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Research Progress of Extraction Process of Natural Plant Anthocyanin

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Abstract

Because anthocyanin is rich in amino acid and vitamin, it has important medicinal and nutritional value, anthocyanin can be extracted from plant peels, which can make waste plant peels obtain high value-added utilization efficiency, therefore, the research on the extraction process of anthocyanin has also become a new research hotspot. This paper summarizes the research progress of anthocyanin extraction process in recent years, and provides basis for the development, utilization and product development of anthocyanin.

Keywords

Anthocyanin; Extraction; Ultrasonic; Microwave.

1. Introduction

Anthocyanin is widespread in the fruits, leaves, seeds, and skins of plants, which is a water-soluble natural pigment, for example, purple sweet potato, cherry, blood orange, blueberry, eggplant skin, hawthorn skin, perilla, morning glory, roselle, coffee peel, beet, etc. are rich in anthocyanin. Anthocyanin contains 18 kinds of amino acids, 21 kinds of trace elements and vitamins, among which the selenium element contained in anthocyanin has the effect of preventing cancer, and the rich zinc, iron, calcium and other elements have the effect of improving intelligence, Therefore, it has extremely high pharmacological activity, such as: antioxidant, anticancer, lowering blood pressure, blood fats, blood sugar, etc., and has high nutritional value, it is a high-quality natural pigment resource in the food industry, and is also widely used in the cosmetics industry [1-3]. This research mainly sorts out, compares and summarizes the extraction process of anthocyanin in anticipation of providing theoretical support and basis for the industrial development, utilization and research of anthocyanin products.

Anthocyanin is mostly extracted and separated from plants, so the extraction and separation methods of anthocyanin are particularly important, if the extraction and separation methods are used properly, the thermal stability and extraction rate of the extracted anthocyanin will need to be improved. The extraction processes of anthocyanin mainly include solvent extraction, enzyme extraction, ultrasonic-assisted extraction, microwave-assisted extraction, direct acidolysis, and supercritical CO2 extraction, etc.

2. Extraction Process of Anthocyanin

2.1 Solvent Extraction

Anthocyanin is soluble in water and most organic solvents; solvent extraction is a method of extracting active ingredients from raw materials based on the principle of like dissolves like. The solvent extraction is simple in operation and operation equipment, but there will be residual toxic extraction solvent in the extraction process and the extraction time is relatively long [4]. Solvent

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extraction mostly uses ethanol, methanol, ethyl acetate, ethyl acetate-water, acetone-water and other solvents as extraction solvents [5]. In recent years, because the price of raw materials for extracting anthocyanin have gone up, as a result, the price of anthocyanin remains stubbornly high, which seriously affects the utilization rate of anthocyanin. Zhang Mingwei et al. [6] used black rice as raw material and ethanol solvent as extractant, optimized the extraction process by changing the extraction environment and acidity, and extracted anthocyanin by warm soaking, which greatly reduced the extraction cost of anthocyanin, the product yield is higher, and the process is stable, which provides theoretical basis for the batch production of anthocyanin.

2.2 Ultrasonic-assisted Extraction

Ultrasonic-assisted extraction technology is a new technology which quickly enter the solvent under the action of ultrasonic waves, it is mainly based on the existence, polarity, solubility of the active ingredients in the substance, etc., and obtain multi-ingredient mixed extract, the extract is separated, refined, and purified, finally get the desired monomer chemical composition [7]. Ultrasonic-assisted extraction technology is widely used especially in the extraction of substances with poor thermal stability and low temperature food processing, which is also widely used in food processing, pharmaceutical extraction, cosmetic production, chemical production and other technical fields. Anthocyanin is a polyphenol substance, which mostly exist in the vacuoles of plant cells, and are surrounded by cell walls and cell membranes, the ultrasonic technology is used to strengthen the extraction process can effectively improve the extraction rate of anthocyanin [1], but the disadvantage is that ultrasonic waves are easy to cavitate, and cavitation should be avoided in the actual operation process, otherwise the extraction rate of anthocyanin will be affected by ultrasonic cavitation. Gu Hongmei[8], Xu Ying et al.[9], Peng Jie et al.[10] used ultrasonic-assisted freezing-melting ultrasonic-assisted enzymatic to extract purple sweet potato anthocyanin, and ultrasonic-assisted acidic ethanol to extract purple sweet potato anthocyanin, respectively, the purple sweet potato anthocyanin obtained were 2.36 mg/g, 2.00 mg/g and 2.74 mg/g, respectively, which greatly improved the extraction rate of purple sweet potato anthocyanins. Huang Bin et al. [11], He Lifang et al. [12] and Cheng Shuiming et al. [13] used ultrasound-assisted technology extract anthocyanin from red pitaya pulp, which effectively improved the extraction rate of anthocyanin in red pitaya.

2.3 Microwave-assisted Extraction

Microwave extraction is shortened to MAE technology, microwave-assisted extraction is a method of selectively extracting target ingredient in materials by using the characteristics of microwave heating, the target components can be effectively heated by adjusting the parameters of microwave, help the extraction and separation of target ingredient. The extraction principle of the microwave-assisted extraction is that the plant sample absorbs a large amount of energy in the microwave field, while the surrounding solvent absorbs less, thereby generating thermal stress inside the cell, plant cells rupture due to thermal stress generated inside, it makes the substance inside the cell come into direct contact with the relatively cold extraction solvent, and accelerates the transfer of the target product from the inside of the cell to the extraction solvent, thereby enhancing the extraction process. The microwave-assisted method is used to extract pigment by heating the material and the extraction solvent, the advantage is not only reducing the extraction time, and due to the strong penetrating power of microwaves, it can quickly and evenly heat the material centrally, and also effectively avoids damage to plant extracts; the disadvantage is that the microwave-assisted extraction is selective internal heating and requires the processed materials to have good water absorption, but due to its fast extraction speed and better extract quality, it has become one of the effective methods for the extraction of natural plant active ingredients. The microwave-assisted extraction of anthocyanin is also widely used, Duan Wenkai et al. [14], Wang Chaoxue et al. [15], and Wang Zhen et al. [16] used microwave extraction process to successfully extract anthocyanins from strawberry, black wolfberry and Bletilla striata, respectively, which provided theoretical support for the application of microwave extraction process in the extraction of plant anthocyanin.

2.4 Enzyme-assisted Extraction

The enzyme-assisted extraction is a method that uses cellulase, pectinase, protease, etc. (mainly cellulase) to destroy the cell wall of plants, and promote the dissolution and separation of plant active ingredients to the greatest extent. Because the cell walls of natural plants are composed of cellulose, the active ingredients of plants are often encapsulated in the cell walls. Therefore, the enzymatic extraction is used to extract the extract from the plant, which can mildly degrade the plant tissue and accelerate the release of the active ingredient to achieve the purpose of improving the extraction efficiency. However, the selection of enzyme preparations, enzyme concentration, pH value, enzymolysis temperature, and enzymolysis time in the extraction process are the keys that affect the extraction rate of plant extracts. Huang Aini et al. [17] and Gong Yushi et al. [18] used dual-enzyme-assisted and response surface to optimize cellulase-assisted extraction of anthocyanin from lotus plant and mangosteen peel, respectively, and achieved good extraction results.

2.5 Acidolysis Extraction Technology

Acidolysis extraction is a method of extracting anthocyanin from plants with hydrochloric acid and ethanol as composite extractants, but it has not been popularized due to its low extraction efficiency. In 2010, Jia Shifang et al. [19] used corn cobs as raw materials to extract anthocyanin from purple corn, used hot water extraction, direct acid hydrolysis, ultrasonic-assisted method and microwave-assisted method to extract anthocyanin from purple corn for comparative experiments. The results show that the extraction efficiency of the direct acidolysis method is not ideal, and there are few reports on the extraction of anthocyanin by this method in the later literature.

2.6 Supercritical CO2 Extraction

The supercritical carbon dioxide extraction is a method to contact the supercritical carbon dioxide with the substance to be separated in the supercritical state, so that the ingredients with different polarity, boiling point and molecular weight can be selectively extracted in turn to extract the active ingredients in the plant. By consulting the literatures, Jiang Guiquan et al. [20] and Ye Chunhao [20] had reported in detail on the process of extracting anthocyanin by supercritical CO2 extraction in 2014 and 2006, respectively, however, due to the limited extraction efficiency, research has been gradually reduced in recent years, it is gradually replaced by new and efficient extraction methods.

2.7 Ultrasonic-Microwave Combined Extraction Technology

The new technology of ultrasonic-microwave synergistic extraction combines the two modes of action of ultrasonic and microwave, makes full use of the cavitation of ultrasonic vibration and the high-energy effect of microwave, overcomes the shortcomings of conventional ultrasonic and microwave extraction, and achieve fast, efficient and reliable pretreatment of solid samples under low temperature and normal pressure conditions. Chen Bin et al. [22] and Wang Xiujie et al. [23] used ultrasonic-microwave combination extract grape skin cellulose and watermelon peel polysaccharide, respectively, and the yield was higher than that of single use of enzyme method or ultrasonic and microwave extraction, this also confirms the feasibility of ultrasonic-microwave-assisted extraction, however, there are few reports on the extraction of anthocyanins, which will also become a new research direction.

3. Conclusion and Outlook

The application of anthocyanin is more and more extensive, and the medicinal effects of plant anthocyanin can be widely used in food, medicine, cosmetics and chemical industries. Moreover, anthocyanin can be extracted from a large number of plants, and their sources are relatively rich, the previous research and utilization progress of plant anthocyanin extraction is summarized, and the following suggestions are put forward:

(1) From the perspective of sustainable development, anthocyanin can be extracted from lotus fruit, coffee peel and pitaya peel, etc., this is also a high value-added recycling of peels that were originally

discarded, moreover, the research and utilization of anthocyanin extracted from plant peel as raw material are relatively few, and it has a good development prospect.

(2) After sorting out several processes of anthocyanin research and comparison, it is found that ultrasonic method and microwave method have higher extraction yield and better stability, there are few reports on the extraction of anthocyanin by ultrasonic-microwave combined extraction, the high extraction yield of this method has been confirmed in the study of grape skin cellulose and watermelon skin polysaccharide [22-23], therefore, it can also be used as the future research direction of anthocyanin extraction process.

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