International Conference on Social Development and Intelligent Technology (SDIT2024)

# Study on the Influence of Different Cooking Methods on the Content of Anthocyanins in Purple Sweet Potatoes

**Lingya Cui**
*Weiyu High School, Shanghai, China*

**Abstract：This study aims to explore the influence of different cooking methods on the content of anthocyanins in purple sweet potatoes, so as to obtain a cooking method that can retain anthocyanins to the greatest extent and help people effectively obtain the nutrients in purple sweet potatoes in their daily diet. Methods: Purple sweet potatoes were processed by microwave, air fryer, steaming and boiling. The commercial total anthocyanin extraction kit was used in combination with the pH differential method to extract and determine the content of anthocyanins in purple sweet potatoes after different cooking processes. Results: Through this experiment, it was found that the anthocyanin detection amount of microwave purple sweet potatoes was the highest and higher than that of fresh purple sweet potatoes, with an increase rate of 72.5%. The loss rate after air fryer treatment was 2.95%, the loss rate after steaming treatment was 22.1%, and the loss rate of boiled purple sweet potatoes was 24.25%. Conclusion: According to the above results, the anthocyanin detection amount under the four cooking methods is microwave, air fryer, steaming, and boiling from large to small. From the perspective of anthocyanin retention, microwave is the best way to cook purple sweet potatoes, which can more effectively retain anthocyanins in purple sweet potatoes.**

**Keywords: Anthocyanin; Purple Sweet Potato; Ph Differential Method; Cooking Method; Extraction**

## 1. Introdution

Anthocyanins are a class of natural pigments found widely in plants and are flavonoid compounds that give red, purple and blue fruits and vegetables their bright colors. Anthocyanins cannot exist alone in nature and must be connected with monosaccharides such as glucose and rhamnose through glycosidic bonds to form anthocyanins. Common anthocyanins include cyanidin, delphinidin, pelargonidin, oligophyllin, and There are 6 types of morning glory and malvidin [1]. Studies have found that anthocyanins have a variety of beneficial physiological functions for the human body, and their antioxidant effects are particularly significant. They can effectively neutralize free radicals, slow down aging, and reduce the risk of various chronic diseases [2]. In addition, anthocyanins also have anti-inflammatory, anti-cancer, and protective cardiovascular health effects, regulate vascular function, lower blood pressure, prevent thrombosis, and play an important role in preventing and controlling cardiovascular and cerebrovascular diseases [Purification of Elderberry Anthocyanins Research on technology and DPPH free radical scavenging activity]. In view of the health benefits of anthocyanins, nutritionists recommend increasing the intake of anthocyanins in the daily diet. According to the recommendations of the Chinese Nutrition Society, each person should consume at least 50 mg of anthocyanins per day [3].

The extraction and purification of anthocyanins occupies an important position in food scientific research. Anthocyanins are polar compounds that are soluble in both water and organic polar solvents. Currently, common extraction methods include water extraction and solvent extraction. In recent years, they have been discovered and used through ultrasound, microwaves, enzymes, etc. This method can effectively improve the extraction efficiency of anthocyanins [4]. The ultrasonic-assisted extraction method is currently widely used in the extraction of anthocyanins in laboratories due to its advantages of high extraction efficiency, simplicity, and low requirements for experimental equipment. Its principle of action is that ultrasonic waves destroy plant cells by

producing high-speed, strong cavitation effects and stirring effects, allowing the solvent to penetrate into the plant cells, which can shorten the extraction time, increase the extraction rate, and effectively prevent high temperature from destroying the anthocyanin structure [5]. Tian Yanji [6] et al. used ultrasound to assist in the extraction of purple potato anthocyanins, and the optimal process for ultrasonic-assisted extraction of purple potato anthocyanins was a solid-to-liquid ratio of 1:20, an extraction temperature of 60°C, and a hydrochloric acid mass fraction of 0.2 %, ultrasonic time 80 minutes. Chen Junpu et al. [7] extracted, purified and identified purple sweet potato anthocyanins and found that the pH difference method is the best method to detect the total anthocyanin content of purple sweet potato. The best dry sample extraction conditions are: solid-liquid ratio 1: 1.22, hydrochloric acid volume fraction 0.63%, ultrasonic time 19 minutes. Wan Xinran [8] et al. studied the effects of liquid-to-material ratio, citric acid concentration, and extraction time on the extraction rate of anthocyanins, and conducted preliminary purification of the crude anthocyanin extract.

Anthocyanins are unstable in nature and are easily affected by conditions such as temperature and pH. In daily meals, anthocyanin-rich ingredients such as purple potatoes and purple cabbage are usually eaten after steaming, boiling, frying and other cooking processes, which to a certain extent will lead to the degradation or loss of anthocyanins and reduce the nutrients of the ingredients themselves. [9]. For the above reasons, a large number of researchers have begun to pay attention to the impact of different cooking methods on the content of anthocyanins and other nutrients in food ingredients. Qi Haoyu [10] et al. studied the effects of different cooking methods on the content of vitamins, total flavonoids, and total phenols in vegetables. Among them, the overall retention rate of nutrients in vegetables was higher when stir-fried at 150 ℃ ~ 180 ℃ for 1 ~ 2 minutes. Qi Minyu et al. [11] studied the differences in the types and compositions of anthocyanins in fresh and processed purple sweet potatoes, as well as the effects of five Chinese cooking thermal processing methods on the total anthocyanin content of purple sweet potatoes, and calculated the total anthocyanin content loss through the pH difference method. , it was concluded that there are differences in the anthocyanin composition of purple sweet potato for fresh consumption and purple sweet potato for processing, and the impact of different thermal processing methods on the anthocyanin loss rate of purple sweet potato, which provides a reference for people to choose the appropriate way of eating purple sweet potato. However, the specific effects of cooking methods on the anthocyanin content of purple sweet potato still need to be further explored in order to provide consumers with scientific dietary advice. In recent years, with the popularization of the concept of healthy eating, the processing methods of vegetables have gradually become diversified. As an important antioxidant, anthocyanins have a variety of health effects on the human body. By analyzing the anthocyanin content after different cooking Measurement, exploring a cooking method that is more effective in retaining the anthocyanins in vegetables, and scientifically guiding dining habits have important nutritional significance.

This study aimed to evaluate the effects of four common cooking methods (microwave heating, steaming, boiling, and air frying) on anthocyanin content in purple sweet potatoes. By comparing the loss of anthocyanins under different cooking methods, this study will provide scientific basis for optimizing the cooking methods of purple sweet potatoes, thereby helping consumers better absorb anthocyanins in their daily diet and improve their health.

## 2. Materials and Methods

### 2.1 Materials, Reagents and Instruments

Purple sweet potato (purchased from a local supermarket); total anthocyanin content detection kit (ADS-W-KY016-96 microplate method 96 samples, Jiangsu Addison Biotechnology Co., Ltd.); 0.1g electronic balance (PTF-B basic standard balance, Huazhi Electronic Technology Co., Ltd.); constant temperature water bath (BWS-10, Shanghai Hengyi Scientific Instrument Co., Ltd.); desktop microcentrifuge (Microfuge 16, Beckman Coulter); multi-function microplate reader (SpectraMax iD5, Molecular Devices); microwave oven (SK01, Xiaozhi Life

Technology Co., Ltd.); air fryer (MWBLXE1ACM, Xiaomi).

### 2.2 Sample Processing

Purple sweet potatoes bought from supermarkets were cleaned and peeled, and divided into uniform small pieces, and the gram weight of each piece was ensured to be consistent (about 5g). Two pieces were processed for each cooking method, forming one group, and one group of untreated fresh purple sweet potatoes was set as the control group, requiring a total of 5 groups of samples. Microwave: Take 1 group of samples in a microwave oven, microwave at 1000W for 1 min; Steam: Take 1 group of samples and place them in the center of the steamer grate to heat with steam, steaming time is 15 minutes; Boil: Take 1 group of samples and place them in boiling water, boiling time is 8 minutes; Air fryer: Take 1 group of samples and place them in an air fryer, bake at 200℃ for 15 minutes; The blank control group purple sweet potato is not treated in any way. After the above samples are prepared, wrap them in tin foil to avoid light and wait for detection.

### 2.3 Analysis Method and Result Calculation

2.3.1 Extraction of purple sweet potato anthocyanins

Ethanol extraction principle: Anthocyanins are easily soluble in polar solvents such as water and ethanol, so ethanol is often used as an extractant in extraction, which can dissolve anthocyanins from plant cells. In addition, anthocyanins are relatively stable under acidic conditions, so acidic substances such as hydrochloric acid and citric acid are usually added to the ethanol extractant to adjust the pH value of the extract, enhance the stability of anthocyanins, and reduce their degradation. During the extraction process, the ethanol solution penetrates into the plant cells, dissolving the anthocyanins in the cells in the extract[12]. This experiment used a commercial anthocyanin/total anthocyanin extraction kit and used the above principle to extract purple sweet potato anthocyanins.

Experimental steps: Use an electronic balance to weigh about 0.5 g of sample, add 1 mL of extract solution, extract in a 75 °C water bath for 35 min, centrifuge at room temperature at 12000 rpm for 10 min, and the supernatant is tested.

2.3.2 pH differential method for detecting anthocyanin content

Principle of pH differential method: Under different pH environments, the chemical structure of anthocyanins will change, thereby affecting their optical properties, especially the absorbance value in the visible light region. Under acidic conditions (pH 1.0): Anthocyanins mainly exist in the form of oxonium ions. The oxonium ion structure has a significant red color, so there is a strong absorption peak at 530 nm. Under weakly acidic to neutral conditions (pH 4.5): the oxonium ions of anthocyanins will transform into pseudobases or partially transform into other structures (such as chalcone or open-chain forms), which have very low or almost no absorbance at 530 nm. Anthocyanins have absorbance at 530 nm and no absorbance at 700 nm; this method eliminates false positives by using the difference in absorbance of anthocyanins at different wavelengths under different pH conditions, making the results more accurate [13].

Experimental steps: Take 100 μL of the supernatant after centrifugation into a new 1.5 mL EP tube, add 400 μL of pH 1.0 and pH 4.5 buffer to each cooking treatment sample, dilute 4 times, and balance in the dark for 15 minutes; preheat the microplate reader for more than 30 minutes, and measure the absorbance of the samples at 530 nm and 700 nm wavelengths respectively.

2.3.3 Calculation of anthocyanin content in purple sweet potato

Total anthocyanin content (mg/g) = $(\Delta A \div (\varepsilon \times d) \times V2 \times 103 \times Mr) \div (W \times V1 \div V) \times D = 0.1336 \times \Delta A \div W \times D$

$\Delta A = (A520nm - A700nm)pH1.0 - (A520nm - A700nm)pH4.5$

E—is the extinction coefficient of cyanidin-3-glucoside: 26900 L/mol/cm;

Mr—is the molecular weight of cyanidin-3-glucoside, 449.2;

d---optical path, 0.5 cm;

D---dilution factor, 4;

V---sample extract, i.e. 1mL;

W---sample weight, i.e. 0.5g;

V1---the sample volume of the supernatant in the detection operation table, 0.1mL;

V2—total test volume, 0.4mL;

Loss rate/increase rate (%) = (amount of anthocyanins in fresh samples - amount of anthocyanins in cooked samples) ÷ amount of

anthocyanins in fresh samples × 100

## 3 Experimental Results and Analysis

### 3.1 Detection and Changes of Anthocyanins in Purple Sweet Potatoes before and after Cooking

**Table 1. Absorbance Values of Purple Sweet Potato Anthocyanins at Different pH and Wavelengths Determined by pH Differential Method.**

| Sample processing | pH1.0 A530nm | pH1.0 A700nm | pH4.5 A530nm | pH4.5 A700nm | Anthocyanin detection amount(mg/g) | Loss rate/increase rate(%) |
|---|---|---|---|---|---|---|
| **microwave 1** | 2.082 | 0.085 | 0.373 | 0.092 | 1.996 | +72.5 |
| **microwave 2** | 1.758 | 0.095 | 0.305 | 0.102 | 1.560 | |
| **Steam 1** | 1.191 | 0.105 | 0.329 | 0.124 | 0.942 | -22.07 |
| **Steam 2** | 0.837 | 0.110 | 0.187 | 0.081 | 0.664 | |
| **cook 1** | 0.838 | 0.082 | 0.219 | 0.103 | 0.684 | -24.26 |
| **cook 2** | 1.094 | 0.084 | 0.268 | 0.079 | 0.877 | |
| **Air fryer 1** | 1.625 | 0.085 | 0.324 | 0.084 | 1.390 | -2.9 |
| **Air fryer 2** | 0.787 | 0.079 | 0.218 | 0.080 | 0.610 | |
| **Unprocessed 1** | 1.333 | 0.084 | 0.272 | 0.082 | 1.134 | —— |
| **Unprocessed 2** | 1.129 | 0.085 | 0.265 | 0.088 | 0.927 | —— |

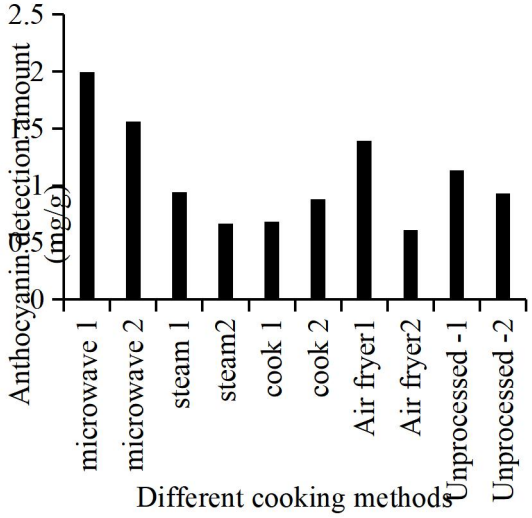


**Figure 1. Detection Number of Anthocyanins in Purple Sweet Potatoes under Different Cooking Treatments (mg/g).**

### 3.2 Analysis of the Difference in Anthocyanin Content in Purple Sweet Potatoes Under Different Cooking Conditions

The experimental results in figure 1 show that different cooking methods have different effects on the anthocyanin content in purple sweet potatoes. As can be seen from Table 1 the anthocyanin detection amount showed different degrees of loss or increase, and the detection amount from high to low was microwave > air fryer > steaming > boiling. Most cooking methods caused the loss of anthocyanins in purple sweet potatoes, with a loss rate ranging from 2.9% to 24.26%. The highest loss rate was 24.26% for boiling, and the loss rate of anthocyanins for steaming was close to boiling, at 22.07%. The second was air frying, with a loss rate of only 2.9%, which was able to effectively retain anthocyanins in purple sweet potatoes. However, the experimental results showed that after microwave processing, the average anthocyanin content of purple sweet potatoes was 1.778 mg/g, which was significantly higher than that of the other three cooking methods, and even higher than that of untreated purple sweet potato samples, with an increase rate of 72.5%, which was consistent with the research results of Lang Jing et al., that the anthocyanin content of purple sweet potatoes after microwave heating was higher than that of fresh samples.

The reason why the purple sweet potato has the highest anthocyanin loss rate after steaming and boiling may be related to the penetration of water molecules. A large amount of water may cause anthocyanins to dissolve in the cooking water, resulting in significant loss of anthocyanins.

The anthocyanin content of purple sweet potato after microwave treatment is higher than that of fresh purple sweet potato, which may be caused by the following reasons: 1. The rapid high temperature of microwave heating will destroy the cell wall structure of purple sweet potato, making anthocyanins in the cell easier to release. This cell destruction can increase the extraction efficiency of anthocyanins, thereby increasing the detection

amount; 2. Microwave treatment can change the chemical structure of anthocyanins through specific physical and chemical effects, making it more stable. Anthocyanin is a very sensitive compound, which is easily affected by factors such as pH, light, and temperature. However, the rapid heating and short-term exposure of microwave treatment may improve the stability of anthocyanin and reduce degradation.

## 4. Experimental Conclusions

The purple sweet potato in season is rich in anthocyanin, which can provide high-quality anthocyanin intake. However, due to the characteristics of anthocyanin being easily soluble in water and extremely sensitive to heat, the common Chinese cooking methods will inevitably cause anthocyanin loss to varying degrees. Through this study, it was found that the same food had different anthocyanin increase/loss rates after being processed by four different cooking methods. Specifically, the purple sweet potato after microwave treatment had the highest anthocyanin content, showing an increasing trend compared with the fresh purple sweet potato; followed by air fryer treatment, with the lowest anthocyanin loss rate; and the anthocyanin loss rate after steaming and boiling was the highest, and the loss degree of the two was comparable. In summary, microwave treatment has been proven to be the best way to retain purple sweet potato anthocyanins at present, which can minimize their loss. At the same time, air frying is a recommended cooking method in the modern fast-paced lifestyle because of its easy operation, unique flavor, and good performance in anthocyanin retention.

## 5. Existing Problems and Prospects

There are some problems in this study. First, the extraction of anthocyanins in unheat-processed purple sweet potatoes is incomplete, resulting in a small content in the control group, and the anthocyanin loss rate cannot be accurately measured; second, the experiment ignores the effect of light on the stability of anthocyanins. Due to the sufficient light in the experiment, errors may be caused. Subsequent studies need to pay attention to avoiding light, and light-shielding equipment and other methods can be used to reduce the impact of light to ensure accurate results.

Cooking methods not only affect the taste and flavor of food, but also affect the intake of nutrients such as anthocyanins. In today's society, people pay attention to nutritional diversity and comprehensiveness and food health effects. Anthocyanins have broad development prospects. In the future, we should explore better cooking methods and tools to retain anthocyanins and other nutrients, comprehensively consider factors such as temperature, time, humidity, and light, and find cooking methods that are both delicious and can retain nutrients through experiments and innovations, and improve the stability of anthocyanins so that they can be retained as much as possible in Chinese heat processing. This is not only a challenge to traditional cooking methods, but also a way to meet people's pursuit of a healthy life. It can provide people with scientific dietary advice and promote the formation of a healthy lifestyle. It can also provide new ideas and directions for the development of the food industry and promote its healthy, green and sustainable development.

## References

[1] Bioavailability of anthocyanins and derivatives de Pascual-Teresa, Sonia, and Maria Teresa Sanchez-Ballesta. "Anthocyanins: from plant to health." Phytochemistry reviews 7 (2008): 281-299.

[2] Introduction to the 2023 revised version of "Dietary Reference Intakes for Chinese Residents"[J]. Journal of Nutrition, 2023, 45(06): 521-524. DOI: 10.13325/j.cnki.acta.nutr.sin.2023.06.001.

[3] Xu Qing, Zhou Yuanjing, Huang Zhu, et al. Research advances in extraction and separation of anthocyanins from blueberry[J]. Journal of Food and Biotechnology, 2016, 35(09): 897-906.

[4] Li, Aoran, et al. "Research advances of purple sweet potato anthocyanins potato anthocyanins: extraction, identification, stability, bioactivity, application, and biotransformation." Molecules 24.21 (2019): 3816.

[5] Tian Yanji, Luo Yifa, Wu Xianhui, et al. Study on the extraction of anthocyanins from purple sweet potato by ultrasonic assisted extraction[J]. Agricultural

Products Processing, 2017, (24): 32-34+45.DOI:10.16693/j.cnki.1671-9646(X).2017.12.036.

[6] Chen Junpu. Study on extraction and antioxidant properties of anthocyanins from purple sweet potato[D]. Hainan University, 2022.DOI:10.27073/d.cnki.ghadu.2022.000319

[7] Wan Xinran, Zheng Xiaotong, Wei Ziqing, et al. Study on extraction technology and preliminary purification of purple sweet potato anthocyanins[J]. Journal of Foshan University of Science and Technology (Natural Science Edition), 2021, 39(06): 49-56. DOI: 10.13797/j.cnki.jfosu.1008-0171.2021.0086.

[8] Liu Hongmei. Study on the influence and protection of cooking methods on food nutrients[J]. China Food Industry, 2024, (10): 168-170.

[9] Qi Haoyu, Chen Jie, Yang Jun, et al. Effect of cooking on nutrients in vegetables[J]. Food Industry, 2017, 38(08): 281-286.

[10] Qi Minyu, Guo Ying, Li Shuyi, et al. Effects of different Chinese cooking heat processing methods on anthocyanin content in fresh and processed purple sweet potatoes[J]. Chinese Food and Nutrition, 2015, 21(05): 28-31.

[11] Rodriguez-Saona, L. E., & Wrolstad, R. E. (2001). Extraction, isolation, and purification of anthocyanins. Current Protocols in Food Analytical Chemistry, F1.1.1-F1.1.11.

[12] Lee, J., Durst, R. W., & Wrolstad, R. E. (2005). Determination of total monomeric anthocyanin pigment content of fruit juices, beverages, natural colorants, and wines by the pH differential method: Collaborative study. Journal of AOAC International, 88(5), 1269-1278.

[13] Lang Jing, Ling Wenhua. Effects of different cooking methods on the stability of anthocyanins in food[J]. Acta Nutrimenta Sinica, 2010, 32(06): 598-602+607. DOI: 10.13325/j.cnki.acta.nutr.sin.2010.06.001.