

Application of high pressure technology in the fruit juice processing: benefits perceived by consumers

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Abstract

The use of high hydrostatic pressure in food processing is of great interest because of its ability to inactivate food borne microorganisms and enzymes, at low temperature, without the need for chemical preservatives. Pressure-treated foods have sensory properties similar to fresh products, which is a major advantage in juice processing as it matches consumer demand for healthy, nutritious and “natural” products. However, an important issue rises when we consider the acceptance of such products by the consumer. This paper discusses the use of pressure processing in fruit juice production from a consumer perspective, focusing on the Brazilian consumer perception and attitude, with respect to information presented on the fruit juice label about the technology. The results have shown that when the technology advantages were presented on pineapple juice labels, participants understood the benefits, and expressed a higher product intention to purchase.

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1. Introduction

Emerging technologies have been investigated to replace or complement conventional alternatives employed in food processing. Such technologies include high hydrostatic pressure, ohmic heating, pulsed electric fields, micro-wave heating, gamma irradiation and ultrasound. The main requirement that these new technologies must meet is to ensure product microbial safety while preserving sensory and nutritional characteristics to obtain products more similar to fresh foods. In pasteurization, sterilization and bleaching, the use of heat can destroy nutrients such as thermally labile vitamins and also components responsible for product flavor and taste. It can also produce some undesirable

compounds originated from Maillard reaction and caramelization. High hydrostatic pressure, alone or in combination with moderate heat treatment, has been investigated to obtain products of high quality and micro-biological stability (Cheftel, 1995).

Despite the recognized advantages of the pressurized products, a positive consumer attitude towards them is necessary, to guarantee the success of the product in today's competitive global market, where the new food product innovation is required for survival. In this sense, emerging and improved technologies are increasingly being used in food innovation to successfully differentiate products (Stewart-Knox & Mitchell, 2003). The knowledge that a product success is dependent upon the product being unique and superior; good understanding of consumer wants, needs and preferences was established during the late 1970s (Calatone & Cooper, 1979), and needs to be kept in the food processor's mind.

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This paper focuses on consumer perception of pressurized fruit juices and hypothesizes that consumer attitudes are very much driven by perceptions of benefits associated with specific applications.

2. High pressure technology in the food processing

Hite carried out at the end of 19th century the first experiments on the application of high pressure to foods. He demonstrated that the shelf-life of raw milk could be extended by about 4 days after pressure treatment of 600 MPa for 1 h at room temperature (Farkas & Hoover, 2000). Although high pressure processing—HPP—experiments continued during the 20th century, it was the 1990s when the study of this technology expanded with the implementation of the **Japanese Program on High Pressure Technology** applied to food processing. The Program involved the participation of Japanese companies, universities and research institutes. As a result, the technical and scientific knowledge about the technology improved significantly, leading to the commercial application of the technology for the preservation of products such as **fruit juices, salad dressings, sauces, seafood, jams and jellies** (Meyer, Cooper, Knorr, & Lelieveld, 2000). Following the Japanese initiative, European and North-American universities, companies and research institutes have also begun to investigate HPP (Alemán, 1998; Alemán et al., 1996). In several countries, **high pressurized food is produced and commercialized, including fruit juices, guacamole and Mexican sauces** (Butz & Tauscher, 2002). HPP is considered a technology with the most promising perspective of industrial utilization (Farkas & Hoover, 2000; Hugas, Garriga, & Monfort, 2002). One of the main advantages of this process is the almost instantaneous and isostatic pressure transmission to the product, independent of size, shape, and food composition yielding highly homogenous products.

Besides destruction of micro-organisms (Smelt, 1998) there are further influences of pressure on protein denaturation or modification, enzyme activation or inactivation, changes in the properties of carbohydrates and fats (Butz & Tauscher, 2002; Rosenthal, Ledward, Defaye, Gilmour, & Trinca, 2002). Some research papers reported the use of high pressure to achieve sterility in low-acid foods using repeated processes of pressurization and depressurization (Hayakawa, Kanno, Yoshiyama, & Fujio, 2000; Meyer et al., 2000; Sojka & Ludwig, 1997).

The non-thermal pasteurization using high pressure is said to extend shelf-life, guarantee safety and maintain fresh quality (Cheftel, 1995). In a study carried out by Butz and Tauscher (2002), in the pressurized orange juices, changes in aroma, flavor and overall quality were scarcely noticeable after 21 days of storage.

Further research is still needed on high pressure technology taking into account the technological aspects, as well as product safety related issues. However, the role of the consumer on the technology validation process is an important issue, and must be considered also. Technological developments have to be translated into products that are attractive to consumers. Similarly, changing consumer values and habits will stimulate food technology innovation aiming at the production of suitable new products. The interdependency between consumer needs and new technology research should be recognized by the food industry, but this is not systematically implemented yet. The interrelationship between technology and consumer behavior should receive more attention in the modeling of food product innovation. Consumer perception and preferences are the start points for the understanding of the interdependency between technology and managerial elements (Linnemann, Meerdink, Meulenberg, & Jongen, 1999).

3. Food packaging and labeling

Food packaging may be the first contact between the consumer and the product. **It protects the food, allowing a longer shelf-life, and may catch the consumer's attention and encourage purchase** (Deliza, 1996). Packaging and labeling of a food or beverage plays an important role in its selection because it is the major source of information for consumers, permitting them to make better choices in the marketplace (Food Australia, 1989; Sloan, 2003). Many studies dealing with different label aspects have been carried out, including food label legislation, brand name and its importance on food consumption, nutritional information and consumer attitude towards the product (Dailland-Spinnler & Issanchou, 1995; Fullmer, Geiger, & Parent, 1991; King & Cook, 1990; Light, Heymann, & Holt, 1992; McNeil, 1992). In addition, other studies have been conducted to determine the characteristics of consumers who read food labels, and the kind of information they seek on food and beverage labels (Crawford & Worsley, 1986; Mueller, 1991; Sloan, 2003).

According to Sloan (2003) the most successful new food products in recent years claimed a taste, flavor, texture, or recipe benefit. **The “fresh” remains the most desirable food label claim**, and about two-thirds of grocery shoppers say that a fresh claim is extremely/very important on food labels. Consumers also continue to look for positive health benefits and they desire to avoid artificial ingredients. Other aspects such as country-of-origin, certified organic, regional and local foods, and environmental concerns, have continued to rank high in public attention, revealing that those aspects have to be adequately communicated to consumers. Concern about biotechnology and genetically modified foods, as

well as irradiation are examples of how technology can affect consumer product perception, requiring appropriate consumer information through the label. The marketer decision about what to put on the label of a food or beverage is a hard task, which has to be achieved with the help of the consumer. The right communication between the food label and the consumer appears to be critical to success (Sloan, 2003).

Given the large literature that has been devoted to consumer perception of labels, it is therefore rather surprising that the role of the information about the used technology on consumer intention to purchase is not currently investigated, mainly when the technology—HPP—delivers products according to the needs of consumers, i.e., fresh, safe, and nutritional properties preserved.

4. HPP and the consumer

The development of healthy foods was rated as the most important area of research by a large majority of the companies interviewed followed closely by developing natural foods (Katz, 2000). The method of production is also of increasing concern to many consumers, who look for products similar to the natural ones. High pressure is a new food processing technology developed to achieve consumer demands for fresher products with reduced micro-biological levels and improved flavor (Khamrui & Rajorhia, 2000; Rosenthal & Silva, 1997; Swientek, 1999; Vardag, Dierkes, & Koener, 1995). The reason for being called *non-conventional*, *emerging*, or even *new* technology is because HPP treatment does not use heat to preserve the food. This non-thermal food preservation technique could have a large food industry impact due the benefits it can bring to products if these benefits are well communicated to consumers.

Studies examining consumer attitudes towards new technologies used in food production have shown that consumers are becoming increasingly interested in non-sensory food qualities in addition to recognizing the importance of the sensory properties of the product. Aspects such as nutritional quality, micro-biological safety, agrochemical residue and environmental pollution are

all examples of consumer concerns (Frewer, 1998). Within this context, the use of technologies which are harmless to the environment and do not add preservatives may contribute to perceptions of increased consumer benefits and satisfaction. Therefore, important issues to be investigated are consumer's opinions, beliefs, and attitudes towards the use of non-conventional technologies in food processing. A study with Brazilian consumers using focus groups was carried out to investigate the impact of the information about the use of high pressure in the fruit juice production on the consumer product perception (Deliza, Rosenthal, & Silva, 2003). Four focus group interviews were conducted with a total of 41 participants, 3 men and 38 women. Respondents were required to be supermarket shoppers. Three pineapple juice labels with different characteristics in terms of information on nutritional, sensory, and employed technology in the juice production were created specially for the study and used during the sessions as a tool for promoting a debate among participants (Fig. 1).

The results indicated that participants showed concern about the appearance and quality of labels in general, and revealed willingness to taste new products. They considered themselves loyal to brand, and some of them declared that brand would overcome price. Although price was not manipulated in this study, the majority of the participants in all four sessions mentioned price as an important attribute during their decision making process. This result confirmed previous work, particularly the study by Pecher and Tregear (2000) in which price was found to be the overwhelming factor dictating quality perception. Furthermore, consumers in this study pointed out that when they were not very familiar with the brand name, they very often read the label/package looking for information. This revealed a very important issue to food producers, since non-familiar brands could be promoted by providing consumer-relevant information about the product.

Results presented by Deliza, MacFie, and Hedderley (1999, 2003) demonstrated that consumers inferred product taste from the package/label, revealing many packaging attributes which affected product expectation and perception. Product information (e.g., nutritional, sensory, safety and ingredients), and as shown by Deliza

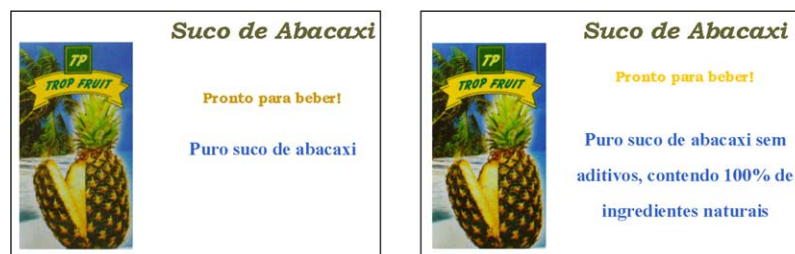


Fig. 1. Two of the labels used in the study.

et al. (2003), technology information appeared to be important package attributes. Effective communication between the producer and the consumer about food and nutrition relies on delivering messages that consumers find believable and that also convinces them that making healthy food choices is achievable (Borra & Earl, 2000). The issue of consumer benefit appears to be an important factor in determining acceptance, and reflects earlier research findings.

Deliza et al. (2003) found out that three out of four consumer groups perceived products as having higher quality when the package label included technology information. This action was perceived as reflecting a greater concern for the consumer by the food producer favoring the consumer selection of such products. The statement “*Saudável com mais sabor*”—healthy with more flavor—contributed to a more positive fruit juice perception in all interview sessions. A peculiar reaction was observed in one of the four consumer groups (housewives working for the administration of a food research institution). Although mentioning the technology—high pressure—caught their attention, such information was not sufficiently clear for these participants. As presented, they considered the information negative and affecting product acceptance leading to a low purchase intention. Although the other three consumer groups considered the technology information as having a positive effect on their product evaluation, the opinion of this fourth group should be considered during product label design. Certainly, an extra couple of words explaining the meaning and advantages of high pressure technology may lead to a higher product satisfaction, and contributing to the market introduction of a juice that offering higher nutritional and sensory qualities (Deliza et al., 2003).

5. Consumer-oriented technology—a case study using HPP

The impact of changes in consumer preferences and market economics on the necessary technological advances (Linnemann et al., 1999) was the key point for the development of the study here presented. Although the previous findings provided partial support to the claim that information on the technology used can be perceived as an advantage and benefit by consumers, their actual perception and preferences were the starting points for those studies. Several food industry research challenges relate to future consumer demands including sensory factors, nutritional values and product stabilization technologies, through the development of processes that combine inactivation of micro-organisms and enzymes with the preservation of sensory properties.

A study was carried out with 96 fruit juice consumers between 18 and 66 years living in the city Rio de

Janeiro—Brazil (Abadio, 2003). The aim was to quantitatively investigate the impact of several package attributes, including information on the fruit juice technology on consumer intention to purchase. Eighteen 200 ml pineapple juice packages were created following an incomplete factorial design with five attributes (brand, price, production type, product definition and technology information) manipulated at several levels. The attribute “technology information” referred to information on the technology used for juice production:

- (1) Pressurized, nutritious with more flavor. The high pressure technology maintains the flavor and preserves fruit vitamins.
- (2) Pressurized with no further explanation about the technology used.
- (3) No information about the technology.

Consumers looked at each pineapple juice package mimicking a shopping situation and rated their purchase intention for each product using a 9-cm non-structured linear scale varying from “definitely would not buy” to “definitely would buy” using a balanced sample presentation order (MacFie, Bratchell, Greenhoff, & Vallis, 1989) to avoid carry-over effects. Their ratings were converted into numbers and the data analyzed using conjoint and cluster analyses (Green & Srinivasan, 1978). Consumers whose data did not fit into the model, i.e., those consumers whose ANOVAS did not show a significant effect ($p > 0.05$) for any package attribute were excluded from further analysis. The remaining 65 consumers presented similar part-worths forming only one consumer segment. The results for these consumers with regards to the attribute “technology information” were further analyzed as follows. The information about the process technology applied to the fruit juice production had a significant effect ($p < 0.05$) on the consumer intention to purchase with a relative importance (RI) of 11%. This attribute significantly contributed to the product evaluation by consumer, revealing the power of the information on the package label. This showed that information on the benefits offered by high pressure technology presented on the juice package had a positive contribution on purchase intention. However, information about technology without additional explanations led to a negative impact on the consumer intention to purchase (Fig. 2). A negative sign reflects negative impact on consumer purchase intention.

Several authors (Deliza et al., 2003; Fox, Hayes, & Shogren, 2002; Frewer, 1998; Gaskel, 2000; Hayes, Fox, & Shogren, 2002; Magnusson & Hursti, 2002) have reported that new technologies should have their safeties described on the package label and that claims not indicating real safety contribute negatively on the consumer intention to purchase.

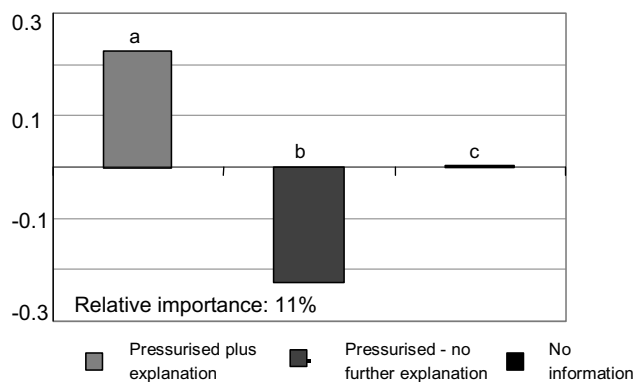


Fig. 2. The effect of information about the employed technology on the consumer intention to purchase of pineapple juice. The negative signals mean negative impact on consumer intention to purchase. Different letters denote significant difference ($p \leq 0.05$).

Consumer-oriented innovation technology is a key point that should be considered by the food industry. However, it requires an integrated view involving marketing and R&D for efficient use of knowledge and labor (Deliza, 1996). A stronger link between these two departments would benefit consumers. Through this collaboration, the marketing department would find out what kind of products the consumers are looking for and then pass this information to R&D. Marketing should then implement communication strategies to inform consumers about product benefits and emphasizing the technology used only when it had consumer benefits.

Although additional research is needed to optimize micro-biological and enzymatic inactivation by HPP in order to ensure shelf-stable pressurized products, this technology offers unique opportunities and challenges to the food industry (Sizer, Balasubramaniam, & Ting, 2002). HPP can enable processors to produce innovative foods with fresh-like, natural-like attributes and natural-looking colors which are all aspects valued by consumers. In this context, the beverage sector has many product development opportunities since a wide range of innovative products can be made available to modern consumers using this technology. Consumers nowadays are more interested than ever before in nutritious, healthy and convenient foods (Sloan, 2003) which are possible by HPP. However, appropriate labels and the information they contain will become more important than ever before, and have to be used aiming at fully informing consumer about the advantages and benefits that HPP can deliver.

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