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Quality changes in high pressure processed ginger paste under refrigerated storage

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ABSTRACT

This investigation was carried out to evaluate quality changes in ginger paste followed by high hydrostatic pressure and thermal treatment during 6 months of storage at 6±1 °C. Ginger samples were washed in water, peeled manually and pulverized in the form of smooth paste and were mixed with ascorbic (100 mg kg^{-1}) and citric (100 mg kg^{-1}) acids and subsequently packed in polyethylene pouches (25 μm thickness, 50 g pack size). The pastes were processed in an isostatic high pressure system at a pressure of 200, 400 and 600 MPa at 30 °C for 5 min. The high pressure and thermal treated samples were analyzed for various physico-chemical, enzymatic, sensory and microbiological parameters. The pH and titratable acidity were not significantly ($p<0.05$) affected by high pressure processing. The microbiological results showed that high pressure and thermal treatment were sufficient to keep microbial populations below the detection limit during the whole storage period. A slight reduction in phenolics, flavonoids and antioxidant capacity was observed in the treated samples during storage time. The indicator of total colour difference (ΔE), showed that there were significant differences ($p<0.05$) in colour between thermal treated and pressure treated samples, the lowest colour difference being obtained for samples treated at 600 MPa. The condiment pastes treated at 600 MPa pressure for 5 min showed an extended shelf-life of 6 months under low temperature (6±1 °C, 80–85% RH) storage based on the retention of physicochemical, sensory and microbiological attributes.

1. Introduction

Consumers have become increasingly aware of food quality and nutritional aspects and the technologies used to process the food, showing a higher preference for fresh-like products free of chemicals and additives (Evans & Cox, 2006). Thus, the present challenge for the food scientists/technologists around the world is to develop alternative technologies that can achieve microbial safety, retain freshness and provide environment friendly products, all within feasible cost limits. Non-thermal processing technologies were designed to eliminate the use of elevated temperatures during processing and to avoid the adverse effects of heat on the flavour, appearance and nutritive value of foods (Leadley, Williams, & Jones, 2003). Early eighties witnessed the emergence of high pressure processing technology which offers numerous opportunities for developing new foods with an extended shelf-life, high nutritional value and excellent organoleptic characteristics (Lado & Yousef, 2002). High pressure processing is an efficient novel non thermal technology that can eliminate the use of high temperatures to kill the microorganisms, avoiding the deleterious effects of heat on flavour, colour and nutritive value of foods. Unlike thermal processing

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and other preservation technologies, the effects of high pressure processing are uniform and nearly instantaneous throughout the food. High pressure processing is gaining in popularity with food processors not only because of its food preservation capability but also because of its potential to achieve interesting functional effects (Balasubramaniam & Farkas, 2008; Unni, Chauhan, Raju, & Bawa, 2011; Kikuzaki, 2000).

Ginger (*Zingiber officinale*) is the underground rhizome of the ginger plant with a firm, striated texture. It is among the oldest cultivated horticultural crops and is a common food additive in a number of foods and beverages. It is valued for its volatile components especially the aromatic compounds which give a spicy, pungent and pleasant smell and for its medicinal properties and is therefore a constituent of many pharmaceutical preparations (Masuda, Kikuzaki, Hisamoto, & Nakatani, 2004). It is a rich source of several phyto-nutrients which confers on it the ability to combat a number of diseases including cancer, coronary heart disease, and obesity, hypercholesterolemia, hypertension and gastrointestinal distress, etc. (Govindarajan, 1982). Though drying is the common method of preservation for spices, for ginger, these drying methods have not been very successful due to problems such as poor colour and flavour of the final product, loss of volatile matters, poor rehydration properties etc. leading to poor acceptance by consumers. Ginger is preserved in various forms including pastes, purees, juice, powder, candies, pickles and oleoresin. Quality of ginger products is evaluated on the basis of their sensory characteristics mainly colour, flavour, and pungency. Reports exist with regards to the preservation of this condiment paste using thermal processing and by use of chemical additives (Ahmed & Shivhare, 2002; Ahmed, 2004; Topno et al., 2013). It is well known fact that thermal processing leads to significant losses in phytonutrients, flavour, texture etc. in food materials. Therefore, the present work was carried out to evaluate the quality changes of pressurized ginger paste during a storage period of 6 months under refrigerated conditions.

2. Materials and methods

2.1. Raw materials and pre-treatments

Ginger samples were obtained from local market of Mysore, India and manually peeled and then pulverized in a high speed mixer (Preethi Heavy Duty mixer grinder, Model no. MG142, Bangalore, India) to yield fine paste. The pastes were mixed with ascorbic (200 mg kg^{-1}) and citric acid (400 mg kg^{-1}) followed by packing in low density polyethylene pouches (75 μm thickness, 50 g pack size) and stored at 6 ± 1 °C and 80–85% RH.

2.2. High pressure processing

A laboratory scale high pressure food processing system (ISO-LAB FPG9400, Stansted Fluid Power Ltd., Stansted, UK) consisting of a high pressure vessel (2 l capacity) with dual high pressure pumps and pressure intensifiers which work simultaneously were used to achieve and maintain the desired pressure (200–600 MPa) in the pressure vessel. The system had a maximum operating pressure of 1000 MPa with provisions for temperature and time variation. The high pressure vessel was surrounded by a liquid circulating jacket connected to a heating–cooling system. The pressure transmitting fluid used was 30% mono-propylene-glycol (supplied by M/S Hydraulicon Systems, Ahmedabad, India). The ramp rates for pressurization and decompression were set at 600 and 1000 MPa min^{-1}, respectively. The initial temperature increase during pressure build-up (approximately 2–3 °C/100 MPa) was taken into consideration in order to achieve the desired operating temperature during pressurization. Pressure and temperature were constantly monitored and recorded (at 1 s intervals) during the process using SCADA based software (Stansted Fluid Power Ltd., Stansted, UK). The condiment pastes samples (50 g) were processed at 200, 400 and 600 MPa pressures for a period of 5 min at 30 °C.

2.3. Thermal processing

Flexible polyethylene bags filled with the sample (50 g) were immersed in a water bath (Medica Instrument Mfg Co., Mumbai, India) for isothermal pasteurization at 90 °C for a time of 5 min.

2.4. Physico-chemical analysis

The pH of the samples was measured using a pH meter (Century, Model CP931, Bangalore, India). Ten gram of ginger paste was added into a 250 ml conical flask, and four drops of phenolphthalein indicator was added. This was titrated with the standard 0.1 N NaOH to faint pink point. The titre for total acidity was expressed as g citric acid l^{-1} (Ranganna, 1999).

2.5. Total phenolics

Total phenolics were estimated by the method described by Singleton and Rosi (1965). Ten grams of sample extract were diluted to 100 ml with distilled water and 1 ml of Folin reagent was added to a 5 ml aliquot. After 6 min, 10 ml of 7% Na_2CO_3 was added and the volume was made up to 25 ml with distilled water followed by incubation at room temperature for 90 min in the dark. The absorbance was read at 750 nm against a reagent blank.

2.6. Total flavonoids

Total flavonoids were estimated using the method described by Zhishen, Mengcheng, and Jianming (1999). 15 g of sample extract was dissolved in distilled water and the volume was made up to 100 ml with distilled water. A 5 ml aliquot was taken and 0.3 ml of $NaNO_2$ (5%) was added, followed by the addition of 0.3 ml of $AlCl_3$ (10%) after 5 min. At sixth minute, 2 ml sodium hydroxide (1 N) was added and the volume was made up to 10 ml with distilled water and absorbance was read at 510 nm against reagent blank.