Innovative Food Science and Emerging Technologies 31 (2015) 28–36

Contents lists available at ScienceDirect

Innovative Food Science and Emerging Technologies

journal homepage: www.elsevier.com/locate/ifset

Quality assurance in pepper and orange juice blend treated by high pressure processing and high temperature short time

Zhenzhen Xu [a,b], Tiantian Lin [a], Yongtao Wang [a], Xiaojun Liao [a,*]

[a] College of Food Science and Nutritional Engineering, China Agricultural University
[b] Institute of Quality Standard & Testing Technology for Agro-Products, Chinese Academy of Agricultural Sciences, Key Laboratory of Agro-food Safety and Quality, Ministry of Agriculture, Beijing 100081, China

ARTICLE INFO

Article history:
Received 26 June 2015
Received in revised form 28 July 2015
Accepted 4 August 2015
Available online 28 August 2015

Keywords:
Juice blend
Quality assurance
High pressure processing
High temperature short time

ABSTRACT

The impact of mixing ratio of pepper juice/orange juice (*v*/*v*) at 1:5, 1:2, 1:1, 1:0.5 and 1:0.2 on sensory attributes of pepper and orange juice blend (POJB) was studied, and the ratio of 1:0.5 achieved the highest ratings in mouthfeel and overall acceptability and was chosen for the following study. Effects of high pressure processing (HPP, 550 MPa, 5 min, ambient temperature) and high temperature short time (HTST, 110 °C, 8.6 s) on quality attributes of the POJBs were compared. Reduction of total aerobic bacteria (TAB) and molds and yeasts (M&Y) in the POJBs was >4 log cycles after HPP and HTST, and the two POJBs were microbiologically safe during the whole refrigerated storage. The color, flavor, appearance, mouthfeel and overall acceptability of HPP-treated POJB were closer to untreated POJB than the HTST-treated one. After 25 days, 77.3% and 75.3% of total phenols content, 90.8% and 90.7% of ascorbic acid, and more than 80% of antioxidant capacity in two POJBs were retained, respectively. Particle size distribution (PSD) of HPP-treated POJB was consistent with untreated POJB (1~76 μm, 3 peaks at 4.2, 17, 52 μm), while HTST changed the PSD (1 to 33 μm, 2 peaks at 2.4 and 17 μm). Higher level of sedimentation in HPP-treated POJB during storage was interpreted by higher residual PME activity (67.0%) and larger and more unstable pulp particles. The POJBs behaved as Newtonian fluids, their viscosity right after processing were ranked as HPP > untreated > HTST, and the values were slightly reduced during storage.

Industrial Relevance: This study was intended to develop yellow sweet pepper and orange juice blend (POJB), which are not available on the market. Further this study was also intended to explore the application of high pressure processing (HPP) and high temperature short time (HTST) on quality assurance of the POJB. This study would provide technical support for commercialization of juice blend products treated by high pressure.

1. Introduction

In a health-awareness society, consumption of fresh vegetable juices with less sweetness and lower calorie, like kale, cabbage, lettuce, celery, pepper juices, etc., is springing up (Simsek, El, Kancabas Kilinc, & Karakaya, 2014; Song et al., 2007), but these juices are not widely acceptable due to their unpleasant flavor and taste. Blending with fresh fruit juices becomes a solution for this problem. Juice blending is also one of the best methods to improve the nutritional quality of the juice (Rathod, Shakya, & Ade, 2014). However, the development of this kind of juice blend is limited due to the short shelf life (Kim & Rhee, 2015; Song et al., 2007). Preservation studies of juice blend are more challenging considering higher pH value and more unstable quality characters of blend. Additionally, consumption of freshly unpasteurized juice blends might raise the risk of various foodborne illness, thus FDA has required processors to achieve a 5 log reduction of the most resistant pathogens in the finished products (Nguyen-The, 2012; Tiwari, O'Donnell, & Cullen, 2009). The demand for safe juice blends possessing great quality, such as sensory freshness characteristics and biological properties has led researchers and manufacturers to develop new processing and conservation technologies (Hernández-Carrión, Hernando, & Quiles, 2014).

In recent years, there has been considerable interest in food preservation by non-thermal technologies, which are effective at ambient or sub-lethal temperatures to minimise negative thermal effects on food nutritional and quality parameters (Knorr, 2003; Rawson et al., 2011; Tiwari et al., 2009). High pressure processing (HPP) (Jiang et al., 2009; Zhao et al., 2013), high-intensity pulsed electric field (Sánchez-Vega, Elez-Martínez, & Martín-Belloso, 2014; Zhong et al., 2005), high pressure carbon dioxide (Li, Zhao, Wu, Zhang, & Liao, 2012; Zhou, Wang, Hu, Wu, & Liao, 2009) and radiation sterilization processing (Kumar et al., 2012; Song et al., 2007) have been applied to ensure product safety and quality of juices and blends. HPP, which subjects foods to 100~1000 MPa using water as pressure transmitting medium at room or mild process temperatures, is one of the most promising alternatives of preservation technology, providing food with fresh-like quality (Oey,

* Corresponding author at: College of Food Science and Nutritional Engineering, China Agricultural University, Beijing 100083, China.
E-mail address: liaoxjun@hotmail.com (X. Liao).

http://dx.doi.org/10.1016/j.ifset.2015.08.001
1466-8564/

Lille, Van Loey, & Hendrickx, 2008). HPP has become a commercially implemented technology, spreading from its origins in Japan, followed by USA and Europe (Pereira & Vicente, 2010), this technology has also been commercialized in China in the very recent 5 years.

Sweet peppers belong to the species *Capsicum annuum*, which are an excellent source of essential nutrients such as carbohydrates, vitamins and minerals (Faustino, Barroca, & Guine, 2007). According to National Nutrient Database for Standard Reference from the United States Department of Agriculture (Release 27:2014), the nutritional compositions of sweet peppers in raw state (per 100 g of edible portion) are 93.89 g of water, 0.86 g of protein, 0.17 g total lipids, 4.64 g of carbohydrate, 2.40 g total sugars and 1.70 g total dietary fiber, corresponding to an energy of 20 kJ. Sweet peppers have attracted the attention of researchers owing to their high content of bioactive compounds, such as fiber, phenols, flavonoids and carotenoids, which possess antioxidant and anti-inflammatory activity, consumption of fresh sweet peppers appears to improve scar formation, prevent atherosclerosis and haemorrhages, reduce blood cholesterol levels and improve stamina (Faustino et al., 2007). However, consumers did not accept the taste of sweet pepper juice, since it was less sweet and slightly astringent.

Yellow sweet pepper juice is attractive, and the yellowness of sweet pepper depends on the ratio of total chlorophyll and carotenoids content (Selahle, Sivakumar, Jifon, & Soundy, 2015). Orange juice is one of the most popular beverages due to its attractive color and pleasant taste in the world (Wibowo, Grauwet, et al., 2015; Wibowo, Vervoort, et al., 2015). The bright yellow/orange color of orange juice was also determined by the composition and concentration of carotenoids (Meléndez-Martínez, Gómez-Robledo, Melgosa, Vicario, & Heredia, 2011).

Orange juice and yellow sweet pepper juice showed similar color, and the widely accepted flavor of orange juice could ameliorate the flavor of yellow sweet pepper juice. The deliverance of a good impression through color will determine consumers' acceptability and their purchase decision (Wibowo, Grauwet, et al., 2015; Wibowo, Vervoort, et al., 2015), so this study was intended to develop a yellow sweet pepper and orange juice blend (POJB), which are not available on the market. HPP and high temperature short time (HTST) were applied to assure the quality of POJB during storage.

2. Materials and methods

2.1. Preparation of sweet pepper and orange juice blend

Fresh yellow sweet peppers (Hebei province, China) and navel oranges (Jiangxi province, China) were purchased from a local market (Beijing, China) in March 2014. Peppers were cleaned with tap water and cut into pieces after removing the seeds, and then they were pressed with a mechanical juice extractor (Joyong Electric Appliance Co., Shandong, China). Navel oranges were washed, peeled, sliced into pieces, then pressed with the same extractor. Two juices were filtered using a four-layer gauze to get original cloudy juices, respectively. Sweet pepper cloudy juice (pH 4.82, 6.4 °Bx, titratable acidity (TA) = 0.18%) and navel orange could juice (pH 3.97, 12.9 °Bx, TA = 0.48%) were then mixed into POJBs by using five ratios of 1:5, 1:2, 1:1, 1:0.5 and 1:0.2 (pepper juice/orange juice, v/v) for optimizing the mixing ratio. The POJBs were analyzed based on sensory evaluations as described later. The POJB with the highest ratings in sensory evaluation was used for further HPP and HTST processing and storage study.

2.2. High pressure processing and high temperature short time treatment

2.2.1. High pressure processing

For the HPP group, 100 mL polyethylene terephthalate bottles with screw-cup closures were filled with POJB. 550 MPa and 5 min HPP treatment were carried out using a hydrostatic pressurization unit (HHP-700, Baotou Kefa Co., Ltd., Inner Mongolia, China) with a capacity of 7.0 L at ambient temperature (≈25 °C). Distilled water was the pressure-transmitting fluid. The pressurization rate was about 120 MPa/min and the depressurization was immediate (less than three seconds). The treatment time reported in this study did not include the pressure increase or release time.

2.2.2. High temperature short time

For the HTST treatment, the POJB was pasteurized at 110 °C for 8.6 s in a pilot scale pasteurizer with a tubular heat exchanger (Armfield FT74, HTST/UHT Processing Unit, Hampshire, England) according to previous studies (Huang et al., 2013; Wang et al., 2012). After pasteurization, the POJB was aseptically filling into the identical polyethylene terephthalate bottles used in HPP after cooling to 20 °C.

2.3. Storage study

Both POJBs after HPP and HTST were stored at 4 °C in darkness, quality analysis was run at Day 1, 3, 6, 9, 15, 20 and 25 of refrigerated storage. Experiments were executed in triplicate for each group.

2.4. Sensory evaluation

The procedure performed for sensory evaluation was described (Wang et al., 2014). A panel of 20 members participated in the sensory tests. Panelists were graduate students from the College of Food Science and Nutritional Engineering at China Agricultural University, and they were trained at least once previously for sensory test. The panelists were asked to rate the samples by their preference for color, appearance, flavor, mouth-feel and overall acceptability by marking on the score sheet standard as described (Wang et al., 2014) with a little modification (Table 1). A nine point hedonic scale was used here, where higher numbers represented the stronger preference for particular attributes (one = dislike extremely; two = dislike very much; five = neither like nor dislike; eight = like very much; nine = like extremely). Two groups of the POJBs were served in randomly numbered scentless paper cups on a tray. A cup containing potable water and a piece of non-salted cracker were also provided to the panelists to eliminate the residual taste between samples. A score of five was taken as the lower limit of acceptability.

2.5. Microbial analysis

Total plate count method was used to measure viable cells of natural microorganisms. Twenty milliliters of the POJB was serially diluted with 0.85% sterile NaCl solution to 250 mL, and 1.0 mL of diluted samples, which were filled into duplicated plates of appropriate agar. The plate count agar incubated at 36 ± 1 °C for 24 ± 2 h was for detecting the viable cells of total aerobic bacteria (TAB) and the Rose Bengal agar incubated at 28 ± 1 °C for 72 ± 2 h was for detecting the viable cells of molds & yeasts (M&Y).

2.6. Physicochemical characters

pH, total soluble solid (TSS) and TA were determined by Orion 868 pH meter (Thermo Orion, USA), WAY-2S digital Abbe Refraction meter (Shanghai Precision and Scientific Instrument Co., Ltd, China) and 851 GPD automatic titrator (Metrohm Co. Ltd., Switzerland) at 20 ± 1 °C, respectively. TSS was reported as degrees Brix and TA was expressed as the percentage of citric acid content.

2.7. Assessment of bioactive compounds and antioxidant capacity

2.7.1. Total phenols content

Total phenols content (TPC) was determined using the Folin–Ciocalteu method described (Cao et al., 2012) with a little modification of sample quantity, which was 0.4 mL of the POJB mixed with 2 mL 10-