Extraction of Anthocyanins from Red Amaranth and Their Antioxidant Activities in Vitro

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Abstract: Amaranth is rich in anthocyanins and has significant antioxidant activity. This paper reviewed the content, extraction methods and antioxidant mechanism of anthocyanins in amaranth. it was found that amaranth not only has a good price, but also has a strong scavenging capacity for superoxide free radicals, DPPH free radicals and hydroxyl free radicals, showing potential medical value. However, the current extraction methods and conditions still need to be further studied and optimized to improve the extraction rate and purity of anthocyanins in amaranth. Therefore, it is suggested that future research should focus on the impact of different extraction methods on extraction efficiency and quality, and further compare the content, cost and quality of anthocyanins in amaranth with those commonly used today, so as to promote the sustainable development of food industry and drug development.
***Keywords*:** red amaranth, anthocyanins, extraction methods, antioxidant mechanism, application prospects

1. Overview of red amaranth and its anthocyanins

1.1 Overview of red amaranth

Amaranth us tricolor L is an annual herb of Amaranthaceae, which is often used as vegetable for people to eat. It is planted in many places in China and has a wide source. The research found that amaranth has the effects of clearing the liver and improving eyesight, lowering blood lipids, protecting the heart.reducing swelling and detoxification, and its effects are mainly derived from a variety of active substances contained in amaranth, such as anthocyanins, polysaccharides and other active ingredients.

1.2 Sources and uses of anthocyanins

Anthocyanin, also known as anthocyanin, is a water-soluble natural food pigment widely existing in nature, which has anti-inflammatory, antioxidant, anti obesity, immune regulation, neuroprotective and other effects, Anthocyanins can be mostly extracted from fruits, grains and plants, and are sensitive to light, temperature, pH, metal ions, oxidants and other factors. According to statistics, more than 500plants of 73 genera in 27 families contain anthocyanins. At present, anthocyanins are widely used in health products, medicine, cosmetics and food coloring.

1.3 Anthocyanin content in various plant species

The anthocyanins can be extracted from fruits and vegetables, and there are more related studies. Yao Huakai[1] et al, selected five kinds of red amaranth, purple rape, purple oilseed rape, purple leaf lettuce and purple cabbage as test materials, detected their anthocyanins by ultraviolet spectrophotometry, and established standard curve equation to calculate their anthocyanin content. The results showed that the content of red amaranth was the highest, 5.46mg/g FW; Peng Zumao[2] et al, selected 17 different plants with high anthocyanin content, including roots, stems and flowers, such as black wolfberry, purple yam blueberry, sea buckthorn, rose king, hawthorn, cherry, blackberry, green grape, black grape, red grape, giant grape, honeysuckle, gongju, chrysanthemum, chrysanthemum, placenta and chrysanthemum, etc. which were extracted by using acid ethanol solution, and analyzed by high-performance liquid chromatography (HPLC), and the results showed that: the anthocyanin pigment of Cornus sativus was most widely distributed among the plants, and the samples in nature could be classified into four major categories. The results showed that cornflower pigments were the most widely distributed in plants, and the anthocyanin samples in nature could be divided into four major categories. At present, most of the blueberries are used as raw materials for anthocyanin extraction, and the market price is high. Compared with the price of vegetables and fruits in the market, the price of red amaranth is extremely low, so if the extraction experiment is successful, the cost of anthocyanin extraction can be greatly reduced.

2. Commonly used anthocyanin extraction methods

2.1 Solvent extraction

Solvent extraction is a commonly used extraction method, this method is simple, low cost, but time-consuming, high solvent consumption, high impurities in the extracted components, solvent selectivity is not high, so it is usually used as a crude extraction. Solvent extraction is also often used in conjunction with other techniques such as ultrasound and microwave. Kokuta[3] et al, compared the effects of solvent extraction, ultrasound-assisted, microwave-assisted and light-wave-assisted treatments on the extraction effect, phenolic content, chemical structure and antioxidant function of blueberry proanthocyanidins, and the yields of blueberry proanthocyanidins were as follows: microwave-assisted, light-wave-assisted.ultrasound-assisted, and solvent extraction in the order of microwave-assisted, light-wave-assisted.ultrasound-assisted, and solvent extraction, in an experiment by et al.

2.2 Microwave-assisted extraction method

Microwave assisted extraction (MAE), as a new technology with high efficiency and environmental protection, has the advantages of high extraction rate, simple process, small pollution, low energy consumption and avoiding the impact on the effective ingredients[4]. However, the anthocyanin decomposition was easily caused during the process of anthocyanin extraction. Liu Ying[5] et al, used microwave-assisted extraction to extract anthocyanins from fresh red raspberries, and the results showed that microwave-assisted extraction of anthocyanins from red raspberries was characterized by rapidity and high efficiency.

2.3 Ultrasound-assisted extraction method

Ultrasonic assisted extraction (UAE) has strong penetration, high extraction rate and processing capacity Large, fast, simple operation and other advantages, but the energy consumption is relatively high when extracting anthocyanins. Mei Han [6]et al, studied the antioxidant activity of proanthocyanidins from grapeseeds by optimizing the ultrasonic extraction conditions of proanthocyanidins from grape seeds through orthogonal design on the basis of single factor experiments. The results showed that the optimal process conditions were ethanol concentration 70%, liquid material ratio 1:25, ultrasonic time 20 min, and extraction twice. Under these conditions, the extraction rate of procyanidins was 4.96%

2.4 Ultrasound-microwave-assisted extraction

Ultrasonic microwave-assisted extraction (UMAE) combines the advantages of UAE and MAE, and alsomakes up for their shortcomings. Duan Dengle [7] et al, used absolute ethanol to extract anthocyanins.Ultrasonic microwave extraction was more efficient than ultrasonic or microwave extraction alone. The highest content of anthocyanins was 0.846 mg/g.

3. Physiological properties and antioxidant mechanisms of anthocyanins

3.1 Physiological properties of anthocyanins

Anthocyanins have anti-cancer, antibacterial, antioxidant, anti-aging, hypoglycemic, scavenging free radicals, protecting the liver, improving memory, improving eyesight, anti-inflammatory, cardiovascular protection, prevention of senile dementia and other active effects. In recent years, other physiological characteristics of anthocyanins have been found, such as reducing DNA damage, breakage and intracellular reactive oxygen species; Alleviate depressive symptoms of adolescents; The testis is targeted[8].

3.2 Antioxidant mechanisms

Anthocyanidins are acidic pigments with the structure of xanthine cation (AH+). Based on this structure.they act as hydrogen atom donors or single electron transfer mechanism, thereby eliminating free radicals and reducing oxidative stress; Most of the functional characteristics of anthocyanins can be explained in this way[8].

3.3 Progress in research related to antioxidant activity

The Anthocyanins can be mostly extracted from fruits, grains and plants, and there are many antioxidant studies. After consulting the literature, studies on anthocyanins extraction from various fruits exist. Zhang Qiang[9] et al, extracted proanthocyanidins from wild jujube leaves by ultrasonic assisted extraction with acetone as solvent, The results showed that the proanthocvanidins from wild jujube leaves had certain antioxidant activity, and their lC50 to DPPH and OH free radicals were 0.83 mg/mL and 1.50 mg/mL respectively; Shi Xiaoyan[10] et al, studied the antioxidant capacity of anthocyanins in blueberry through in vitro antioxidant experiment and cell injury model experiment. The experimental results showed that with the increase of anthocyanin concentration, the scavenging capacity of ABTS free radicals, DPPH free radicals, iron ion

chelating capacity and hydroxyl radical scavenging capacity increased, and the antioxidant effect was significantly higher than that of the model group ($P<0.05$). The anthocyanin extraction in amaranth has the advantages of high anthocyanin content and low cost compared with the above raw materials.Chai Mingyan et al, and others studied the antioxidant activity of extracts from different parts of amaranth.The root, stem and leaf of Amaranthus amaranth were extracted by ultrasonic with 75% ethanol solution.and the scavenging effects of each extract on superoxide free radicals, DPPH free radicals, hydroxyl free radicals, total antioxidant capacity and reducing capacity were further evaluated,. The results showed that Amaranth had better antioxidant activity, and the stronger part was the leaf.

4. Conclusions and recommendations

4.1 Conclusions

This paper reviewed the content of anthocyanins in various plants, the extraction methods of anthocyanins in common use, the physiological characteristics and antioxidant mechanism of anthocyanins, and the research progress of antioxidant activity of anthocyanins. lt can be seen that the extraction of anthocyanins from Amaranthus amaranthus and their antioxidant activity in vitro have received certain attention. According to the current research results, Amaranthus amaranthus anthocyanins have excellent antioxidant activity, It can scavenge hydroxyl radicals; Moreover, it has strong scavenging capacity for superoxide free radicals, DPPH free radicals and total antioxidant capacity, These results can provide scientific basis for the application of amaranth anthocyanins in food industry and drug development, However, the extraction method and corresponding extraction conditions have not been optimized, and the research in this area still needs to be improved to improve the extraction rate and purity of anthocyanins in amaranth.

4.2 Recommendations

(1) To study the effects of different extraction methods on the extraction rate and quality of anthocyanins.optimize the extraction process and improve the extraction efficiency.

(2) To further compare the anthocyanins in red amaranth with the anthocyanins extracted from today's commonly used anthocyanin sources in terms of content and cost quality, and to promote the sustainable development of the food industry and drug development.

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