Does High Pressure Really Preserve Pineapple Juice Sensory Attributes?

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Abstract
Pineapple is a well appreciated fruit worldwide due to its distinct sensory characteristics. Brazil is the fourth world pineapple producer, presenting a seven fold increase in the pineapple juice exportation in the last five years. Consumers are looking for products with nutritional and sensory characteristics similar to the fresh ones, as well as microbiological safety. High Hydrostatic Pressure (HHP) is an innovative technology capable of inactivating pathogenic and deteriorating microorganisms, while minimizing loss of sensory and nutritional product quality. The objective of this study was to characterize, by Quantitative Descriptive Analysis (QDA), pineapple juices obtained from the pressurized pineapple purée (HHP), the in natura purée, and four different commercial products available in the Brazilian market. Eleven selected and trained assessors evaluated the samples following the QDA procedures. The data were analyzed using ANOVA and PCA. The QDA elicited 17 attributes as follows: three for appearance; six for aroma; six for flavor and two for consistency. QDA revealed high similarity between the pineapple juice sensory attributes obtained from the in natura and the pressurized purées, both differing (p<0,05) in many attributes from the commercial pineapple juices evaluated in this study. The main sensory attributes which characterized the pressurized and in natura juices were: characteristic pineapple juice color, natural pineapple juice aroma; natural pineapple juice flavor; consistency, fiber presence (visually perceived), and fiber presence (perceived in the mouth). These results suggest that HHP may be successfully used to preserve pineapple puree, yielding an improved sensory quality juice, compared to those commercially available.

Keywords: high hydrostatic pressure, pineapple juice, sensory evaluation

1. Introduction

Brazil is the fourth world pineapple producer, presenting a seven fold increase in the pineapple juice exportation in the last five years [1]. Pineapple is a tropical fruit with a unique taste and aroma. It may be consumed in natura or processed in many different ways, being juice the most popular product in Brazil [2]. The pineapple juice can be processed using heat, however, associated with the thermal treatment are the changes on sensory and nutritional characteristics, which may lead to consumer dissatisfaction [3].

Consumers are looking for foods easy to prepare and with sensory and nutritional characteristics similar to the fresh products. Emerging technologies have been investigated to replace or complement conventional alternatives employed in food processing. The main
requirement that these new technologies must meet is to ensure product microbial safety, while preserving sensory and nutritional characteristics [4-7]. The High Hydrostatic Pressure (HHP) is a technology that can achieve these goals, destroying food-borne pathogens and inactivating enzymes, while minimising loss of sensory and nutritional product quality [8 - 10,11]. Food researchers are exploring high-pressure processing to determine the adequate process conditions for a wide variety of food, such as citrus juice, dairy products, jams meat, fish and eggs [12]. The technology has been considered as an effective alternative to the thermal processes currently used in juice pasteurisation.

The consumer acceptance is the main challenge for the food industry [13], and to achieve success in new product development is an essential issue to all food companies [14]. Thus, to evaluate a new product obtained by this emerging technology is essential to investigate its sensory characteristics. The objective of this study was to characterise pineapple juices obtained from the pressurised pineapple purée (HHP), the in natura purée, and four different commercial products available in the Brazilian market.

2. Material & Methods

2.1 Pineapple Purée and Its Pressurization

Pineapple purée (Ananas comosus (L.) Merrill) variety Smooth Cayenne produced in a commercial fruit juice industry in Minas Gerais, Brazil, was used in this study. The purée was taken from the processing line before thermal treatment, immediately frozen in polyethylene recipients in an air forced circulation freezer, transported and kept at –18º C until use. The purée presented the following physicochemical characteristics: 10.6ºBrix; pH = 3.56; total acidity expressed as g of citric acid/100g of purée = 0.64; total solid content in g/100g of purée = 13.18; determined according to AOAC [15].

Pressurization of samples was carried out using a Stansted Food Lab 9000 (Stansted Fluid Power Ltd., England) isostatic high pressure chamber. The chamber temperature was controlled by a water bath, the water circulating through the chamber jacket. The come-up rate was approximately 200 MPa/min and the depressurization was instantaneous. The pineapple purée was packed in polyethylene bags, heat sealed and kept at 4ºC prior to pressurization treatment. Experiments were held at 300MPa during 5 minutes at 25ºC.

2.2 Sensory Evaluation

Thirty-two participants were invited to participate in the study and 14 were selected using samples of pineapple juice and triangle tests. After assessor selection, several sessions were conducted to establish the list of attributes which best described samples, as well as their definitions and the reference terms, for the elaboration of the evaluation cards. A wide diversity of pineapple juice was used in order to facilitate the development of descriptive terms. Synonymous and related terms were then reduced as a result of consensus among assessors. Panel members participated in several sessions aimed at ensuring a homogeneous interpretation of the meaning of the terms, and at fixing scale limits and reference values for sensory attributes. Training sessions were performed daily employing score cards containing the consensual descriptive terms, using the following anchor terms: “weak”, “little” or “absent” for the left anchors and “strong” or “much” for the right anchors.
Assessors performance evaluation was carried out by collecting data from three different sessions. During each session, seven different juices were evaluated by assessors for all sensory attributes. The final sensory panel was then identified based on discrimination among samples, panel scoring reproducibility and agreement, using Analysis of Variance (ANOVA) with two factors - samples and sessions for each attribute and assessor.

Samples comprising *in natura* pineapple juice (IN), pressurized (300 MPa/5 min/25°C) pineapple juice (HHP), and four commercial thermally processed juices (C, D, E and F) available in the Brazilian market were evaluated in this study, following standard QDA procedures [17]. In profiling, the six juice samples were monadically scored in triplicate, following a balanced presentation order design [16]. For appearance and aroma evaluation, samples were presented at room temperature and under white lightning in capped glass tubes and capped Erlenmeyer flasks, respectively, coded with three digit numbers. For the evaluation of aroma, flavor and consistency samples were served at room temperature in 50 ml transparent plastic cups coded with three digit numbers, under red lightning.

Water and unsalted biscuit were provided for cleansing the palate. Score cards were prepared and each selected and trained assessor evaluated the intensity of each descriptor placing a mark in an unstructured 9 cm line scale, anchored with the words “weak”, “little” or “absent” and “strong” or “much” as already stated [17]. The data were analyzed using ANOVA, employing SAS [18] and Principal Components Analysis (PCA), using XLSTAT-MX [19].

3. Results and Discussion

The data of nine assessors were kept for the QDA of pineapple juice based on their sensory ability. QDA procedure elicited 17 attributes as follows: three for appearance; six for aroma; six for flavor and two for consistency. The descriptors for appearance were: characteristic pineapple juice color, fiber presence, particle presence; for aroma: natural pineapple juice, artificial pineapple juice, sweet, sour, cooked, fermented; for flavor: natural pineapple juice, artificial pineapple juice, sweet, sour, cooked, fermented; for consistency: fiber presence and consistency. One can notice that the attributes aroma and cooked flavor, aroma and artificial pineapple juice flavor, particle presence and aroma and fermented flavor are associated to pineapple fruit juice defects.

Table 1 presents the sensory attribute means of the six pineapple juices evaluated in this study. QDA revealed high similarity between the pineapple juice sensory attributes obtained from the *in natura* purée and the pressurized purée, both differing (p<0.05) in many attributes from the commercial pineapple juices evaluated in this study. No significant difference (p>0.05) was observed between the *in natura* and the pressurized juice, considering all the investigated attributes. This result suggests that the pressurization was not able to destroy covalent bonds, keeping the molecules responsible for taste, flavor and color of pressurised pineapple juice similar to the *in natura* one [10-11].

The main sensory attributes which characterized the pressurized and *in natura* juices were: characteristic pineapple juice color, natural pineapple juice aroma; natural pineapple juice flavor; consistency, fiber presence (visually perceived), and fiber presence (perceived in the mouth). Very few articles available in the literature addressed the sensory evaluation of products processed by HHP, especially by QDA [20, 21, 22], and no reference regarding pressurized pineapple juice was found. Boyton et al. [20] worked on mango cubes,
comparing *in natura* and pressurized (300MPa/1min and 600MPa/1min) samples. The results showed a significant difference (p≤0.05) between samples, differently from the findings presented in this study.

<table>
<thead>
<tr>
<th>Table 1. Pineapple fruit juice sensory attribute means*</th>
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<td><strong>Appearance</strong></td>
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<td>Particle presence</td>
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<td><strong>Aroma</strong></td>
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<td>Fibre Presence</td>
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*Means in the same line followed by different letters imply a significant difference (p≤0.05) according to Tukey test. **Minimal significant difference.

Gárcia et al. [21] investigated orange juice and a mix of orange, lemon and carrot juice. The authors compared the *in natura* sample with the pressurised one (500MPa/5min and 800MPa/5min). Results revealed a significant difference (p≤0.05) in the attributes among pressurised samples (500MPa/5min and 800MPa/5min) in relation to the control (*in natura*), for both juices. These results differed from the present study as the *in natura* and the pressurised juices had similar sensory characteristics.

According to Borgognone, Bussi and Hough [23] the Principal Component Analysis (PCA) is an extremely used tool in sensory analysis. Figure 1a shows the position of the six pineapple juices, and Fig. 1b the sensory attributes, in the space defined by the first and second PC dimensions. The first and second dimensions accounted for by 93.76% of variations.

The first dimension separated the evaluated samples in three groups. The first contains the *in natura* and pressurised juices, confirming the high similarity between those two products. In the second group are samples C, E, and F. Juice D appears isolated in the space. This analysis and the QDA stressed the importance of the sensory attributes: characteristic pineapple juice color, natural pineapple juice aroma; natural pineapple juice flavor;
consistency, fiber presence (visually perceived), and fiber presence (perceived in the mouth), for the characterization of the pressurized and in natura juices.

![Figure 2](image-url)

**Fig. 2.** Space of pineapple juices defined by the first two Principal Components: (a) position of samples; (b) position of sensory attributes. IN: in natura pineapple juice; HHP: pressurized pineapple juice (HHP); A – D: commercial juices.

### 4. Conclusion

The QDA demonstrated the similarity between the in natura (IN) and pressurized (300 MPa/5 min/25°C) pineapple juice (HHP). These results suggest that HHP can be
successfully used to preserve pineapple purée, yielding an improved sensory quality juice, compared to commercially available pineapple juices.

5. References