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Research on the Prevention of Cataracts and Age-Related Macular Degeneration by Black Rice Anthocyanins

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Abstract: *Objective:* To observe the effectiveness and safety of black rice anthocyanins in preventing cataracts and age-related macular degeneration (dry form). *Methods:* Patients with cataracts and age-related macular degeneration who were outpatients or inpatients at the Ophthalmology Department of Changchun Hospital of Traditional Chinese Medicine from December 2024 to December 2025 were selected as the study subjects. They were randomly divided into an observation group and a control group, with 50 cases in each group, using a random number table method. The observation group received oral black rice anthocyanins, while the control group received oral vitamin C pills. Both groups were treated for 20 days and observed for 3 months. Visual acuity, lens, and retina conditions were compared before and after treatment to verify whether black rice anthocyanins could effectively prevent the occurrence and development of cataracts and age-related macular degeneration (dry form) and delay disease progression. *Results:* Comparing the clinical efficacy of the two groups, the observation group had a total effective rate of 84%, while the control group had a total effective rate of 62%. The observation group was significantly superior to the control group. After χ^2 testing, $p = 0.013$, $p < 0.05$, indicating a significant difference in the total effective rates between the two groups. In terms of visual acuity and the number of lines improved, the observation group was significantly superior to the control group. *Conclusion*: Black rice anthocyanins effectively improve visual acuity, lens opacity, and retinal conditions in patients with early-stage cataracts and age-related macular degeneration (dry form), demonstrating definite clinical efficacy and safety without side effects. This study provides a new approach for the early prevention of cataracts and age-related macular degeneration (dry form).

Keywords: Black rice anthocyanins; Cataracts; Age-related macular degeneration

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1. Introduction

With the aggravation of population aging in China, the incidence of age-related eye diseases has been increasing year by year. Cataracts and age-related macular degeneration have become the leading causes of blindness in China. Cataracts refer to eye diseases caused by various factors such as aging, local nutritional disorders, immune and metabolic abnormalities, leading to metabolic disorders of the lens, lens protein denaturation, and opacity, ultimately resulting in decreased vision or even blindness. Age-related macular degeneration is related to age, smoking, genetics, chronic light damage, etc. The pathogenesis of both is related to oxidative stress, slow metabolism, and aging. Therefore, early intervention in the disease is crucial.

2. Materials and methods

2.1. General information

This study selected 100 patients diagnosed with cataracts and age-related macular degeneration at the Ophthalmology Department of our hospital from December 2024 to December 2025. They were randomly divided into an observation group and a control group using a random number table method, with 50 cases (50 eyes) in each group. In the observation group, there were 24 males and 26 females, aged 50–73 (60.24 ± 6.20) years old; in the control group, there were 29 males and 21 females, aged 51–75 (60.44 ± 5.79) years old. There were no statistically significant differences in general information between the two groups ($p > 0.05$). This study was reviewed and approved by the hospital's medical ethics committee, and all subjects were informed of the study content and signed informed consent forms before treatment.

2.2. Inclusion and exclusion criteria

2.2.1. Inclusion criteria

(1) Patients diagnosed with early-stage cataracts and age-related macular degeneration (dry form);
(2) Aged 50–75 years old;
(3) No history of eye surgery or trauma;
(4) Signed the "informed consent form" for inclusion in the observation cases.

2.2.2. Exclusion criteria

(1) Accompanied by other eye diseases;
(2) Aged under 50 or over 75;
(3) Cardiac, hepatic, or renal insufficiency;
(4) Vision abnormalities caused by other reasons;
(5) Accompanied by other serious diseases.

2.3. Methods

2.3.1. Observation group

Administered black rice anthocyanins (Jilin Haitao Biotechnology Co., Ltd.), 2 tablets each time, 3 times a day.

2.3.2. Control group

Administered vitamin C pills (Sichuan Yike Pharmaceutical Co., Ltd.), 1 pill each time, 3 times a day.

2.3.3. Observation period

Continuous treatment for 2 courses, with each course lasting 10 days, for a total of 20 days.

2.4. Observation indicators and evaluation criteria

(1) Markedly effective

The degree of lens opacity and fundus retina in patients was reduced compared to before treatment, and visual acuity improved by more than 4 lines.

(2) Effective

The degree of lens opacity and fundus retina in patients showed no significant changes, but visual acuity improved by 2–4 lines.

(3) Ineffective

After treatment, neither of the above criteria was met.

2.5. Statistical methods

Statistical analysis was performed using SPSS 26.0 software, and corresponding statistical methods were adopted according to different research data. Measurement data were expressed as mean ± standard deviation and tested using *t*-tests; count data were tested using χ^2 tests; $p < 0.05$ indicated a statistically significant difference.

3. Results

3.1. Comparison of general information

3.1.1. Comparison of gender between the two groups

The gender comparison between the observation group and the control group showed no statistically significant difference ($p = 0.316$, $p > 0.05$) after χ^2 testing, allowing for comparison. See **Table 1**.

Table 1. Comparison of gender between the two groups

Group	Number of cases	Male	Female	Male-to-female ratio	*p* value
Observation group	50	24	26	0.92:1	0.316
Control group	50	29	21	1.38:1	

3.1.2. Age comparison between the two groups of patients

The minimum age in the observation group was 50 years old, and the maximum age was 73 years old; in the control group, the minimum age was 51 years old, and the maximum age was 75 years old. The ages of patients in both groups followed a normal distribution. An independent samples *t*-test was conducted, yielding a *t*-value of -0.016 and a *p*-value of 0.868 ($p > 0.05$), indicating that there was no statistically significant difference in age between the two groups, allowing for comparison. See **Table 2**.

Table 2. Age comparison between the two groups of patients

Group	Number of cases	Mean age	*t* value	*p* value
Observation group	50	60.24 ± 6.20	-0.167	0.868
Control group	50	60.44 ± 5.79		

3.2. Comparison of clinical efficacy between the two groups

The total effective rate in the observation group was 84%, while that in the control group was 62%. After χ^2 testing, $p = 0.013$, $p < 0.05$, indicating a significant difference in the total effective rates between the two groups.

Table 3. Clinical comparison between the two groups of patients

Group	Number of cases	Markedly effective	Effective	Ineffective	Total effective rate	χ^2	p value
Observation group	50	10	32	8	84%	6.139	0.013
Control group	50	2	29	19	62%		

3.3. Comparison of visual acuity and the number of lines improved before and after treatment between the two groups

3.3.1. Comparison of visual acuity before and after treatment between the two groups

The visual acuity of patients in both groups after treatment was higher than that before treatment within their respective groups, with $p < 0.01$ indicating a significant difference. This demonstrates a significant improvement in visual acuity in both groups before and after treatment, with the difference being statistically significant. See **Table 4**.

Table 4. Comparison of visual acuity before and after treatment between the two groups

Group	Number of cases	Before treatment	After treatment	z value	p value
Observation group	50	0.39 ± 0.16	0.65 ± 0.18	-4.669	< 0.01
Control group	50	0.46 ± 0.18	0.65 ± 0.21	-5.114	

3.3.2. Comparison of the number of lines of visual acuity improvement before and after treatment between the two groups

When comparing the number of lines of visual acuity improvement between the two groups after treatment, $z = -2.865$, $p = 0.004$, $p < 0.01$, indicating a significant difference. This suggests that the observation group had a higher number of lines of visual acuity improvement compared to the control group, and the therapeutic effect in the observation group was significantly better than that in the control group. See **Table 5**.

Table 5. Number of lines of visual acuity improvement after treatment in both groups

Group	Number of cases	Lines of visual improvement after treatment	z value	p value
Observation group	50	2.42 ± 1.36	-2.865	0.004
Control group	50	1.60 ± 1.40		

4. Discussion

With the intensification of population aging in China, the incidence of age-related eye diseases has been increasing annually. Cataracts and age-related macular degeneration (AMD) have become the leading causes of blindness. Cataracts refer to eye diseases caused by metabolic disorders of the lens due to various factors such as aging, local nutritional disorders, immune and metabolic abnormalities, leading to lens protein denaturation and opacity, ultimately resulting in decreased vision or even blindness. Oxidative stress is considered one of the key pathogenic mechanisms of age-related cataracts [1]. Currently, the primary treatment for cataracts is lens replacement surgery, which involves removing the opaque lens and implanting an artificial lens. However, for patients in economically underdeveloped regions, the high cost of surgery and treatment may be unaffordable. Therefore, the research and development of drugs with preventive and therapeutic effects on cataracts are urgently needed [2]. AMD, also known as age-related macular degeneration, is the leading cause of blindness among individuals aged 50 and above in developed countries, according to epidemiological surveys, and approximately one-fourth of individuals aged 65 and above are affected by AMD [3–5]. Clinically, AMD is classified into dry and wet types, with about 90% of patients having the dry type. If the dry type, which has relatively mild symptoms, does not receive sufficient attention, it may progress to the wet type. Currently, dry AMD is considered a complex ocular disease caused by a combination of environmental and genetic factors, including chronic inflammation, lipofuscin deposition, oxidative stress, VEGF, and complement system mutations [6]. Oxidative stress refers to a state of imbalance between oxidation and antioxidation in the body, favoring oxidation, leading to neutrophil inflammatory infiltration, increased protease secretion, and the production of a large number of oxidative intermediates. Oxidative stress is a negative effect caused by free radicals in the body and is considered an important factor contributing to aging and disease. When the balance between oxidative substances and antioxidant defense mechanisms in our body is disrupted, oxidative stress is triggered, leading to the accumulation of harmful oxidative products in cells and tissues, posing a threat to health and potentially inducing various systemic diseases, such as respiratory, cardiovascular, endocrine, and ocular diseases. Oxidative stress can increase vascular permeability, cause microvascular abnormalities, and promote the formation of new blood vessels, leading to corneal, conjunctival, and optic nerve lesions, as well as clinical manifestations such as lens protein denaturation, increased intraocular pressure, and retinal degeneration. Therefore, the key role of oxidative stress in the development of ocular diseases has received increasing attention in recent years, and related research is further deepening. For cataracts, oxidative stress reduces the synthesis of antioxidants in the lens, causing oxidative damage to various biomolecules and exacerbating the deposition of lens proteins, leading to lens opacity. For AMD, although it is related to factors such as age, smoking, genetics, and chronic light damage, and the incidence is significantly higher in women than in men, the exact cause remains unclear [3–5]. Since the macular region is avascular, the retinal pigment epithelium (RPE) extends from the optic nerve to the ora serrata of the retina and continues as the pigment epithelium of the ciliary body. From the fovea to the periphery, RPE density decreases, with the highest density in the macular region, making it most susceptible to oxidative stress and light damage. Therefore, supplementing antioxidants to counteract oxidative stress is crucial in the early treatment of cataracts and AMD. Thus, seeking an early intervention method is particularly important in clinical practice.

This study selected black rice anthocyanins and vitamin C for comparative observation. Both anthocyanins and vitamin C are important antioxidants, but they have different mechanisms of action. Anthocyanins, belonging to the flavonoid family, primarily delay cellular oxidation by scavenging free radicals, especially providing stronger protection against oxidative damage caused by ultraviolet light and inflammation. They have targeted protective effects, can enhance retinal function, improve microcirculation (e.g., reducing the risk of arteriosclerosis), and inhibit the activity of some cancer cells. Due to their lipophilic nature, anthocyanins bind more tightly to cell membranes, providing more direct protection for vascular endothelial cells and visual cells. In contrast, vitamin C is a water-soluble vitamin that promotes collagen synthesis and is essential for maintaining the health of skin, bones, and blood vessels. Although vitamin C also has antioxidant effects, they are weaker than those of anthocyanins. Additionally, vitamin C can enhance immunity and promote iron absorption. This study primarily applies the traditional Chinese medicine concept of “medicine and food homology”, which means “incorporating medicine into food” and “imbuing food with medicinal properties”. The history of medicine and food homology in China is long-standing. “Huangdi Neijing Taisu” records, “When used to satiate hunger, it is called food; when used to treat diseases, it is called medicine” [6]. Medicine and food homology essentially refers to edible Chinese herbal medicines that have both medicinal and food uses and are applied in healthcare through forms such as dietary therapy, food supplementation, and medicinal diets [7,8]. The black rice anthocyanins used in this study are anthocyanin extracts derived from black rice. Black rice has a long cultivation history in China, primarily in Guangdong, Fujian, Yunnan, and other regions. Also known as blood rice or black rice, it is a unique variety cultivated over a long period within the rice family. Black rice grains are long and elliptical, with gray-brown shells, and can be classified as indica or japonica, belonging to non-glutinous rice. Black rice has health benefits such as invigorating the spleen, warming the liver, improving eyesight, promoting blood circulation, nourishing Yin, and tonifying the kidneys, as recorded in the “Compendium of Materia Medica”. Therefore, it is known as “tribute rice” or “medicinal rice” among the people [9]. Rich in nutrients and functional components, black rice contains essential amino acids, unsaturated fatty acids, proteins, vitamins B1, B2, and C, as well as mineral nutrients such as iron, zinc, copper, and calcium. Anthocyanins are a class of water-soluble natural pigments widely found in plants. Modern research has shown that anthocyanins have antioxidant, free radical-scavenging, anti-anemic, lipid-lowering, and anti-atherosclerotic effects, protect vascular endothelium, and have anti-fatigue, anti-hypoxic, anti-cancer, and anti-tumor properties, with certain therapeutic effects on ocular diseases, blood circulation disorders, coronary heart disease, and other diseases. Anthocyanins are found in products such as grapes, blueberries, black wolfberries, and black rice. Among these raw materials, black rice is the least expensive, and the cyanidin content in black rice anthocyanins is higher, with significantly stronger antioxidant capacity than anthocyanins extracted from other raw materials. Black rice anthocyanins are more stable and better absorbed in the human body. Modern pharmacological research has shown that black rice anthocyanins have various biological activities, such as antioxidant, anti-tumor, antibacterial, lipid-regulating, vision-enhancing, liver-protecting, anti-asthmatic, and anti-atherosclerotic effects. The improvement of vision by black rice anthocyanins is primarily achieved by enhancing the expression levels and activity of NF-κB and AP-1 in the retina, thereby inhibiting photoreceptor cell apoptosis and avoiding photochemical damage to maintain retinal health.

5. Conclusion

Therefore, through clinical observation of a small sample of cases, this study found that black rice anthocyanins significantly improved vision, lens opacity, and retinal conditions in patients with early-stage cataracts and dry AMD compared to vitamin C. This study provides a new approach for the early prevention of early-stage cataracts and dry AMD.

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Disclosure statement

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