Effect of ultra-high temperature processing on quality of watermelon juice

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ABSTRACT: The effect of ultra-high temperature processing on the quality and flavor of watermelon juice was evaluated. The temperature of 120 and 135 oC was effective to reduce the total flora count to 2 LogCFU/ml and reduce the color variety of the watermelon juice. However, the higher temperature leaded to a flavor change compared with the un-treatment juice. The ultra-high temperature processing of 120 oC was a proper temperature for the processing of the watermelon juice.

INTRODUCTION

Watermelon is welcomed all over the world especially in summer. Consumers enjoy the flavor and crisp mouth-feel of the watermelon. Most watermelons are fresh consumed due to the flavor of the watermelon is hard to hold (Zhang, et al., 2010). The thermal pasteurization, exposure to air, contact with the mental vessel and some other exogenous factors all result in the deterioration of the watermelon flavor (Aguiló-Aguayo, et al., 2010, Feng, et al., 2013, Mosqueda-Melgar, et al., 2008).

The technologies, such as the high-intensity pulsed electric field (Oms-Oliu, et al., 2009) , thermosonication (Rawson, et al.), high pressure carbon dioxide (Liu, et al., 2012), and high pressure (Zhang, et al., 2010), have been applied for the processing of the watermelon juice. Among the technologies, ultra-high temperature (UHT) processing gives the high temperature to products in a very short period, and avoid the air exposure of the products, which could be an option for the processing of watermelon juice. The UHT processing has been widely applied in the production of milk and milk-related products (Bönisch, et al., 2004, Lavigne, et al., 1989, Poliseli-Scopel, et al., 2012). However, application of the UHT on the quality and flavor of watermelon was not found to our knowledge.

The influence of the temperature (110, 120, and 135 ^{o}C) on the quality of watermelon juice was evaluated. The flavor of the treated juice was compared by the electrical nose.

Material and Methods

Preparation of watermelon juice

Watermelons were brought from a local farmer market, which was fresh and mature. The fruits were peeled and put into in a Philips juicer (HR1861, Philips Co. Ltd., Beijing, China). The watermelon juice was mix with a complex food additive that was optimized in our lab. The complex food additive included the carboxymethylcellulose sodium, ascorbic acid, xanthan gum, ethylene diamine tetraacetic acid, carminum, sodium pyrophosphate and etc.. The juice was stirred and adjusted to the pH 4.10 with the citric acid, and adjusted to the soluble solid content (SSC) to 8.0

Brix° with the high fructose corn syrup (4502504-01, Fresh Juice Industry (Kunshan) Co. Ltd., China). And then the juice was pasteurized by a pilot scale tubular UHT heat exchanger (Model No. FT74 UHT/HTST Processing System, Armfield Technical Education Co. Ltd., Ringwood, UK) at 110, 120 and 135 °C for 15s, respectively. The outlet temperature was lower than 45 °C. The pasteurized juice was sterile filling in 500 ml PET bottles followed by further cooling in the cold water. The products were store at 4 °C for the further analysis.

Total flora counts

Samples were serially diluted, plated in total count agar for total flora counts, followed the recently reported method (Rivasa, et al., 2006). The plates were incubated at 37°C for 48 h and counted manually.

Determination of color and SSC

Color of the sample was conducted randomly in the reflectance mode for 6 times at 23°C (Chromameter CR-300, Minolta, Japan). Color L^*, a^*, and b^* value of sample was measured and total color difference (ΔE) was calculated by Equation (1).

$$\Delta E = \sqrt{(L^* - L_0^*)^2 + (a^* - a_0^*)^2 + (b^* - b_0^*)^2} \quad (1)$$

where ΔE is the total color difference between a sample and the control; $L^*, a^*,$ and b^* are the lightness, redness and yellowness of a sample, respectively; L_0, a_0 and b_0 are the lightness, redness and yellowness of the control.

The SSC of the watermelon juice was recorded by a pocket refractometer (Pal-α, ATAGO, Japan) with distilled water as a blank.

Flavor comparison

The flavor of the samples was compared by the electronic nose PEN2 (Airsense Analytics GmbH, Schwerin, Germany). The electronic nose was turned on for 30 min and flushed the testing system for 180 s. The sample of 2 ml was put in the testing tube. And then the electronic sensor was put into the testing tube to collect the results for 60 s. The response of the sensor in 48~52 s were evaluated by a principal component analysis.

Statistical Analysis

Analysis of variance (ANOVA) was used to compare mean differences of the results. If the differences in mean existed, multiple comparisons were performed using Duncan's Multiple Range Test. All analysis was conducted using SPSS for Window Version 19. All experiments were done in triplicates or more.

Results and Discussion

Effect of temperature on total flora count of watermelon juice

The effect of the UHT temperature on the total flora count of the watermelon juice is shown in Figure 1. The total flora count of the UHT120 and UHT135 was below than 2.0 LogCFU/ml that was the flora threshold for juice in China, while the total flora count of the UHT110 was higher than 2.0 LogCFU/ml. Moreover, the total flora count of the UHT120 and UHT135 was significantly lower than that of the UHT110. Consequently, the UHT120 and UHT135 accorded with the microbiological criteria of China.

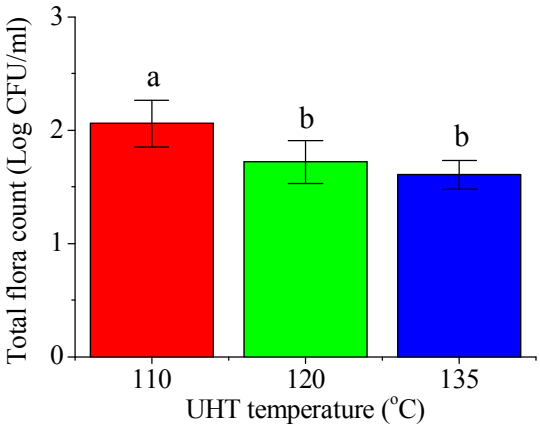

Figure 1 Effect of temperature on the total flora count of watermelon juice

Effect of temperature on quality of watermelon juice

The effect of UHT temperature on color varieties and SSC of the watermelon juice is shown in Figure 2. The color variety of the 2 samples is hard to be distinguished by normal human vision when the ΔE between the 2 samples is below 6.0 (Wu & Sun, 2013). The ΔE of the UHT110, UHT120 and UHT135 was lower than 6.0 Consequently, the color of the UHT110, UHT120 and UHT135 was not changed significantly. Remarkably, the ΔE of the UHT120 and UHT135 was significantly lower than that of the UHT110. Being different to our results, the UHT processing of 135 and 140 °C leads to a significant color variety on the sugarcane juice (Jittanit, et al., 2011). This phenomenon could resulted from the different SSC of the sugarcane juice and watermelon juice. The high temperature could result in the Maillard or caramelization (Bozkurta, et al., 1999, Göğüş, et al., 1998) . The SSC of the watermelon juice was about 8.0 Brix°, while that of the sugarcane juice was higher than 30 Brix°. The Maillard or caramelization had more chance to begin in the sugarcane juice.

The UHT temperature showed no influence on the SSC of the watermelon juice. Being similar to our results, the UHT treatment of 135 and 140 °C shows no influence on the SSC of the sugarcane juice (Jittanit, et al., 2011).

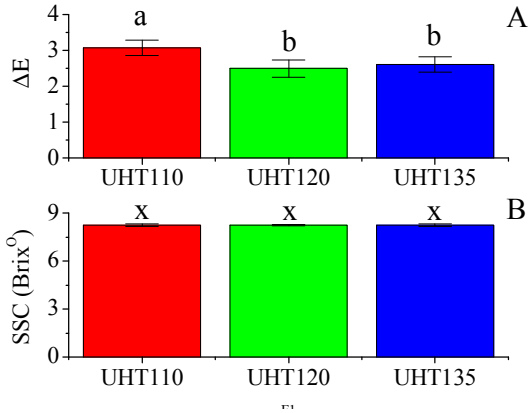

Figure 2 Effect of temperature on the quality of the watermelon juice

Effect of temperature on flavor of watermelon juice

The flavor of the UHT processed juice was compared with the control juice by the electric nose analysis. The main component 1 and main component 2 contributed 95.32 % and 3.27 % for the flavor of the watermelon juice (Figure 3). Hence, the main component 1 and 2 accounted 98.59% of the total flavor. The distant of the UHT110 and UHT120 to the control was similar, while that of the UHT135 to the control was longer. Consequently, the flavor of the UHT110 and UHT120 was more similar to that of the control. The higher temperature leaded to the flavor variety of the watermelon juice.

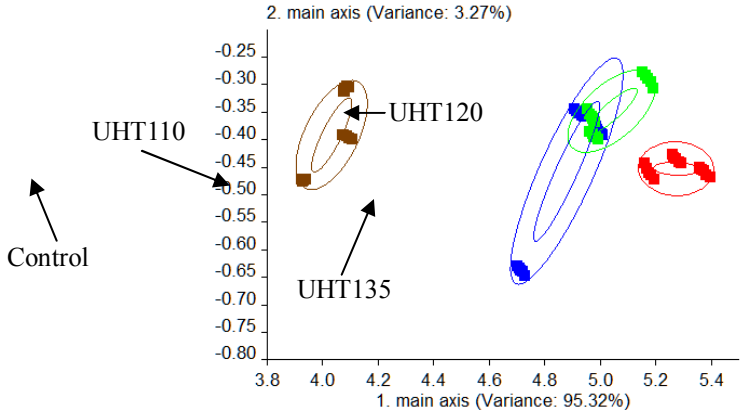

Figure 3 Effect of UHT temperature on the flavor of the watermelon juice

Conclusion

The effect of ultra-high temperature treatment on the quality and flavor of watermelon juice was evaluated. The temperature of 120 and 135 ^{o}C was effective to reduce the total flora count to 2 LogCFU/ml and reduce the color variety of the watermelon juice. However, the high temperature leaded to a flavor change compared with the un-treatment juice. The ultra-high temperature treatment of 120 ^{o}C was a proper temperature for the processing of the watermelon juice.

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