Starch gelation by high pressure processing

Identification

Key words
Gelatinization, gelation, gel, high pressure, swelling, starch

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How does it work?

Primary objective
Starch gelation by high pressure processing without heat treatment.

Working principle
Through heat-induced starch gelatinization, different types of starch have characteristic temperature and gelatinization times. Similarly, in pressure-induced gelation, different types of starch gelatinize over different ranges of pressure, treatment time and the temperature of pressurization. In this process, hydration of starch granules occurs, leading to swelling of the granules and distortion of the crystalline regions, and changing its optical properties due to the loss of the crystallinity. Thus the crystalline regions become more accessible for water. Starch granules swell and viscosity changes.

Also other products can be used for pressure-induced gel formation apart from starches. Polysacharides (different from starches, e.g. pectin), proteins and polymers can form gel, through a cross-linked system retaining water in its structure and forming a soft solid.

Images

Additional effects
Texture modification, viscosity changes, water retention, enzyme inactivation, protein denaturation.

Important process parameters
pressure, holding time at pressure, temperature

Important product parameters
starch type, water/food composition

What can it be used for?

Products
Most polysaccharide containing foods in a liquid or semi-liquid form in order to modify its texture properties.

Operations
Structure formation by texture or viscosity modification.

High pressure processing in the food industry is mainly applied for food pasteurisation, but because its additional effects on food physical properties, other uses have been described: seafood processing (e.g. Vibrio inactivation) and starch gelation as examples.

Solutions for shortcomings
• Texture modification (viscosity increase or solidification) in liquid or semi-liquid food products
• Modification of food physical properties without need of heating and minimizing destruction of thermolabile components (vitamins- enzymes-etc.)
• To induce new texture properties different that from heating-induced gel formation
What can it NOT be used for?

**Products**
Dry and solid foods

**Operations**
Sterilisation by HP (still under research)

**Other limitations**
- High pressure processing works in a discontinuous mode
- Equipments need a high investment
- Texture or viscosity modifications cannot easily be predicted meaning that specific studies are needed for each product and process

**Risks or hazards**
Up to date, no risks are described to human beings.

Implementation

**Maturity**
Application of high pressure in the field of food processing is known since end of the 19th century, but the study on the effects on polysaccharides gel formation is more recent.
Specific product applications have been developed (fish, chicken, surimi, egg...) (2, 8, 9, 12). At industrial level, new equipments with lower costs and higher production rates are being developed, meaning that new applications are being developed and are economically feasible.

**Modularity/Implementation**
High pressure processing needs loading and unloading phases and modularity in the production line is not easy.

**Consumer aspects**
Most research studies focused on consumer attitudes towards HPP technology are favorable.
According to Olsen et al. (11) attitudes towards novel processing products as HPP are based on both general socio-political attitudes, on risk/benefit trade-offs of the product attributes, and on consumers’ possibilities to evaluate the products. The main benefits linked to HPP technologies are the health-related, taste-related and environment-related benefits. The results show that consumers perceived the main advantages of HPP products to be the products’ naturalness, improved taste and their high nutritional value, whereas the main disadvantage was the lack of information about the HPP products.
Furthermore, HPP products were seen as positive because the natural texture is retained better, and because of the environmental friendliness. (10) According to several researches HPP has been judged to be relatively similar to conventional process technologies in terms of overall consumer acceptability (13). Although Nielsen et al. (10) and Cardello et al. (2) cautioned that an element of consumer uncertainty and risk could still be expected with high pressure processed foods.

**Legal aspects**
High hydrostatic processed foods fall in the scope of Regulation (EC) 258/97 on novel foods and novel food ingredients, article 1, item f (5). Among other categories, this legislation applies to foods and food ingredients to which a production process not currently used has been applied, and evaluates possible changes in nutritional value, metabolism and level of undesirable substances. In January 14th 2008, EU published a proposal for the amendment of Regulation (EC) 258/97. (6)
The competent authorities of the member states agreed in 2001 that the national authorities should decide on the legal status of high pressure treated foods, as it was no longer considered to be a novel process. Case-by-case assessment by national authorities must ensure the products’ safety.

**Environmental aspects**
Some research articles have quoted environmental-friendliness of HPP:

- HPP products are seen as positive because the natural texture is retained better, and because of the environmental friendliness. (10)
- Cardello et al. (2) concluded that the important benefit of the HPP and PEF treatments are the improved nutritional value of the foodstuffs, the retained vitamins, the products fresher taste and the environmental friendliness.
Facilities that might be interesting for you

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<tr>
<th>Title</th>
<th>Institute/company</th>
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<tbody>
<tr>
<td>HP FRIP unit</td>
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<td>HP Industrial scale IRTA</td>
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<td>HP Labscale IRTA</td>
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<td>HP lab-scale multivessel equipment KU Leuven</td>
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<td>HPP Pilot system DIL</td>
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Further Information

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<th>Institutes</th>
<th>IRTA, DIL, KU Leuven LFT, FRIP, Wageningen UR - FBR, TU Berlin</th>
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<tr>
<td>Companies</td>
<td>Hiperbaric, Resato, Uhde-HPT, ŽĎAS, Beskyd Fryčovice, APA Processing</td>
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References

10. Nielsen H.B. et al. (2009). Consumer perception of the use of high-pressure processing and pulsed electric field technologies in food production, Appetite 52: 115-126

Source: