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Influence of High Hydrostatic Pressure on Vitamin C, Beta-carotene Retention, Residual Polyphenol Oxidase and Peroxidase Activity, Antioxidant Capacity and Overall Acceptance of Mango (*Mangifera indica*) Juice

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ABSTRACT

High hydrostatic pressure (HHP) has been considered as one of the most innovative technologies widely applied in food processing by its superior advantages to other conventional processing methods. HHP destroys vegetative cells and inactivates enzymes with an insignificant modification in the organoleptic attributes. Mango (*Mangifera indica* L.) juice is a healthy food drink highly appreciated by its sweet-sour taste and high nutritional components. It's commonly treated by thermal treatment to inactivate microbial and enzyme activity to achieve a long stability in storage and distribution. However, heat seriously affected to sensitive phytochemical components as well as organoleptic properties. Mango juice was treated with hydrostatic pressure under different conditions (150/30, 200/25, 250/20, 300/15, 350/10, MPa/min) to evaluate vitamin C (mg/100g), beta-caroten (µg/g) retention; residual polyphenol oxidase and peroxidase activity (%); free radical scavenging activity (% DPPH), ferric reducing antioxidant power (FRAP, µg/mL); overall acceptance of mango juice. Results showed that vitamin C, beta-caroten, free radical scavenging activity (% DPPH), ferric reducing antioxidant power (FRAP, µg/mL) were highly maintained at 250 MPa in 20 minutes while the residual polyphenol oxidase and peroxidase activity (%) were kept in the highest level. Under the hydrostatic pressure treatment, mango juice also had good overall acceptance. Therefore HPP treatment at 250 MPa/20 min would be ideal in making of mango juice.

KEY WORDS: BETA-CAROTEN, DPPH, FRAP, HYDROSTATIC PRESSURE, MANGO JUICE, PEROXIDASE, POLYPHENOLOXIDASE.

INTRODUCTION

Thermal treatment is a conventional method to inactivate microbial organisms and enzymes in fruit juices; however, heating also causes negative impacts on vitamin C, speeds up decomposition of bioactive constituents, and decreases physicochemical attributes as well as sensory, functional and nutritional values, (Suh et al. 2004; Ndiaye et al. 2009; Patras et al. 2010; Zhang et al., 2016). High hydrostatic pressure (HHP) is one of non-thermal innovative emerging methods not only satisfying the Pasteurization but also significantly maintaining phytochemical components inside fruit juice by the lower processing temperature (Allenda et al. 2006; Rawson and Patras 2011).

Different literatures in the recent past have mentioned that HHP is effective in inactivating microorganisms as

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well as retention of physicochemical characteristics of strawberry juice (Ferrar et al. 2011), pomegranate juice (Varela-Santos et al., 2012), blueberry juice (Barba et al. 2012), apricot, peach, and pear (Anthoula et al., 2014), strawberry juice (Xiamin et al., 2014), beetroot (Paciulli et al., 2016), carrot juice (Zhang et al., 2016), jabuticaba juice (Kim et al., 2017), apple juice (Nayak et al., 2017), grape juice (Chang et al., 2017), mulberry juice (Engmann et al., 2020).

Moreover, high hydrostatic pressure also enhanced antioxidant activity, polyphenol content, flavor, taste and overall acceptability of these juices in comparison to non-pressurized or thermally processed samples. HHP could accelerate the extractability of bioactive elements from food matrix by causing microstructural modification in plant tissues, thus favoring the release of these components (Vázquez-Gutiérrez et al., 2011; Vázquez-Gutiérrez et al., 2013; Xi and Luo, 2016). HPP causes physical damage to the structures of food products, it can also be used as a synergistic extraction technology to enhance the extraction efficiency of functional components, thereby reducing extraction time (Hsiao-Wen et al., 2020). HHP technology offers an effective and safe method of modifying protein structure, enzyme inactivation, and formation of chemical constituents (Gezai et al., 2019).

Mango (*Mangifera indica* L.) has favourable nutrient properties as a source of phenolics, carotenoid, vitamin C, excellent flavour, aroma and colour. It is rich in bioactive molecules protecting human cells from the detrimental effect of free radicals. This fruit is rich in antioxidants potentially reducing the risk of cardiac disease, anti-diabetic, anticancer, anti-inflammatory and antiviral activities (Abbasi et al., 2011; Kalpn et al., 2016; Masud et al., 2016). Because of high perishability, mango fruit becomes rotten quickly and preservation is very essential to make it available for a long stability (Sajeda et al., 2018). Objective of our study focused on the vitamin C (mg/100g), beta-carotene (µg/g) retention; residual polyphenol oxidase and peroxidase activity (%); free radical scavenging activity (% DPPH), ferric reducing antioxidant power (FRAP, µg/mL); overall acceptance of mango juice under high hydrostatic pressure under different conditions (150/30, 200/25, 250/20, 300/15, 350/10, MPa/min).

MATERIAL AND METHODS

Material: Fully ripen raw mango fruits were collected from Soc Trang province, Vietnam. After washing thoroughly with clean water, the fruits were peeled by sharp knife. They were cut into small pieces and then pressed by a screw extractor. The juice was obtained from the filter. The juice was centrifuged at 2000g for 10 min to remove fine solid particles.

Method: Mango juice was filled into polyethylene terephthalate bottles with screw-cup closures. These bottles were placed a hydrostatic pressurization unit. Different conditions (150/30, 200/25, 250/20, 300/15, 350/10, MPa/min) were examined to evaluate vitamin C, beta-carotene retention; residual polyphenol oxidase and peroxidase activity; (%); free radical scavenging activity (% DPPH), ferric reducing antioxidant power (FRAP, µg/mL); overall acceptance of mango juice.

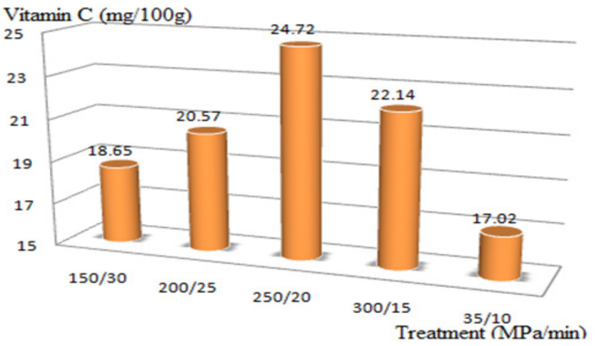
Physicochemical and sensory analysis: Vitamin C (mg/100g) was determined by using 2,6 dichlorophenolindophenol titration as described in the AOAC (2015). Beta-carotene content (µg/g) was analyzed by using high performance liquid chromatography (Nauman et al., 2007). Residual polyphenol oxidase (%) and peroxidase (%) activities were assayed using UV spectrophotometry method proposed by Engmann et al. (2020). DPPH (%) was conducted according to Bakar et al. (2015). FRAP (µg/mL) assay was performed by procedure of Benzie and Strain (1996). Overall acceptance of mango juice was evaluated by a group of panelists using 9 point-Hedonic scale.

Statistical analysis: The experiments were run in triplicate with three different lots of samples. The data were presented as mean ± standard deviation. Statistical analysis was performed by the Statgraphics Centurion version XVI.

RESULTS AND DISCUSSION

HPP application resulted in an instantaneous and uniform transmission of the pressure throughout the product independent of the product size and geometry (Ramirez-Suarez and Morrissey, 2006). As HPP only influenced non-covalent bonds, such as hydrogen bonds, ionic bonds, and hydrophobic bonds, it induced changes in the physicochemical properties and functional activities of biomacromolecules in food products, and even resulted in protein denaturation, enzyme deactivation, and microbe inactivation. In contrast, low molecular weight compounds, such as flavor substances, natural nutrients, and aromatic components, were not affected by HPP (Martinez-Monteagudo and Saldana, 2014).

Figure 1: Effect of HPP treatment (MPa/min) on vitamin C (mg/100g) of mango juice



In our research, bottles of mango juice was treated by HPP under different parameters (150/30, 200/25, 250/20, 300/15, 350/10, MPa/min). Results revealed that vitamin C (mg/100g), beta-carotene (µg/g), free radical scavenging activity (% DPPH), ferric reducing antioxidant power (FRAP, µg/mL) were highly maintained at 250 MPa in 20 minutes while the residual polyphenol oxidase and peroxidase activity (%) were kept in the highest level. Under the hydrostatic pressure treatment, mango juice also had good overall acceptance (figure 1-7). Yen and Lin (1996) reported that 11.32% of ascorbic acid in strawberry coulis decreased after HHP treatment at 400 MPa/20°C/30 min.

Figure 2: Effect of HPP treatment (MPa/min) on beta-carotene (µg/g) of mango juice

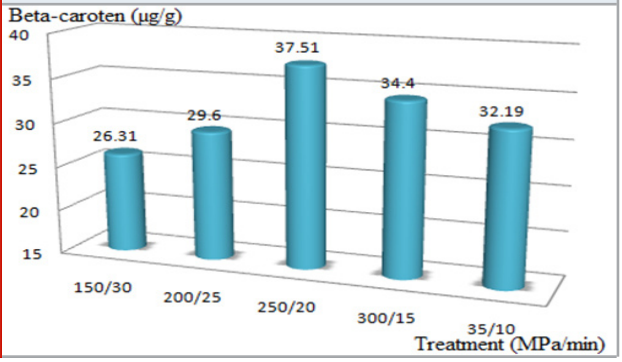


Figure 3: Effect of HPP treatment (MPa/min) on DPPH (%)of mango juice

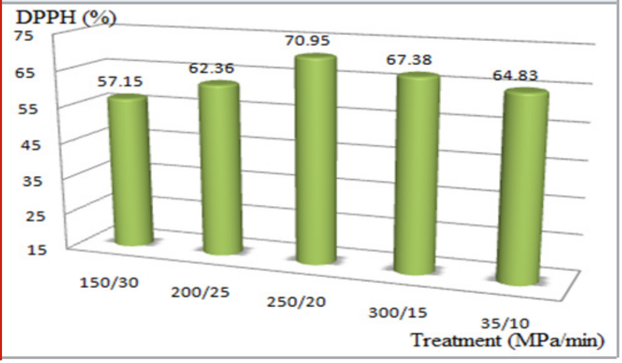
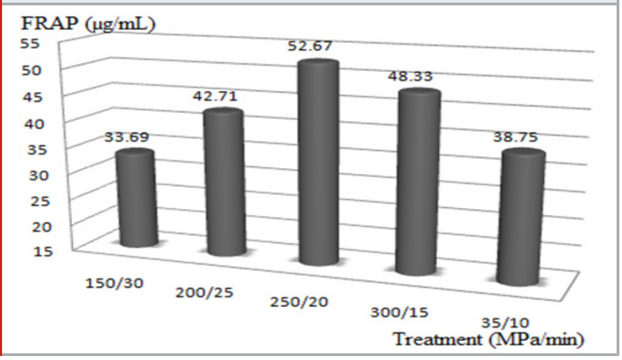


Figure 4: Effect of HPP treatment (MPa/min) on FRAP (µg/mL) of mango juice



HHP can improve cell permeability due to its aptitude to deprotonate charged groups and disrupt salt bridges and hydrophobic bonds in cell membranes; therefore, the extraction of polyphenols from pulp particles is more accessible, (Xiamin et al., 2014). Antioxidant activity of strawberry and blackberry purees was reduced by 25% by thermal processing but there was only 5% reduction treated by HPP with better antioxidants and ascorbic acid retention, (Gezai, 2019).

Figure 5: Effect of HPP treatment (MPa/min) on residual PPO (%) of mango juice

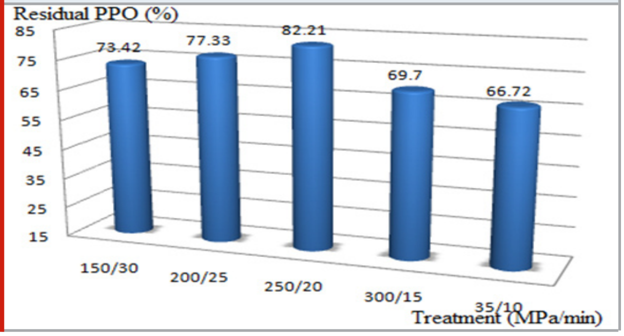


Figure 6: Effect of HPP treatment (MPa/min) on residual PO (%) of mango juice

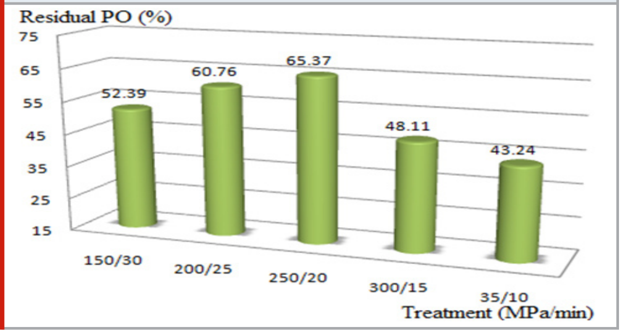
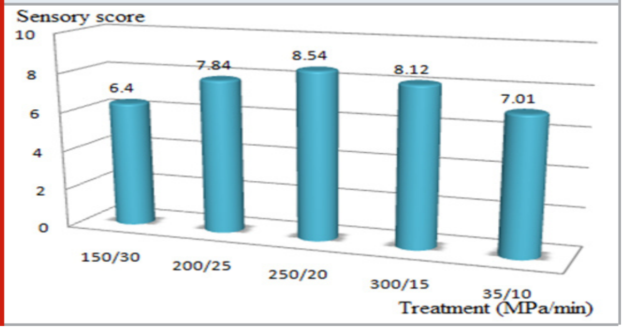


Figure 7: Effect of HPP treatment (MPa/min) on sensory score of mango juice



Aaby et al. (2018) proved that HPP did not result in significantly different vitamin C contents in strawberry juice. Andrés et al. (2016) showed that the total carotenoid content of soy-smoothies increased after HPP (650 MPa/3 min). Ali et al. (2019) demonstrated that HPP resulted in a substantial retention of vitamin C content of wheatgrass juice. Some studies reported that HHP could not effectively inactivate polyphenol oxidase, peroxidase in fruits and vegetables (Goodner et al., 1999; Corredig et al., 2002; Baron et al., 2006; Dalmadi et al., 2006). The antioxidant capacity in mango juice after HHP treatment was evaluated using•DPPH and FRAP methods. Phenolic compounds were responsible for antioxidant capacities in fruits, and the fruits with higher phenolic contents generally showed stronger antioxidant capacities. Sánchez-Moreno et al. (2006) indicated that total scavenging activity (DPPH) in aqueous and organic fractions of tomato puree was unaffected by HHP treatment at 400 MPa/15 min/25°C.

Chaikham and Prangthip (2015) found that DPPH radical inhibition (%) and FRAP value (mMFeSO4/g) revealed a higher antioxidant capacity in pressure-treated longan flower-honey. González-Cebrino et al. (2016) proved that HHP influenced the volatile constituents of red plum purée. Hartyáni et al. (2011) and Ferrari et al. (2010) demonstrated that the aroma of HHP-treated citrus and pomegranate juices, could be significantly different from that of the fresh juice. Oey et al. (2008) suggested that HHP resulted in slightly modified organoleptic properties. Engmann et al. (2020) demonstrated that hydrostatic pressure treatment at 200 MPa in 10 min showed a better inactivation of enzyme activity, higher conservation of anthocyanin of the mulberry juice.

CONCLUSION

High hydrostatic pressure is an innovative processing strategy that includes subjecting fruit juice to high isostatic pressures, causing microbial and enzyme inactivation to ensure improvement of food safety and stability of perishable components, while maintaining nutritional, functional and organoleptic properties. Consumers are demanding minimally processed and fresh food products, the application of non-thermal techniques like HHP is gaining popularity.

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Conflict of Interest: The authors declared that present study was performed in absence of any conflict of interest.

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