

High Pressure Processing (HPP) of food: the case of Human Milk

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High Pressure Processing - introduction

Modern societies expect food with the qualities of a fresh product, from taste and texture to nutritional value, the desired bioactivity, or vitamin composition. In turn, storage, logistics, and trade require time, extended shelf-life, and product safety, which is ensured by chemical preservatives or pasteurizing liquids. It is also the key to full store shelves. Unfortunately, such preserved products significantly lose pro-health features. Some chemical preservatives are responsible for the epidemic of obesity, intestinal disease, allergies, and even cancers.

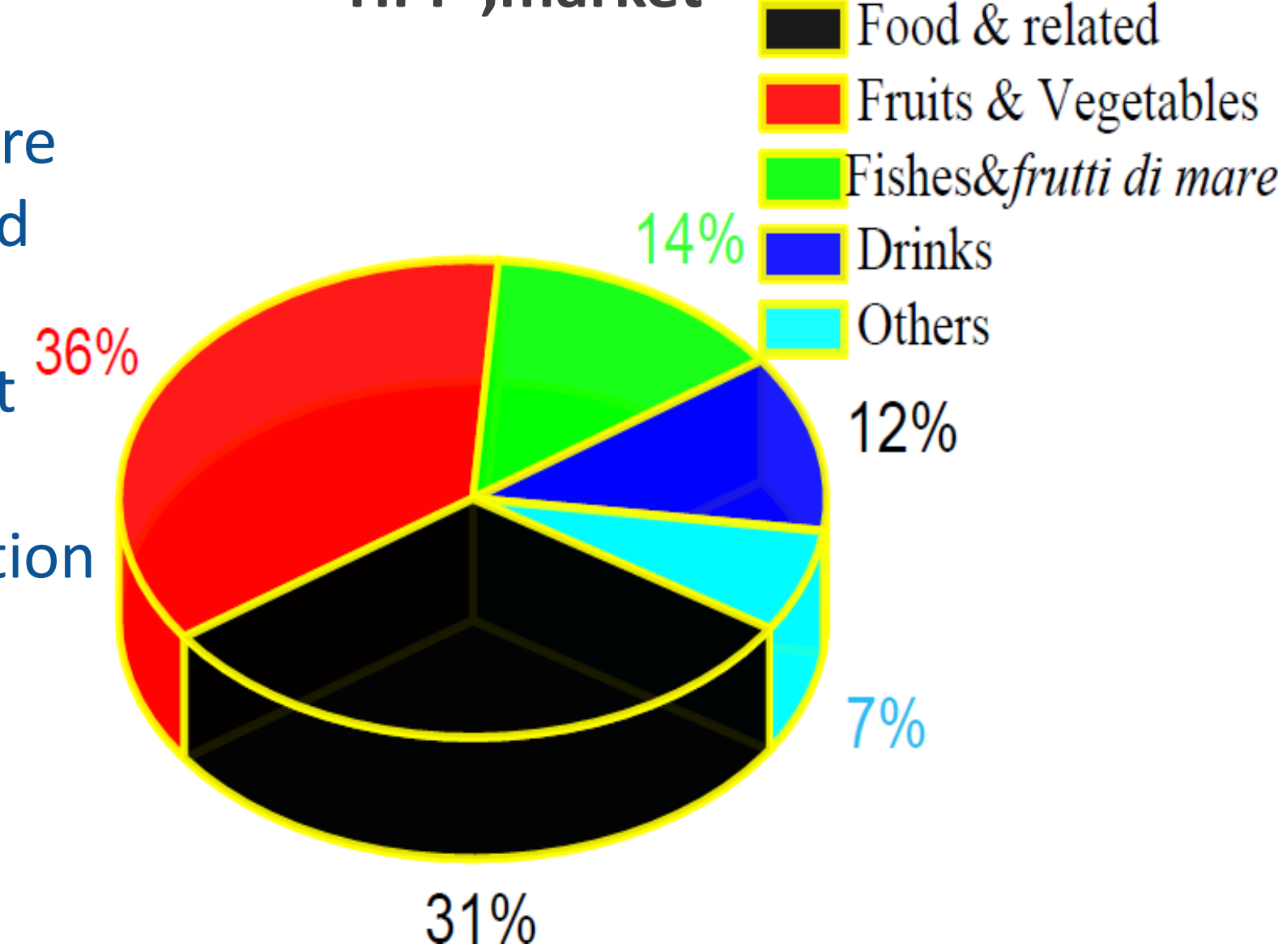
The conflict between expectations of consumers and producers/logistics, as well as the food safety requirements, is solved by innovative non-thermal preservation methods, where high-pressure processing/preservation (HPP) is the most successful. HPP is related to 300-600 MPa for 5 -10 minutes.. The first market product ('velvety' jam) appeared in Japan in 1989.

Unique features of HPP nowadays:

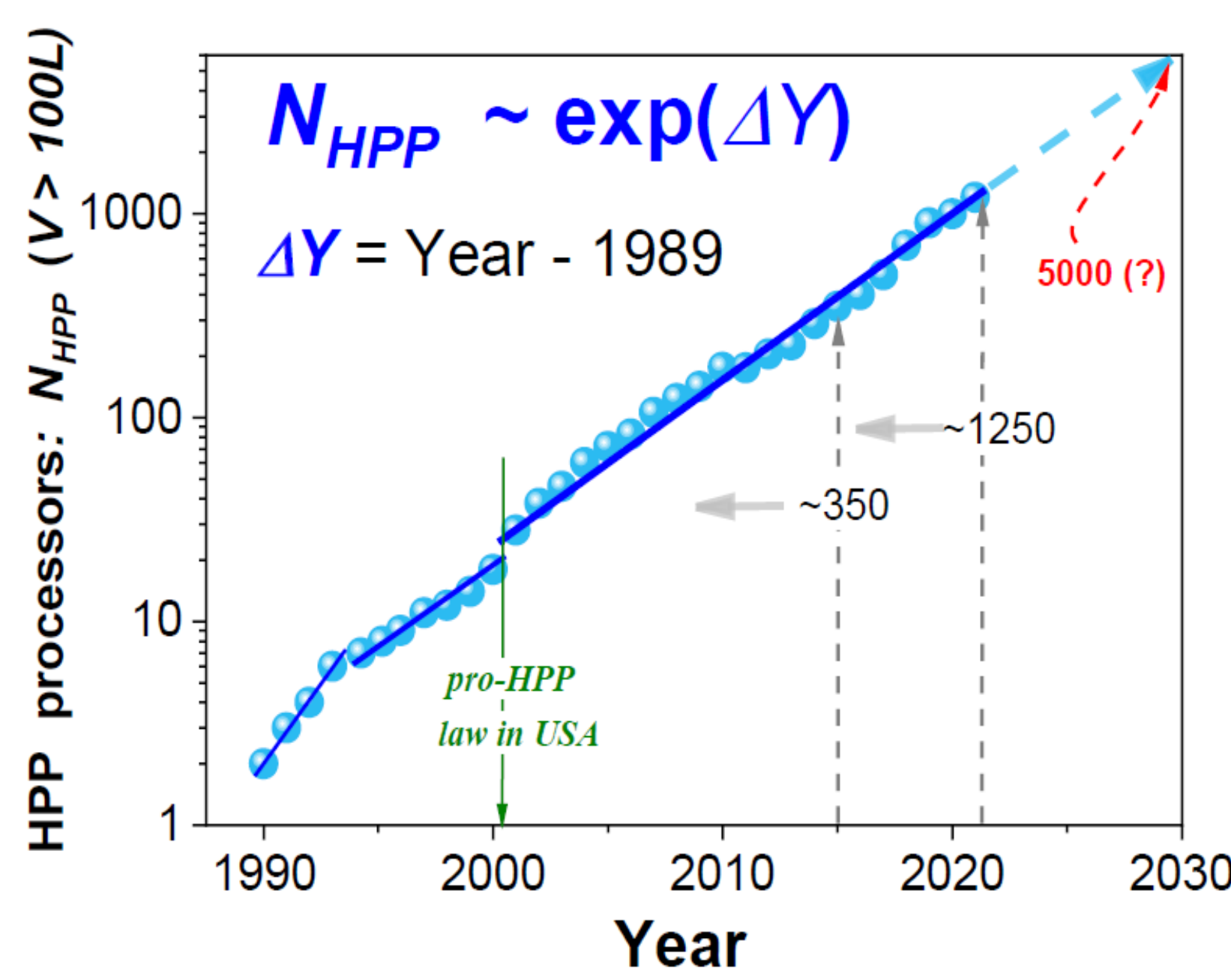
- ✓ Preservation even up to 180 days
- ✓ Top microbiological safety
- ✓ Fresh food taste, flavor, and texture
- ✓ Vitamine content of the fresh food
- ✓ 100 % immunological properties
- ✓ No chemical preservatives, no salt
- ✓ No deep freezing needed
- ✓ Possible some enzymes deactivation
- ✓ New functional foods
- ✓ Used for already packed foods
- ✓ For 'fluid' and 'solid' products
- ✓ Environment-friendly method

The World

HPP ,market

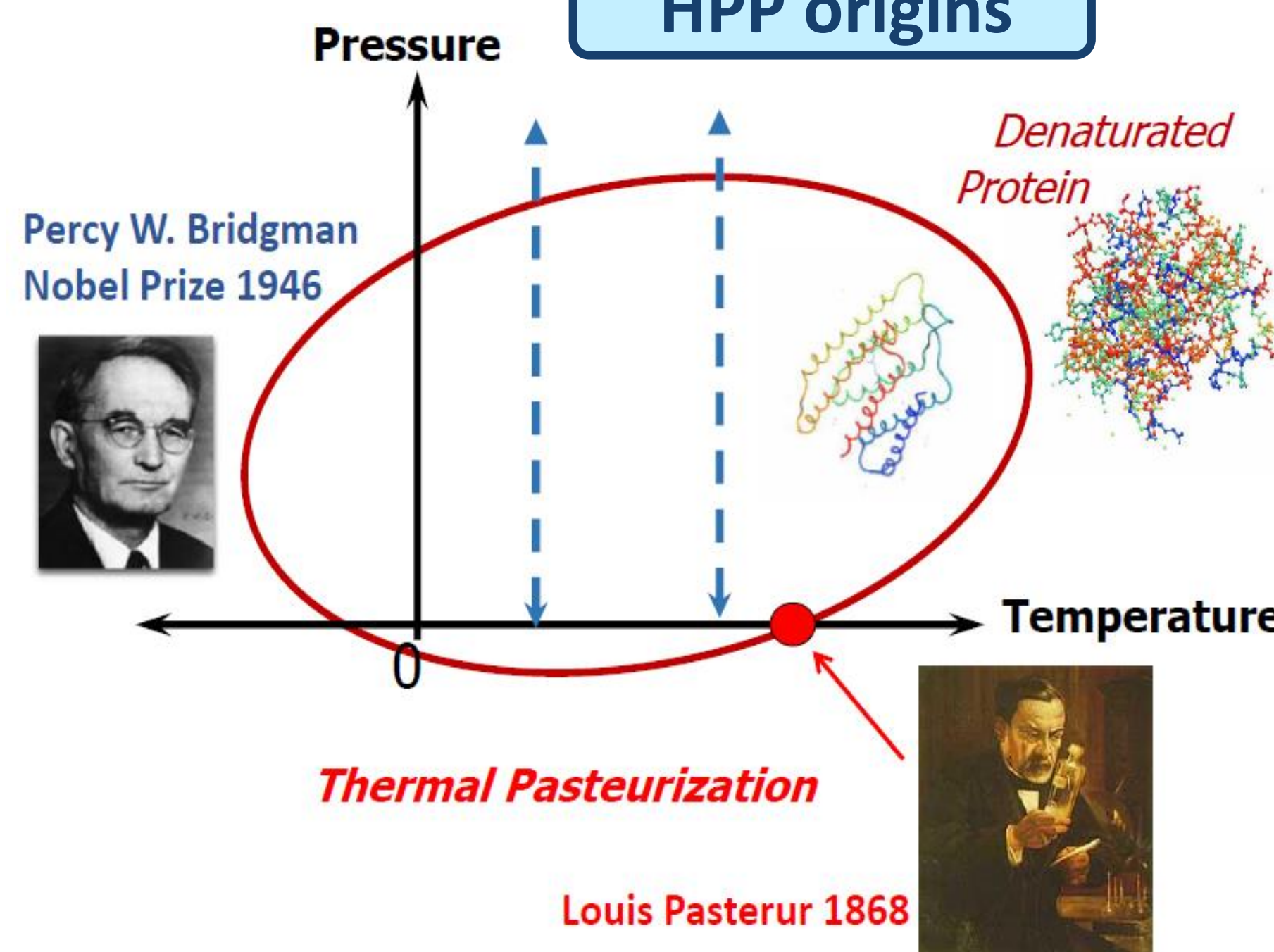


HPP developments and perspectives



The measure of the market development of HPP technology is the number of processors applied in the industry with a pressure chamber volume above the volume $V = 100$ L. It is usually presented using a 'bar graph'. However, a simple, quantitative parameterization of these changes is possible. It allows for a reliable prediction of development trends.

HPP origins



The denaturation curve in P-T plane. Dashed arrows are for typical HPP implementations. The classic thermal pasteurization is related to the thermal denaturation of proteins under atmospheric pressure. HPP is related to:

- isothermal denaturation, partially reversible,
- bacteria's cell. walls break
- organelles destruction.

The meaning of Human Milk

Mother's milk is the natural first choice feed for every newborn.

Access to human milk is critical, especially for very preterm babies. Human milk has not only a nutritional function but it is a source of non-nutritive bioactive compounds. The cumulative effects of thousands of substances such as **anti-inflammatory agents, immunoglobulins, cytokines, growth factors, oligosaccharides, and bioactive peptides** prevent serious prematurity complications: **necrotizing enterocolitis (NEC)**. Many of them, such as **hormones and cytokines, have the potential for long-term metabolic programming. Insulin, leptin, and adiponectin impact infant growth and body composition. Hepatocyte Growth Factor (HGF) and multifunctional milk protein as lactoferrin act in synergy to support the function of the immature gastrointestinal tract.**

HPP(+) studies

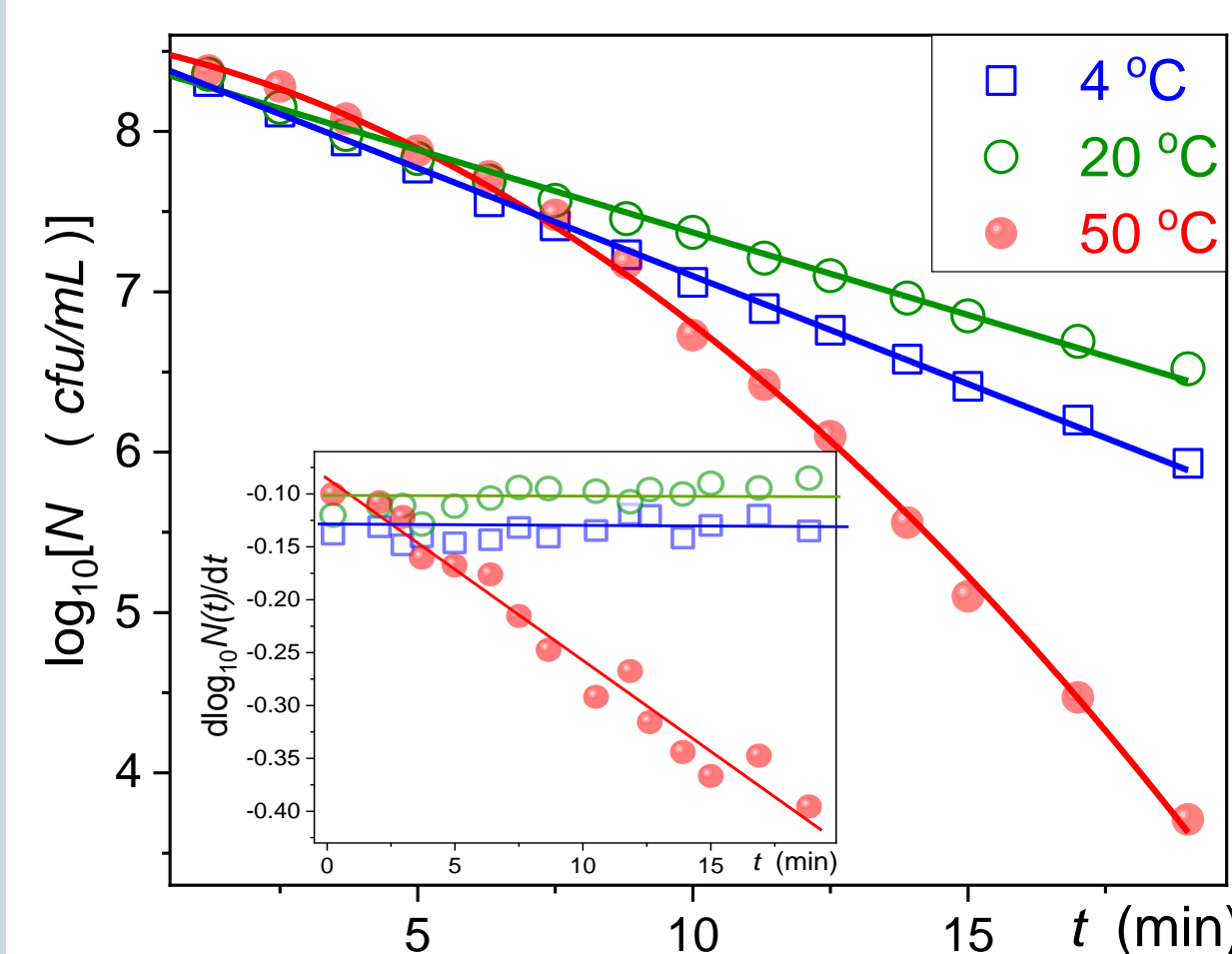
HPP(+) studies on Human Milk in IHPP PAS began from the contact of

Sylwester J Rzoska (IHPP PAS) and Aleksandra Wesołowska (WUM & Human Milk Foundation), in 2014. In subsequent years joint research, mostly voluntaristic, led to in-deep insight into the impact of high pressure on human milk: microbiological safety and significant constituents activity.

The 'implementation rules' have been established: 2 high pressure (HP) pulses with defined values, pulse width, delay, and pressure decay pattern: patented in Poland and EU, also for HP created 'amplifiers' (Super- Milk) and HPP supported freeze-dry milk. After HPP(+), the processed Human Milk can be stored in 'normal' refrigeration ($6 -8$ °C), preserving all Mother's Milk features or Super-Milk characteristics.

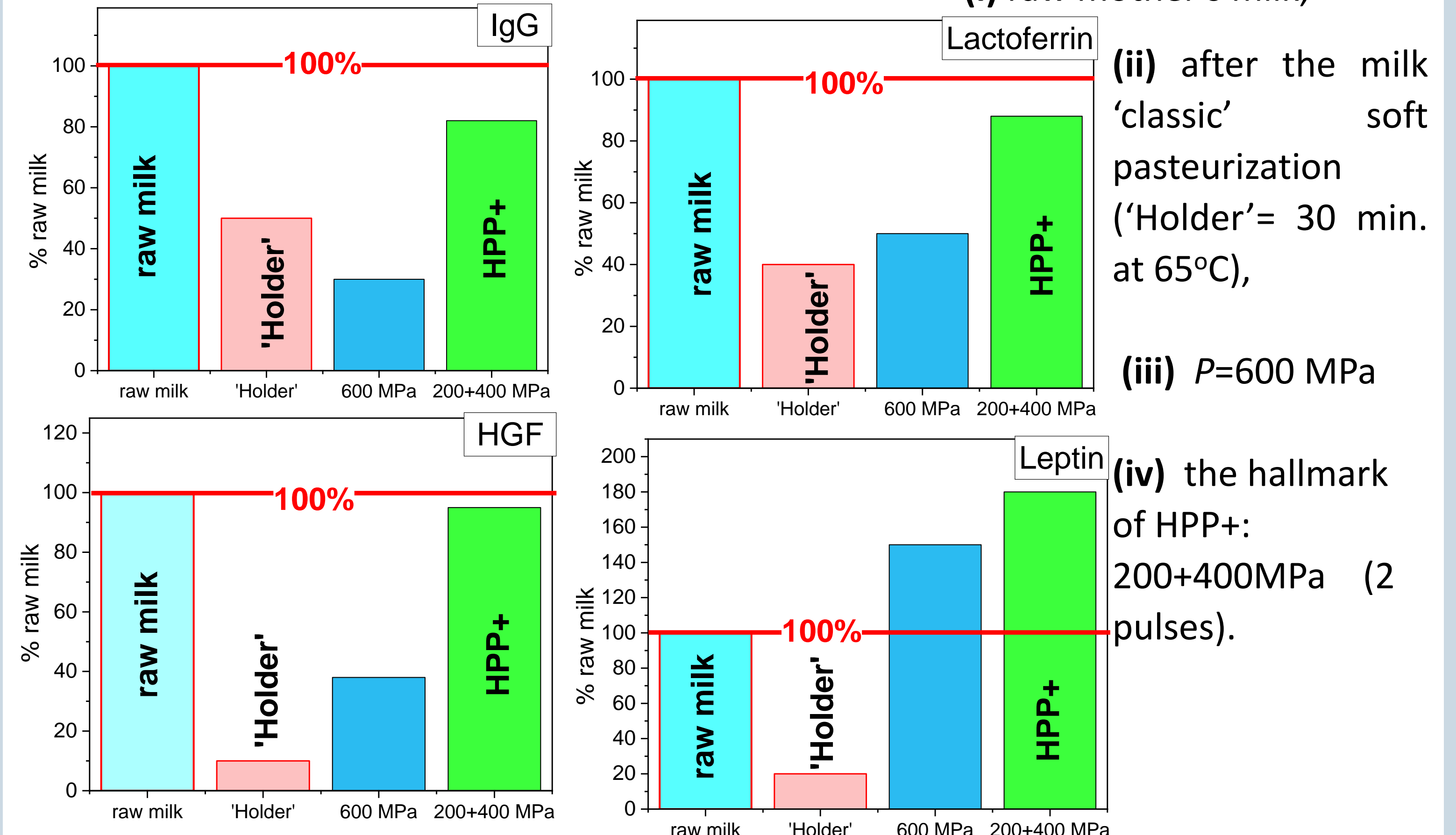
In the opinion of teams involved in the Project, implementing technology can have countless beneficial effects on the health of the nation.

We are waiting for now.



Left: the Decay of *S. Aureus* bacteria after switching HP pulse for a few (constant) temperatures. The inset shows the derivative of these data. All of these show the classic pattern $N(t) \sim \exp(t/\tau)$ for $T = 4^\circ\text{C}, 20^\circ\text{C}$ and the atypical decay $N(t) \sim \exp(t^2/\tau)$ for $T = 50^\circ\text{C}$.

Down: essential milk components in:



- raw mother's milk,
- after the milk 'classic' soft pasteurization ('Holder'= 30 min. at 65°C),
- $P=600$ MPa
- the hallmark of HPP+: 200+400MPa (2 pulses).

References

- S. J. Rzoska,, A. Drozd-Rzoska, A. Wesołowska, ..., *Comments on the high pressure preservation of human milk*, *Food Sc. & Nutri. I Studies*,. 1, 17 (2017)
- A. Wesołowska,...S. J. Rzoska, ..., *New achievements in high-pressure processing to preserve human milk bioactivity*, *Frontiers in Pediatrics* 6, 323, (2018).
- under research action....

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