INDUSTRIAL HIGH PRESSURE PROCESSING OF AVOCADO PRODUCTS : EMERGING TRENDS AND IMPLEMENTATION IN NEW MARKETS

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ABSTRACT

High pressure processing (HPP) technology emerged as a post-harvest, post-packaging technique for high value avocado products in the late 90's. The North American avocado processing industry was the main drive for this innovative technology, which during the current century started to become mainstream for high value propositions such as fresh avocado pulp or guacamole in both Mexico and the US.

The market trend towards products that can be labeled as "natural", "minimally processed", "with no artificial ingredients" and a clean label pushed the level of its implementation. This, together with the evolution in the technology and the improvement of HPP industrial equipment - which in beginning of 2011 are 35% more productive and cost effective than those of i.e. 2007, or up to 50% when compared to those of 2005- allowed HPP systems to cross borders and broaden their utilisation outside North America. In the last 24 months, avocado processing industries in Chile, Peru, Spain, Australia or New Zealand have integrated HPP lines in their plants, in an effort towards NPD, value-added propositions, market expansion, and better management of stocks and logistics.

This technical session will provide real examples of recent HPP avocado applications, business cases, and economical models.

INTRODUCTION

Avocado-based products such as guacamole, avocado flesh, chunks or paste, avocado-based salsas, etc have a very short shelf-life period (5-10 days) due to the spoilage effects of various enzymes over this product, particularly PPO –poliphenol oxidase- and LOX –lipidoxigenase-. A reduction in enzymatic activity is achieved through conventional or traditional thermal methods or addition of chemical additives, but this involves a significative loss in product quality, colour, smell, and flavor in comparison with the fresh product.

New industrial, non-thermal processing technologies mean a valuable alternative for the shelf-life extension of guacamole and other avocado products. Particularly, High Pressure Processing technology or HPP (also known as Ultra High Pressure treatment - UHP - or High Hydrostatic Pressure Processing – HHP-) greatly reduces the microorganism counts and inactivates the enzymes in these products without damaging its original organoleptic quality and properties.

High Pressure Processing (HPP) is a non-thermal pasteurisation method for food processing. Food products are put into a high pressure chamber or vessel and subjected to very high levels of hydrostatic pressure –isostatic pressure transmited by water-. The products are always processed in its final packaging to avoid the processing water entering or soaking the food product. The only requirements for packaging with this technique are flexibility, so the package can resist the isostatic compression caused by hydrostatic pressure, and a good sealing.

The pressures applied for food pasteurisation range between 400-600 MPa (or 4,000-6,000 bar, or 58,0000-87,000 psi). Even at these pressures, product shape and integrity remain unchanged.

HPP causes only a modification in big-sized mollecules such as proteins, as it only affects non-covalent bonds between mollecules –hydrogen bridges, Forces of Van der Waals-. Hydrostatic pressures applied this way do not affect small mollecules in the food such as vitamins, antioxidants, mollecules responsible of functional properties, flavor or taste. The abovementioned change in proteins is what causes both inactivation of microorganisms and enzymes which, with the shape and 3D structure of its complex proteins irreversibly modified, cannot function.

Avocado products are probably one of the foods that are benefited by HPP to a greater extent, and actually the application of the technology for this field was one of the first successful industrial uses of this innovative food processing technique. Avomex, Inc (now Fresherized Foods) started to use High Pressure Processing for the processing of natural guacamole, avocado halves, avocado salsas etc back in 2002. Since then, Avomex-Fresherized Foods expanded capacity and is now the biggest HPP user in the World. Due to this success, other avocado processing companies followed both in the USA and Mexico. Right now there are HPP installations for avocado in other top countries producing this fruit such as Chile, Peru, Spain, Australia and New Zealand.

Current users of High Pressure Processing are being able to market and export high-value added, high quality, higher margin, fresh, minimally processed, natural avocado products. For them, guaranteeing a greater microbiological stability and preventing browning of the product, together with the improvement in texture and other organoleptic attributes of the High Pressure Processed avocado range, are a distinctive characteristic of their value propositions.

REVIEW

Scientific Literature

Many research groups are carrying extensive studies on the potential applications and effects of High Pressure Processing since the late 80’s. There are a good number of references regarding

studies on microbiology and shelf-life of high pressure processed avocado products, enzymatic activity with focus on PPO and LOX, organoleptic quality and kinetic models for this particular product and technology.
The available literature has been reviewed and consulted for this work. Please see references.

Industrial experience and relevance

Fresherized Foods, Inc (formerly Avomex) a Texas-based company who started its activities back in 1966 with a tex-mex restaurant in Dallas, began importing fresh avocados from Mexico using a small airplane for guaranteeing the fast delivery of a high-quality, fresh avocado product - a product with a very short shelf-life-. Looking for new solutions for their range of products, they were one of the first users of high pressure processing technology in the world, installing a first equipment at the end of the last decade. In 2011 they already have some 12 HPP big industrial equipment – the biggest HPP technology user in the world - with a total capacity of around 2000 liters (total volume of the processing vessels) in Mexico, Peru and Chile. Fresherized Foods sells its avocado products in major North American retailers (Walmart, Costco, Safeway, Giant, Wild Oats…) and exports these products to countries such as England, Japan and Australia.
Other avocado growers and processors followed this successful business case in North America including Calavo, San Lorenzo, Simplot, Verfruco and Sociedad Cooperativa Cupanda.
In the last 24 months, HPP technology for avocado applications was also implemented in industrial facilities outside America, and now we find avocado processors utilising this technique in Spain, Australia and New Zealand.
The products being marketed include:

- Avocado halves
- Avocado chunks
- Avocado puree
- Guacamole (various recipes)
- Avocado-based salsas and sauces

The parameters used for industrial production vary between 5000-6000 bar of pressure and 2-5 minutes of holding this high pressure up, at refrigeration conditions (3-7ºC).

In Australia, Austchilli-Pressure Fresh, Bundaberg, Queensland, pioneered the way of adoption of high pressure processing as a post-harvest intervention to a range of avocado pulp and guacamole. First with foodservice formats and secondly with a more recent launch of retail packs, Pressure Fresh is expanding its offer and markets for premium avocado propositions.
The latest adoption example in the Ocenaia region comes from New Zealand, where Fressure Foods, Pukekohe, have been first in that country to install and successfully run the HPP solution. The technology was considered critical for the success of the project as the main target was being able to supply an all-natural, premium refrigerated range of avocado value propositions.

Production and economical data

The investment costs for a 600MPa machine have been reduced 3-fold in the last 10 years for similar output. This is mainly because of technical improvements leading to reductions in the processing cycle time and increase in installation nominal volume. Nevertheless, HPP cannot yet be perceived as a technique to decrease the food processing costs.

However, it is affordable for premium, high-quality or niche products. For example, for a typical RTE product treated with a horizontal indirect compression system having a 3 min holding time at 600MPa with a volumetric efficiency of 60%, the processing cost is between €0.066–0.127 per kg (US$0.045–0.087 per lbs), depending on the HPP equipment size.

Even with a volumetric efficiency of 100%, direct compression systems are less profitable owing to their small size. The lowest operating costs are achieved with the largest equipment. Depreciation of the equipment is the most important factor of the operating costs, and the equipment cost per liter decreases with increase in vessel volume.

The cost of commercial HPP machines is in the range €500,000–2,000,000 (US$750,000–3,000,000), depending of their capacity; therefore, amortization of the equipment is responsible for about 60% of the processing cost. Parts replacement represents 36% of the cost. The energy cost is less than 4% and water consumption is negligible. Labor costs can increase processing costs from 20 to 50%. This depends on the level of automation of the processing lines (which includes loading of products in the baskets and drying after processing)

a Calculations were made for a treatment at 600MPa and a holding time of 3 min, with a vessel filling ratio of 60%.

b Calculations included amortization in 5 years – 300 working days per year, 16 hours per day, wear parts and utilities.

DISCUSSION / CONCLUSION

Avocado products constitute a particularly good target for High Pressure Processing technology : being a non-thermal process, HPP respects the genuine quality and fresh properties of avocado and avocado-based products while destroying microorganisms and multiplying shelf-life. HPP also destroys polyphenoloxidase enzyme avoiding browning problems during shelf-life, retaining the original organoleptic properties of such products. The technology is a estimable tool for NPD, value-added propositions, market expansion, and better management of production and logistics.

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