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Fermented minced pepper by high pressure processing, high pressure processing with mild temperature and thermal pasteurization

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ABSTRACT

High pressure processing (HPP) and thermal pasteurization (TP) of fermented minced pepper (FMP) were comparatively evaluated by examining their impacts on microbial load, titratable acid (TA), pH, a_w, firmness, color, capsanthin, ascorbic acid (AA), and biogenic amines (BAs) after processing and during 12 weeks of storage at 25 and 37 °C. The total plate count (TPC) in FMP samples was reduced by 1.48, 0.12 and 1.58 $\log_{10}$ CFU/g after TP (83 °C/15 min), HPP1 (500 MPa/20 °C/5 min) and HPP2 (500 MPa/50 °C/5 min), respectively. The population of spores was reduced by 1.21 $\log_{10}$ CFU/g only after HPP2. During storage at 25 or 37 °C, the TPC in TP, HPP1, and HPP2 samples increased by 0.88/1.21, 0.41/0.62 and 0.60/0.86 $\log_{10}$ CFU/g, respectively, while the spores decreased below the detection limit. The retention of firmness after TP, HPP1 and HPP2 was 36.91, 91.15 and 66.48% respectively, and HPP-treated samples exhibited more retention during the storage. Color of FMP samples was not changed by TP, but slightly changed by HPP1 and HPP2. The content of capsanthin retained 78.99, 93.71 and 88.19% after TP, HPP1 and HPP2, it showed a small decrease during storage. Levels of biogenic amines (BAs) in HPP2 samples were lower than that of TP and HPP1 ones. There were better sensory quality and lower microbial level in HPP-treated samples during storage, indicating that HPP is a better choice for the preservation of FMP.

Industrial relevance: Consumption of fermented minced pepper (FMP), as a traditional Chinese food, is becoming increasingly popular. Considering that heat treatment may destroy some heat-sensitive quality of the products, this study evaluated the effects of high pressure processing (HPP) on quality of FMP. Findings of this study could help processors commercialize HPP to replace current thermal processing in industrial production.

1. Introduction

Fermented minced pepper (FMP), a traditional and local vegetable fermented by lactic acid bacteria in China, is widely consumed due to its nutritional and sensory properties. Thermal pasteurization (80–85 °C, 15–20 min) is widely used in FMP processing (Deng et al., 2004), but it often causes loss of sensory qualities, texture softening and discoloration of FMP samples. To avoid these problems, calcium chloride, sodium pyrosulfite and potassium sorbate are used, which leads to the abuse of these food additives in FMP production. In addition, a growing demand for natural, fresh-like and safe food has aroused an increased interest in non-thermal processing technologies. As a consequence, an alternative non-thermal processing technology for FMP industry is needed.

High pressure processing (HPP), a non-thermal processing technology, has been commercially and scientifically shown to produce microbiologically safe and stable products with improved quality (Barba, Terefe, Buckow, Knorr, & Orlien, 2015). HPP retains better firmness of food than thermal treatments, which were proved in the investigations into kimchi (Sohn & Lee, 1998), pepper (Castro et al., 2008), fresh carrot (Araya et al., 2007), and yellow peach (Zhang et al., 2012).

Currently, HPP at 250–600 MPa and 5–10 min was shown as very effective in reducing the microbial load of fermented foods, such as Nozawana-zuke (a fermented vegetable from Japan) (Kuribayashi, Ohsawa, Takanami, & Kurokouchi, 1996), kimchi (Sohn & Lee, 1998), sour Chinese cabbage (Li et al., 2010), black table olives (Tokuşoğlu, Alpas, & Bozoğlu, 2010), and Cornezuelo dressed olives (Pradas et al., 2012). HPP could extend the shelf life of these foods, and give them

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preferable texture, color or flavor. To date, research on the application of HPP in FMP was not reported.

The objective of this study was to investigate the effect of HPP on microbial load, firmness, color and biogenic amines in FMP and their changes during 12 weeks of storage at 25 °C and 37 °C.

2. Materials and methods

2.1. Preparation of FMP

FMP was provided by Tantanxiang Food Company (Changsha, Hunan province, China) without pasteurization and any preservatives. Fresh pepper (Cultivar Erjintiao) was cleaned and minced with 10% garlic and 10% ginger. After fermentation with 20% NaCl for 3 months at room temperature, FMP was desalinated. The desalination was carried out by adding 100 °C water and stir for 5 min (50 kg FMP mixed with 50 kg 100 °C water). Then FMP was drained and seasoned with sugar and white spirit, the final products had 7% NaCl. Then the FMP was packed into glass jar and placed in incubator filled with ice, and transport to laboratory in 24 h. The samples were packed into polypropylene/ethylene vinyl alcohol copolymer/polypropylene (PP/EVOH/PP) bags (100 mm × 60 mm × 0.50 mm). An ADZQ400/500/600 vacuum-packing machine (Rishang Co., Ltd., Beijing, China) was used for degassing. The final thickness of the samples was less than 5 mm. Prepared samples were kept at 4 °C before used.

2.2. HPP and thermal pasteurization

HPP was carried out by using an FPG7100, 2L hydrostatic pressurization unit (Stansted Fluid Power Co., Ltd., United Kingdom). The rate of pressure increase was about 600 MPa/min and the pressure release was immediate. The treatment time in this study did not include the pressure increase and release time. The FMP samples were placed in the pressure vessel and treated by 500 MPa for 5 min at 20 °C (HPP1) and 50 °C (HPP2), respectively. When the temperature of the vessel reached the desired temperature, pressurization was started. The pressurization was started at 43.5 °C, and increased to 54.7 °C when reached 500 MPa, then kept not lower than 49.7 °C for 5 min. The treatment conditions were confirmed by preliminary experiment.

Thermal pasteurization was carried out in a LY-9A thermostatic water bath (Qingyuan Science & Technology Development Co., Ltd., Beijing, China) and held for 15 min after the temperature reached 83 °C, which modeled practical production of FMP industry. Then samples were immediately cooled to room temperature by running water.

2.3. Storage study

Following the treatments, the samples were stored at 25 °C or 37 °C for 12 weeks. The samples were taken at 0, 1, 2, 3, 4, 6, 8, 10 and 12 weeks to determine related changes of indicators during the storage.

2.4. Microbial analysis

2.4.1. Determination of total plate count

To detect TPC in FMP samples, the total plate count method was used. Each sample was mixed by Interscience BagMixer 400 VM, then transfer 5.0 g turbid liquid (from the mixed sample) dilute with 45.0 mL sterile 0.85% NaCl solution, and 1.0 mL of each dilution and 1.0 g undiluted samples (turbid liquid from the mixed sample) were plated into duplicate plates with nutrient agar (Beijing Land Bridge Technology Co. Ltd., Beijing, China). Initial population of TPC in FMP samples was $(2.40 \pm 0.78) \times 10^3$ CFU/g.

2.4.2. Determination of bacterial spores

Due to high salt concentration, vegetative cells of spore-forming bacteria in FMP were changed into spores for survival. The population of bacterial spores in the FMP samples was analyzed. Samples were pasteurized (80 °C, 10 min) to inactivate the vegetative cells (Han, Cao, Rombouts, & Nout, 2004), and the spores were enumerated by the method illustrated in 2.4.1, after incubation at 30 °C for 72 ± 2 h. Initial population of bacterial spores in the FMP samples was $(1.21 \pm 0.31) \times 10^2$ CFU/g, which made up 5% of the population of TPC.

2.4.3. Determination of lactic acid bacteria

To detect lactic acid bacteria in FMP, untreated or treated samples were serially diluted with sterile 0.85% NaCl solution, and 1.0 mL of each dilution was plated into duplicate plates with MRS agar (MRSA, Beijing Land Bridge Technology Co. Ltd., Beijing, China). The plates were incubated at 30 °C for 72 ± 2 h.

2.4.4. Determination of yeasts and molds

The rose bengal agar (RBA, Beijing Luqiao Technology Co., Ltd., Beijing, China) was used for detecting the viable cells of yeasts and molds. The plates were incubated at 27 °C for 5 days.

2.4.5. Determination of total coliform

Analysis of total coliform in all samples was conducted using the three-tube most probable number (MPN) method. Lauryl sulfate tryptose broth (LST broth) and brilliant green lactose bile (2%) broth (BGLB broth) were used for presumptive and confirmed tests for total coliform, respectively.

After incubation, the colonies were enumerated. The detection limit of TPC, bacteria spores, LAB, yeasts and molds was 1 CFU/g.

2.5. Texture analysis

Texture measurements were performed with a TAXT2i texture analyzer (Stable Micro Systems, Surrey, England). Parameters for texture analysis were set according to Hu (2010) with some modifications. The compression force at 30% strain was obtained by using a cylindrical flat-probe (50 mm diameter; aluminum).The samples were drained and cut into 3 mm in height and 5 mm in square, using a stainless surgical blade and placed 6 pieces on the platform into 2 rows (3 flesh side up, 3 flesh side down, staggered), measured with a pre-test speed of 2 mm/s, test speed of 1 mm/s, post-test speed of 10 mm/s, strain at 80% and 5 g trigger force. Texture analysis was carried out within 1 h after the pressure treatments had been applied, and the samples were kept at 4 °C during this period. All the measurements were conducted at room temperature.

2.6. Color analysis

Color analysis was conducted at 25 ± 2 °C using a HunterLab ColorQuest XE color measurement spectrophotometer (Hunter Associates Laboratory, Inc., Virginia, USA) in the reflectance mode. Color was expressed in L^*, a^*, and b^* values. All measurements were made in triplicate and results were averaged. In addition, total color difference $\Delta E^*$and Chroma C^* were calculated.

$$\Delta E^* = \left[(L^* - L^*_0)^2 + (a^* - a^*_0)^2 + (b^* - b^*_0)^2\right]^{1/2.}$$

$$C^* = \left[(a^*)^2 + (b^*)^2\right]^{1/2}$$

2.7. Determination of capsanthin

The method was proposed by Zhang, Jiang, Zhan-Sheng, Zhao, and Tian (2006) with some modifications. One gram of FMP was freeze-dried and mixed with 25 mL acetone. The mixture was ultrasonic processed (30 min), and shook at 25 °C for 30 min. After that, the mixture