could have been prevented and can be treated with a plant-based diet. The plant-based diet also has the advantages of having no adverse reactions or contraindications.

One weakness of this review is that many studies do not report the subtype of age-related cataract. However, all subtypes will most likely require surgery. Therefore, prescribing a plant-based diet to reduce the risk of cataracts will still reduce the necessity for surgical treatment.

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