Changes in Content and Component of Purple Corn (Zea Mays L.) Anthocyanin during the Extraction and Preparation

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***Abstract*—The contents of the total anthocyanin and color were detected in the purple corn at different process. The anthocyanin content at concentrating and spry drying process was decreased by 10.93%, 21.46% respectively compared to the extraction. The redness (a*) decreased significantly during the preparation process. Furthermore, the components of acylated group will decrease, whereas the unacylated group will increase during the extraction and preparation process.**

Keywords- purple corn; anthocyanin; color

I. INTRODUCTION

Anthocyanin is a novel natural pigment that is responsible for the blue, purple, orange and red color in plant. In recent years, many studies have reported that anthocyanins have strong antioxidants, which could lower the size of adipocytes and anticarcinogenic properties [1,2,3,4]. Meanwhile, it can protect the DNA from being damaged by free radicals [5].

Purple corn is an important source of anthocyanin. The cob, bract and seed of it were generally used to extract the anthocyanins. The major anthocyanins have been characterized previously. Pelargonidin-3-glucoside, peonidin-3-glucoside, cyaniding-3-glucoside, cyaniding-3-(6'-malonylglucoside) were found to be the major compositions [5]. However, the change of the individual composition during the preparation process has not been researched in detail. In this study, the HPLC-ESI-MS spectrometry was used to identify the change of these compositions of purple corn anthocyanin at extracting, concentrating and spray drying process. Meanwhile, the color and the total anthocyanin were also studied.

II. MATERIALS AND METHODS

A. Materials

Purple corn bract was supplied by Beijing Vegetable Research Center, Beijing Academy of Agriculture and Forestry Science.

B. Extraction of Anthocyanin

Bract was macerated with 60% ethanol. The pH was adjusted to 3 by adding 1 mmol/L HCL. The samples were extracted at temperature 50℃ for 4 h. The product to solution was kept at 1:65 (W/V). The samples were obtained by filtering through the filtered paper. The extraction solvent were then concentrated at 8.5 kPa, 35 r/min, 50 °C for 3 h. The remaining aqueous extract was brought to a spray drying equipment (BÜCHI Mini Spray Dryer B-290), which the drying temperature was 160 °C.

C. Determination of Anthocyanin

The total anthocyanin content in purple corn was determined using the pH differential method. The samples were diluted in buffers at pH 1.0 (KCL-HCL) and pH 4.5 (CH_3COONa-HCL), respectively. The resulting mixture was allowed to stand for 10 min at room temperature, followed measuring on the UV-Vis spectrophotometer at 512 nm and 700 nm. Absorbance (A) was calculated as follows:

$$A = (A_{\lambda_{max}} - A_{700})_{pH1.0} - (A_{\lambda_{max}} - A_{700})_{pH4.5} \quad (1)$$

where $(A_{\lambda_{max}} - A_{700})_{pH1.0}$: the absorbance of the sample at pH1.0;

The anthocyanin concentration was calculated using the following equation:

$$C = (A \times MW \times DF \times 1000) / (\varepsilon \times L) \quad (2)$$

where C is the mass concentration (g/L), MW is the molecular weight of cyanidin-3-O-glucoside (449.2 g/mol), DF is the dilution factor, ε is the molar extinction coefficient of cyanidin-3-glucoside (26900 L cm $^{-1}$mol $^{-1}$), *and* L is length of the optical path (1cm).

D. Color Analysis

Color values of the extracted anthocyanin were measured using a Hunter colorimeter (Spectrophoto METER CM-3700d). Colors of the samples were indicated by CIELAB. *L*(*brightness*), a*(*redness*), b*(*yellowness*)* were determined using an illumination (illuminant D65, 10°observer). *C** and *h°* were calculated from *L**, *a** and *b** value.

$$C^* = (a^{*2} + b^{*2})^{1/2} \quad (3)$$

$$h^\circ = \arctan(b^*/a^*) \quad (4)$$

E. Chromatographic Conditions

The HPLC analysis was performed on an Agilent 1200 series. The separation was achieved on a Waters XBridge C_{18} column (4.6×250 mm, 5 μm) using formic acid/water (5%, v/v) and acetonitrile at thermostat 30 °C. An aliquot of 20 μL was injected onto the program and the flow rate is 0.8 mL/min. The gradient program was set as follows: 0-15 min, 5%-10% B; 15-30 min, 10%-13% B; 30-34 min, 13%-20% B; 34-40 min, 20%-25% B; 40-43 min, 25%-100% B. A diode-array detector was monitored at 520 nm.

The HPLC was coupled to a 6000 ion trap with an ESI source in a positive ionization mode. The data was dealt with an Agilent Chemstation Rev.A.09.01 software (Agilent, Palo Alto, CA). The MS parameters were as follows: MS scanning rage from 100-1500; drying temperature 350 ℃; nitrogen flow rate 12 L/min; capillary current 34 nA; nebulizer pressure 0.31 MPa.

F. Statistical Analysis

The figure was treated by the software origin 8.0. And all the experiments were performed three times.

III. Results and Discussion

A. Changes in the Content of Anthocyanins in Purple Corn during Processing

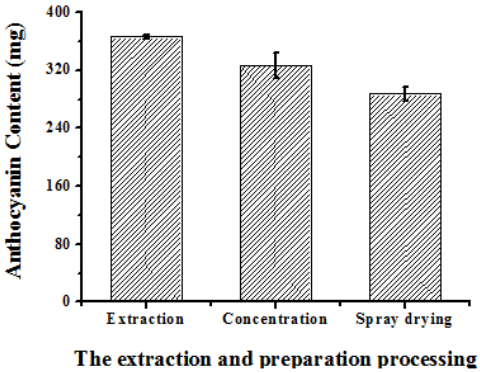

FIGURE I. THE CHANGE OF THE ANTHOCYANIN CONTENT DURING THE PROCESSING.

Purple corn is a rich source of anthocyanins. In this study, the impact of process on the changes of the total anthocyanins was evaluated by comparing the purple corn with extraction, concentration and spry drying. As shown in Figure 1, the anthocyanin content decreased with the preparation process. The anthocyanin content at concentration and spry drying was decreased 10.93%, 21.46% respectively compared to the extraction.

B. Changes in Component of Purple Corn

Table 1 shows the anthocyanin composition of the purple corn and the changes of their relative amounts that calculated by their peak area during the process. As Table 1 displayed, the major anthocyanin identified were cyaniding-type, pelargonidin-type and peonidin-type. What is more, all of them were acylated in the glucose moiety. Furthermore, it can be seen that the acylated group were decreased, whereas the unacylated group increased during the extraction and preparation processing.

TABLE I .CHANGES IN COMPONENT OF PURPLE CORN DURING THE PROCESSING.

Compound identity	Percentage of anthocyanin calculated from the peak area (%)		
	Extraction	Concentration	Spry drying
Cyanidin-3-O-glucoside	10.289	11.211	15.011
Pelargonidin-3-O-glucoside	1.964	1.317	2.705
Peonidin-3-O-glucoside	6.184	6.55	7.828
Isocyanidin-3-(6”-malonylglucoside)	25.182	26.763	34.898
Pelargonidin-3-(6”-malonylglucoside)	7.903	7.607	8.181
Cyanidin-3-2malonlyglucoside	40.061	38.549	26.234
Pelargonidin-3-2malonlyglucoside	4.984	4.568	3.131
Peonidin-3-2malonlyglucoside	3.433	3.435	2.012
Total (%)	100	100	100

C. Color Analysis

The effect of extraction, concentration and spry drying on the visual appearance of athocyanin was shown in Figure 2. As can be seen, redness (a*) decreased significantly with the preparation process. The a* value denotes the red color of the product. The color of the athocyanin showed the similar trend with athocyanin content, which indicated that the changes of the red color is greatly related to the athocyanin content [6]. Furthermore, some studies had reported that the acylated group attributed to the color intensity as well [7]. The more glycoside substituents, the redder of the athocyanins.

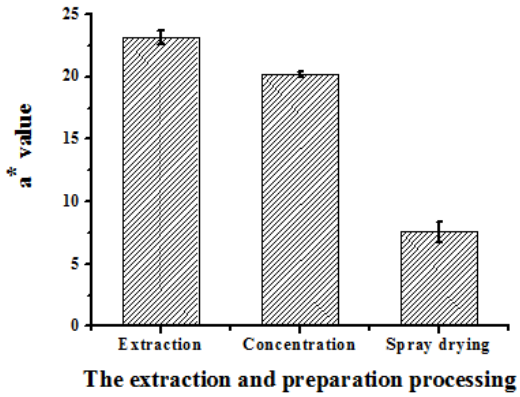

FIGURE II. THE COLOR CHANGE OF THE ANTHOCYANIN DURING THE PROCESSING.

IV. Conclusions

The results suggested that the athocyanin was not stable. The total athocyanin content decreased with the extraction and preparation process. The athocyanin contributed to the color of the product. In addition, the anthocyanin composition of the purple corn varied with the process.

Acknowledgements

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