

Review article

Nutraceuticals in prevention of cataract – An evidence based approach

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Abstract

Cataract is a principal cause of blindness in the world and is characterized by clouding of eye's natural lens. Surgery is the major therapeutic step taken to cure cataract; however, it is having its own limitations and complications such as iris prolapse, raised IOP, infection, cystoid macular edema and posterior capsular opacification (PCO). So world is looking toward more robust and natural ways to prevent cataract. One of the important factors that can play a role in prevention of any and many diseases is diet of the people. The inclusion of certain naturally occurring food and nutraceuticals is coming up as a best alternative for curing cataract because of their presumed safety, potential nutritional and therapeutic effects. Some nutraceuticals can act as an anticataract agent through some or the other molecular mechanism if consumed by normal population deliberately or inadvertently.

Keywords: Cataract, Nutraceutical, Age, Antioxidant, Diabetes

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Introduction

Cataract is a principal cause of blindness in the world and occurs due to the clouding of the eye's natural lens. The proteins in the lens aggregate resulting in clouding of the lens and formation of cataract. As the light cannot pass clearly through the lens, there is some loss of vision. Since new cells cover the outside of lens, the other cells are compacted into the center of the lens resulting in the cataract. Cataract ultimately results in the loss of vision in people over the age of 40 years. The most recent estimates from World Health Organization (WHO) reveal that 47.8% of global blindness is due to cataract. In India cataract is the principal cause of blindness accounting for 62.6% cases of blindness and 77.5% cases of avoidable blindness.¹ India is one of the signa-

tories in a program Vision 2020 for elimination of avoidable blindness. It can occur due to aging, infection in newborn babies, injury or poor development prior to birth or during childhood, complications of various diseases and exposure to toxic substances such as UV radiations, corticosteroids and diuretics.

In the early stages of the disease, optimal refractive management and advice on glare reduction can lessen the impact of cataract formation. Surgery is undertaken only in case other measures are no longer adequate for the patient's visual needs because of its known limitations. Significant intraoperative complications of phacoemulsification in experienced hands are rare. Early postoperative complications include iris prolapse, raised IOP and infection. Cystoid macular edema (CMO) and posterior capsular opacification (PCO) are the most common late complications. So world is looking

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toward more robust and natural ways to prevent cataract. One of the important factors that can play a role in prevention of any and many diseases is the diet of people.

The inclusion of certain naturally occurring food and nutraceuticals is coming up as a best alternative that reminds words of Hippocrates 2500 years ago "Let thy food be medicine and medicine be thy food". A nutraceutical is the opposite of "junk food and according to the World Health Organization, over 80% of the world's population (4.3 billion people) rely upon such traditional plant-based systems of medicine as phytochemicals, nutritional constituents or as functional food.² The term "Nutraceutical" was coined in 1979 by Stephen De Felice and is defined "as a food or part of diet with medical or health benefits, including the prevention and treatment of disease". Nutraceuticals may be isolated nutrients, dietary supplements, genetically engineered "designer" food, traditional herbal product and processed products such as cereals, soups, and beverages. Plant derived nutraceuticals/functional foods have received considerable attention because of their presumed safety, potential nutritional and therapeutic effects. This renewed interest in nutraceuticals reflects the fact that consumers are aware about epidemiological studies which indicate the role of a specific diet or component of the diet in association with a lower risk of certain diseases. This review is about the hypothesis behind the mechanism of action of various nutraceuticals in prevention of cataract. Authors have compiled a list of commonly used vegetables, fruits, nuts and grains that have a probable mechanism of action against cataract formation. This compilation is intended to provide information to scientists working in this particular field to create more evidences for the mechanism of action and to disseminate the idea of use of nutraceuticals for prevention of cataract.

Pathogenesis of age related cataract

An eye lens consists of crystallins, cytoskeletal and membrane proteins. Crystallins make up to 90% of lens proteins and have high refractive index. It exists in the cytoplasm of lens fibers in the form of complex protein solution. The majority of proteins are in a soluble phase, and this soluble form accounts for transparency. With increase in age a wide range of proteins leave the soluble phase and form high molecular weight aggregates. The primary mechanism that lies behind protein aggregation is posttranslational modification associated disulfide bond formation and non-enzymatic glycation. These changes occur in the nucleus that contains the long-lived proteins.^{3,4} Reactive oxygen species (ROS) such as peroxide, superoxide and hydroxyl radicals are causes of protein modification. Normally the healthy lens contains antioxidants such as glutathione, ascorbate and catalase that protect lens proteins against ROS. Glutathione is one of the most important antioxidants found in eye lens.⁵ Reduced glutathione (GSH) reacts with ROS and is converted to its oxidized form (GSSG). GSH is restored through the action of the enzyme glutathione reductase (GR). Hydrogen peroxide (H_2O_2) has been considered as the major oxidant in the pathogenesis of cataract. Normally, H_2O_2 is eliminated by GSH, or through the action of the enzymes glutathione peroxidase and catalase. However, with age there is decrease in activity of these protective mechanisms that result into elevation of H_2O_2 levels in the lens.³ This acts on

the lens epithelium and inhibits membrane lipids as well as transporter proteins such as Na^+K^+ ATPase ultimately leading to epithelial cell death and loss of lens transparency. Although individuals may have a genetic susceptibility to ROS, yet exposure to environmental factors such as smoking and UV exposure, the presence of certain diseases such as diabetes and the intake of systemic drugs are also important variables.

Pathogenesis of diabetic cataract

In diabetes, there is high concentration of glucose in the aqueous humor that is passively transported into the lens. The enzyme Aldose Reductase (AR) catalyzes the conversion of glucose to sorbitol through the polyol pathway and results in intracellular accumulation of sorbitol that further leads to osmotic changes resulting in degeneration of hydropic lens fibers and formation of cataract.^{6,7} In addition, the intracellular sorbitol cannot be removed through diffusion because of its polar character. The intracellular accumulation of sorbitol leads to a collapse and liquefaction of lens fibers that causes opacities in lens.^{6,8} Further studies have shown that osmotic stress in the lens caused by sorbitol accumulation⁹ induces apoptosis in Lens Epithelial Cells (LEC)¹⁰ leading to the development of cataract.¹¹ Moreover, increased glucose levels in the aqueous humor may cause glycation of lens proteins, a process resulting in the generation of superoxide radicals (O_2^-) and in the formation of Advanced Glycation End products (AGE).¹² As the AGE interacts with cell surface receptors in the epithelium of the lens, there is generation of O_2^- and H_2O_2 .

Prevention of cataract

Cataract is a major global cause of blindness, and large section of the world's population cannot assess cataract surgery. It has been found that mechanisms related to glucose toxicity, namely oxidative stress, processes of non-enzymatic glycation and enhanced polyol pathway are significantly involved in the development of eye lens opacity. There is an urgent need for inexpensive, non-surgical approaches to prevent cataract. The following types of dietary phytochemicals could be implied to obtain the desired therapeutic action:

1. Antioxidants or ROS scavengers
2. Aldose Reductase inhibitors
3. Antiglycating agents
4. Inhibitors of Lens Epithelial Cell apoptosis.

Antioxidants

Various classes of antioxidants that can be used to prevent cataract are flavonoids, carotenoids, ascorbic acid, tocopherol, caffeine, and pyruvate.

Flavonoids: Flavonoids are C6-C3-C6 compounds with fifteen carbon atoms. Flavonoids exert antioxidant effects due to their ability to scavenge free radicals, donate hydrogen as hydrogen donating compounds, and act as singlet oxygen quenchers and metal ion chelators. Examples of few flavonoids acting as antioxidants are myricetin, quercetin, rhamnetin, morin, diosmetin, naringenin, apigenin, catechin,

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