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Application of fuzzy logic technique for sensory evaluation of high pressure processed mango pulp and litchi juice and its comparison to thermal treatment

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ABSTRACT

Sensory attributes of high pressure processed (200, 400, and 600 MPa/20, 27 (ambient temperature), 40 and 60 °C/10 min (fixed)) mango pulp (*Mangifera indica* cv. Amrapali) and litchi juice (*Litchi chinensis* cv. Bombai) were evaluated and compared with untreated and thermally treated (0.1 MPa/95 °C/10 min) samples using fuzzy logic. A semi-trained panel of judges analyzed the samples for various sensory attributes viz., color, aroma, body, taste, aftertaste, mouthfeel, and appearance. Judges' preference on the importance of sensory attributes was obtained as crisp numbers instead of linguistic variables, using the 5-point fuzzy logic scale. Sensory quality of samples was then compared based on estimated overall sensory scores, overall membership function, similarity values, ranking of the samples, and quality attributes.

The sensory attributes of mango pulp and litchi juice were found to be dependent on product type and process severity. In general, high pressure processed samples had higher likeness than their thermally processed counterparts. The sensory acceptance of high pressure treatment was similar to fresh litchi juice, irrespective of the applied pressure/temperature level, whereas severe deterioration was observed after thermal treatment. In case of mango pulp, 600 MPa/60 °C emerged as the upper boundary limit beyond which HPP considerably affected the sensory attributes of the product, whereas no such effect was seen in litchi juice. Among the tested attributes, "taste" was adjudged extremely important sensory characteristic for both mango pulp and litchi juice. Further, the changes in sensory attributes of both fruit products upon processing were correlated to changes in physico-chemical parameters, viz., color, pH, total soluble solids and phenolics content.

Industrial Relevance: Fruit consumption has increased in the recent years, among which tropical fruit-based products, such as mango pulp and litchi juice, have gained huge popularity. High pressure processing has emerged as an alternate to thermal processing for preservation of fruit products. Many aspects of HPP have been studied; however, information regarding sensory characteristics is scarce. This study aims at reducing this information gap which will assist in product and process development.

1. Introduction

Sensory evaluation is the ultimate criteria for judging the quality of food. It is important for product development and comparison of similar kinds of food. It provides useful information to the food industry and scientists about the sensory characteristics of food (Chakraborty, Das, & Das, 2013). Sensory evaluation of food is characterized by imprecision, inaccuracy, and uncertain repeatability. Nonetheless, the evaluation of the sensory quality of processed foods especially the ones treated by novel processing technologies, such as high pressure processing (HPP), is a very important factor because it influences consumer acceptance of the product. Extensive research has been carried out to assess the effect of HPP on sensory quality of fruits due to their vast popularity. It is commonly assumed that the fresh flavor of fruits is not altered by HPP, since the structure of small molecular flavor compounds is not directly affected by high pressure (Oey, Lille, Van Loey, & Hendrickx, 2008). It is a major advantage for fruit puree or juice processing as it fulfills the consumer demand for "healthy, nutritious, and natural" products.

Takahashi, Ohta, Yonei, and Ifuku (1993) observed no changes in the sensory quality of Mandarin juice after applying high pressure (400–600 MPa/25 °C/5 to 30 min) in comparison with fresh juice. Parish (1998), using a trained panel, concluded that the flavor of high-pressure-treated orange juice (500–900 MPa/60 °C/1 s to 10 min) was better than heat-treated ones (75–98 °C/10 s). Yen and Lin (1999) found similar aroma of guava puree after high pressure treatments (600 MPa/25 °C/15 min) as the untreated sample, whereas unpleasant flavors were

Abbreviations: EVOH, Ethyl vinyl alcohol copolymer; GAE, Gallic acid equivalents; HPP, High pressure processing; TCD, Total color difference; TP, Total phenolics; TSS, Total soluble solids.

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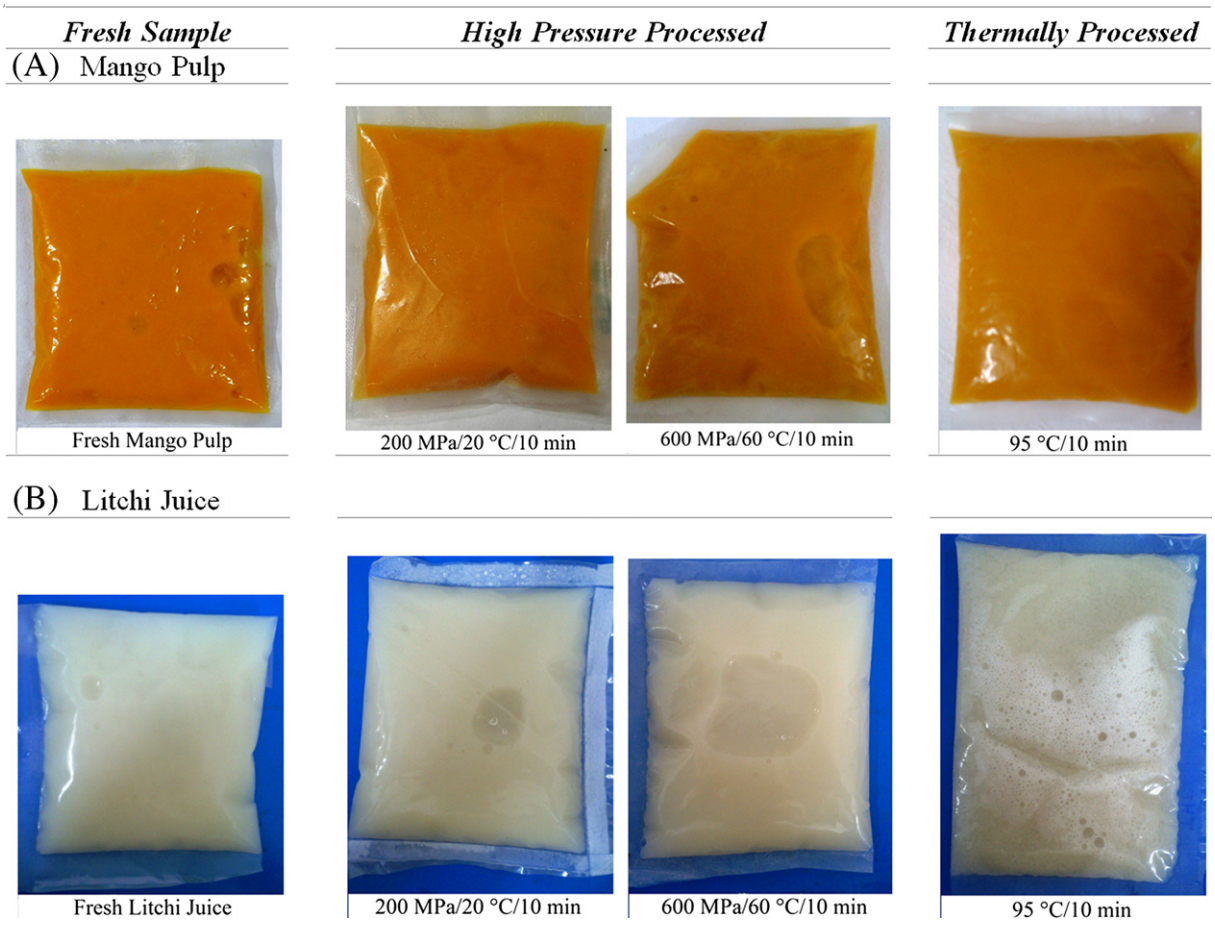

Fig. 1. Visual appearance of fresh and representative mango pulp and litchi juice samples.

reported in heat-treated (95 °C/5 min) puree. They also reported the effects of storage (4 and 25 °C) on volatile flavor components of these samples, where refrigerated temperatures stabilized the sensory changes. Polydera, Stoforos, and Taoukis (2003, 2005) reported that HPP of orange juice (500 MPa/35 °C/5 min and 600 MPa/40 °C/4 min) resulted in lower flavor loss and superior sensory characteristics compared with thermal pasteurization (80 °C/30 to 60 s). On the other hand, Baxter, Easton, Schneebeli, and Whitfield (2005) observed similar concentration of volatile flavor compounds in freshly frozen, heat-treated (85 °C/25 s) or high-pressure-treated (600 MPa/18 to 20 °C/60 s) orange juice.

Most of these studies used trained or semi-trained panel for objectively assessing the sensorial quality of high-pressure-treated fruit products. Though sensory analysis experiments are time-consuming and vulnerable to individual bias, till date, they remain the most used and reliable test for assessing sensory properties of foods. Both affective and descriptive tests are employed for sensory testing of foods such as 9-point hedonic scoring, triangle test, descriptive analysis, fuzzy logic, and so on. The advantage of affective sensory tests is that they provide a direct link between the consumer preference and product development process.

Table 1
Fuzzy logic sensory score cord based on 5-point scale.

Part 1: Taste each of the samples and rate them according to the linguistic variables given below against each quality attribute.						
	1. Excellent	2. Good	3.Medium	4.Fair	5.Not satisfactory	
Sl. No	Quality Attribute	*Sample 1*	*Sample 2*	*Sample 3*	*Sample 4*	*Sample 5*
1	Color					
2	Appearance					
3	Texture/body					
4	Aroma					
5	Taste					
6	Mouth feel					
7	After taste					

Part 2: Based on your own taste regarding the given product give marks for each of the quality attributes out of 100							
0–20: Not at all important;			20–40: Somewhat important;			40–60: Important;	
60–80: Highly important;			80–100: Extremely important.				
Quality attribute	Color	Appearance	Texture/body	Aroma	Taste	Mouthfeel	After taste
—/100							