Study on the Stability and Application of Anthocyanin from Purple Sweet Potato

Ning YANG¹, Yong WANG¹, Yu-bo WANG², Li ZHANG¹, Yong LU¹, Quan-jie CHEN¹, Wen-ge ZHANG³, Dan-hua SU⁴ and Ruo-peng LU⁴

¹University of Science and Technology Liaoning, Anshan, 114051 P.R.China
²Shenyang Agricultural University, Shenyang, 110161 P.R. China
³Anshan Normal University Affiliated Medical School, Anshan and 114001 P.R. China
⁴Qianshan Datun Town Agricultural Technology Extension Station, Anshan 114000 P.R.China

*Corresponding author

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Abstract. The purple sweet potato anthocyanin was extracted by ethanol extraction, the stability of purple sweet potato anthocyanin was investigated in this paper, the purple sweet potato anthocyanin was water-soluble pigment, it had a strong resistance of heat and the best stability of anthocyanin was kept from light. Food preservatives had no significant effect on the stability of purple sweet potato anthocyanins; glucose and sucrose had a certain color-protecting effect on purple sweet potato anthocyanin; Ve had effects on purple sweet potato anthocyanin obviously; H₂O₂, Cu²⁺, Fe²⁺ had a greater impact on the stability of purple sweet potato anthocyanin. The solution of anthocyanin would become turbid with the effect of Cu²⁺ and Fe²⁺.

Introduction

In recent years, natural pigment is safe, non-toxic, rich in resources and has a certain nutritional value and pharmacological action, which has been popular among consumers. But natural pigments are easily degraded by the influence of pH, temperature, light, redox agents, metal ions and other factors, and its application is limited. [1]The results showed that the purple sweet potato anthocyanin had potential stability.[2]

Purple sweet potato is a new kind of sweet potato, which is a kind of annual, fine, Convolvulaceae herb. The root of purple sweet potato is all purple and it contains not only the various nutrients with ordinary sweet potato, but also rich in natural red pigment, namely anthocyanin pigment. Purple sweet potato pigment is a kind of edible pigment, its color is bright and natural, can change with pH value, have no special smell, nontoxic, its stability is more similar pigment is stable. Purple sweet potato is rich in resources, it has many functions such as health care, [3-5] and it has great development prospect in food, medicine and so on. [6, 7]

Experimental

Materials and Instruments

Purple sweet potato, Anhydrous ethanol, Hydrochloric acid, Citric acid, KCl, NaCl, CuSO₄, ZnSO₄, FeSO₄, 30% Hydrogen peroxide, L-ascorbic acid, Potassium sorbate, Sodium benzoate, glucose, sucrose, TA2003N electronic balance, LD4-2A centrifuge, HH-8 digital display thermostatic water bath pot, WFZUV - 2000 ultraviolet visible spectrophotometer, BD-156LTA horizontal cryogenic freezer, Freeze dryer, DHG-9240 electric thermostatic air drying oven.
Method

The Preparation of Purple Sweet Potato Anthocyanin

The crushed purple sweet potato powder according to the material liquid than 1: 15 add 80% of the ethanol solution (Containing 1% hydrochloric acid), 2 hours at 70°C extraction, 3500 r/min centrifuge for 10 min, the supernatant was rotary evaporated at 45°C and 100r/min, after being concentrated to a certain concentration, a certain amount of ethyl acetate was added. After stratification, the water phase was collected, and the impurities such as sugar and protein were removed by macroporous resin. It then rotates and evaporates, freezing and drying.

The Stability Test of Purple Sweet Potato Anthocyanin

Effect of Temperature on the Stability of Anthocyanin. A certain amount of anthocyanin powder was weighed, which was dissolved in pH3.0 citric acid - disodium hydrogen disodium buffer solution. Respectively in 4°C, Room temperature, 40°C, 60°C, 80°C, 100°C, and the absorbance at 525nm was determined. The stability of anthocyanins in solution to temperature was investigated.

Effects of Light on the Stability of Anthocyanin. A certain amount of anthocyanin powder was weighed, which was dissolved in pH3.0 citric acid - disodium hydrogen disodium buffer solution. Respectively in natural light, fluorescent lamp, light avoiding, and the absorbance at 525nm was determined. The stability of anthocyanin in the solution was investigated.

Effects of Metal ions on the Stability of Anthocyanin. Different quality of K⁺, Na⁺, Zn²⁺, Cu²⁺, Mg²⁺ and Fe²⁺, constant volume with pigment solution of pH3.0. Each ion concentration is separately 1mM, 5mM and 10mM, and the absorbance at 525nm was determined. The stability of anthocyanin on different metal ions was investigated.

Effect of Food Preservative on the Stability of Anthocyanin. In the pigment solution of pH3.0, different quality of potassium sorbate and sodium benzoate were added. To achieve the quality score (g/mL) 0.01%, 0.05% and 0.1%, and the absorbance at 525nm was determined. The stability of anthocyanins in solution to food additives was investigated.

Effect of Reducing Substance on the Stability of Anthocyanin. In the pigment solution of pH3.0, different quality of Vc and sodium sulfite are added. To achieve the quality score (g/mL) 0.01% and 1%, and the absorbance at 525nm was determined. The stability of anthocyanins in solution to reducing substances was investigated.

Effect of Oxidant on the Stability of Anthocyanin. In the pigment solution of pH3.0, add the different volume of H₂O₂. To achieve the concentration of 0.1mL/100mL, 0.5mL/100mL and 1.0mL/100mL, and the absorbance at 525nm was determined. The stability of anthocyanin in solution to oxidant was investigated.

Effect of Sugar on the Stability of Anthocyanin. In the pigment solution of pH3.0, different quality of sucrose and glucose were added. To achieve the quality score (g/mL) 1%, 5% and 10%, and the absorbance at 525nm was determined. The stability of anthocyanins in solution to sugars was investigated.

Results and Discussion

Effect of Temperature on the Stability of Purple Sweet Potato Anthocyanin

As can be seen from figure 1, under low temperature, the relative preservation rate of anthocyanin in purple sweet potato did not change significantly with the extension of processing time, but the relative preservation rate of anthocyanins decreased significantly under high temperature. After heating half an hour at 60°C, the preservation rate of anthocyanin was slightly decreased, but the preservation rate did not change significantly with the extension of heating time. The relative preservation rate of anthocyanins in purple sweet potato showed a decreasing trend when the temperature rose to 80 and
100 respectively. However, the preservation rate remained above 80% after heating 5h, suggesting that the purple sweet potato anthocyanins has good heat resistance. But in order to make better use of purple sweet potato anthocyanin, it should be avoided to be placed in the environment of high temperature for a long time.

![Figure 1. Effect of temperature on the stability of purple sweet potato anthocyanin.](image1)

**Effect of Light on the Stability of Purple Sweet Potato Anthocyanins**

As can be seen from figure 2, the direct sunlight has a great influence on the stability of purple sweet potato anthocyanin, but the content of anthocyanin did not change greatly under natural light and light avoidance conditions. According to reports in the literature, the long light will cause the degradation of anthocyanin, the intermediate product to generate hydroxyl C4 in the C2 site by hydrolysis of the open-loop, and then the chalcones was generated, chalcones transforms into substituted benzoic acid and 2,4,6-three hydroxy benzaldehyde and some other products, resulting in the degradation of anthocyanins being and the color faded. Therefore, anthocyanin is best protected from light.

![Figure 2. Effect of light on the stability of purple sweet potato anthocyanins.](image2)

**The Effect of Metal ions on the Stability of Purple Sweet Potato Anthocyanins**

As can be seen from figure 3-7, Na⁺, K⁺ had little effect on the stability of purple sweet potato anthocyanins. Zn²⁺, Cu²⁺ and Fe²⁺ have a certain influence on the stability of purple sweet potato anthocyanins, the anthocyanin solution containing Fe²⁺ that appeared turbid, the greater the concentration, the more obvious the turbidity, and the anthocyanin solution containing Cu²⁺ and Fe²⁺ all changed color, thus, Zn²⁺, Cu²⁺ and Fe²⁺ can reduce the stability of anthocyanins to some extent, therefore, when preparing and using anthocyanin, we should avoid contact with metal ions such as Zn²⁺, Cu²⁺ and Fe²⁺.

![Figure 3. K⁺ influence on the stability of anthocyanin.](image3)  ![Figure 4. Na⁺ influence on the stability of anthocyanin.](image4)
Figure 5. Cu2+ influence on the stability of anthocyanin.  
Figure 6. Fe2+ influence on the stability of anthocyanin.  

Figure 7. Zn2+ influence on the stability of anthocyanin.  

**Effect of Food Preservatives on Stability of Purple Sweet Potato Anthocyanin**

As can be seen from figure 8-9, Potassium sorbate and sodium benzoate had no significant effect on the stability of purple sweet potato anthocyanin.

Figure 8. Potassium sorbate influence on the stability of anthocyanin.  

Figure 9. Sodium benzoate influence on the stability of anthocyanin.  

**Effect of Reducing Substance on Stability of Purple Sweet Potato Anthocyanin**

As can be seen from figure 10, anthocyanin solution at room temperature after placing 7d haven’t Vc with the relative anthocyanin retention rate was 95.77%, the concentration of Vc was 0.01%, 0.1%
solution relative anthocyanin preservation rate was 55.41% and 28.76%. The above results show that, purple sweet potato anthocyanins are sensitive to Vc. Therefore, the pigment should be used in the absence of Vc or its low concentration.

Effect of Oxidant on Stability of Purple Sweet Potato Anthocyanin

As can be seen from figure 11, H₂O₂ has a great influence on the stability of purple sweet potato anthocyanin, and it has a destructive effect on Anthocyanin. This may be due to H₂O₂ direct nucleophilic attack C from purple sweet potato anthocyanin, the pyran ring cation rupture, generate chalcone, and further degraded into various colorless esters and coumarin derivatives, these decomposition products or between aggregation or further degradation. Therefore, the purple sweet potato anthocyanin should avoid contact with oxidant.

Effect of Sugar on Stability of Purple Sweet Potato Anthocyanin

As can be seen from figure 12-13, anthocyanin solution that haven’t amylaceum and saccharose after placing 7d at room temperature, the relative anthocyanin retention rate was 95.77%, the concentration of glucose was 1%, 5% and 10% relative anthocyanin retention rate was 99.56%, 100.29% and 100.58%, while the sucrose concentration was 1%, 5% and 10% of the anthocyanin relative retention rate was 99.42%, 100.29% and 100.44%. The pigment preservation rate was increased, indicating that glucose and sucrose had the color protection effect on purple sweet potato anthocyanins.
Conclusion
Purple sweet potato anthocyanin is water soluble pigment and has good thermal stability. Under 60 °C stability is good, preserve survival rate could reach 93.77% after 7 d. The stability of purple sweet potato anthocyanin under different pH value is different, and it appears stable red and purple in acidic conditions. It is not only the color and characteristic absorption spectrum change is not obvious, but also the alkaline condition presents the blue green with poor stability. Because the sunlight has a great influence on the stability of purple sweet potato anthocyanin, the stability of anthocyanin is best when it is preserved.

Sucrose, glucose, potassium acid sodium and potassium sorbate has no significant influence on the stability of purple sweet potato anthocyanin. And sugar has certain protective effect on anthocyanin. Vc and sodium sulfite have some influence on the stability of purple sweet potato anthocyanin, but the effect is not obvious.

Purple sweet potato anthocyanin is extremely sensitive to H₂O₂. It can cause the degradation of purple sweet potato anthocyanin.

The effects of Na⁺ and K⁺ on the stability of purple sweet potato anthocyanin were not significant. Zn²⁺, Cu²⁺ and Fe²⁺ has a great influence on the stability of purple sweet potato anthocyanin, and the Cu²⁺ and Fe²⁺ will make the anthocyanin solution cloudy.

References