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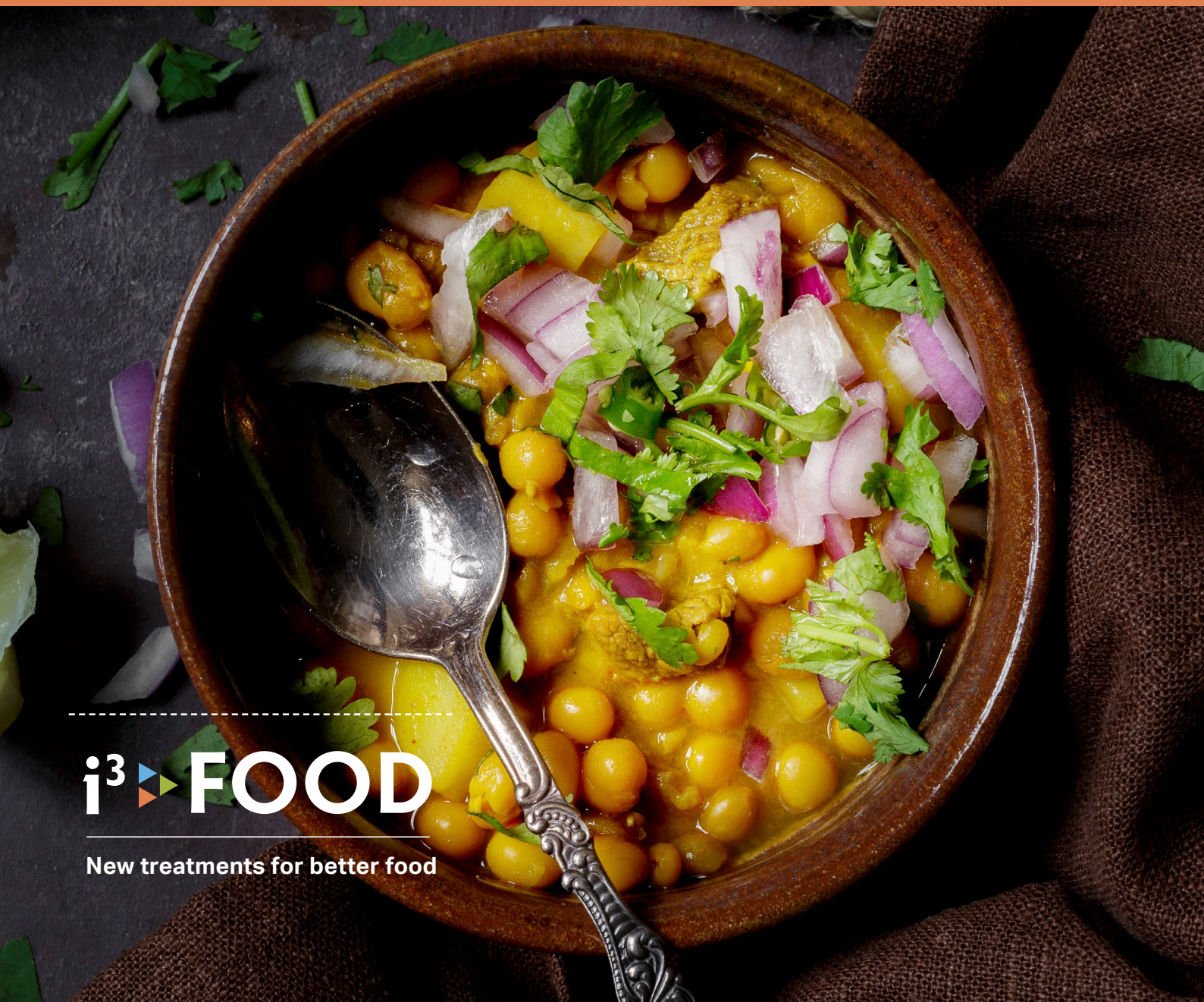
ROADMAP HIGH PRESSURE THERMAL STERILISATION (HPTS)



i³ FOOD

New treatments for better food

THE I³-FOOD CONSORTIUM

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THE I³-FOOD PROJECT

The i³-food project achieves an optimum process control, leading to application of three food processing technologies under real life operating conditions. This is done by demonstrating and piloting in a near to operational environment of applicable validation systems for each technology. We are defining a scientific and cutting edge strategy for overcoming the market barriers ensuring a fast and wide market uptake. Finally, our multidisciplinary endeavor is connecting and amplifying the EU strengths in advanced technology research. This project is supported by the Horizon 2020 EU Research and Innovation programme.

Novel food processing technologies have been further developed in recent years and decades. Although technical advantages have been made in terms of time savings, energy savings, extending of shelf life for retailers and 'ready to use' products, the implementation of these technologies in industrial food production is often still rather limited. The reasons for that are manifold and vary from low acceptance or rejection by consumers (e.g. ionizing radiation of food), to non-open market access or lack of knowledge and information among food producers on how to integrate novel technologies. An applicable validation system for integrating these technologies one by one based on a generally approach is missing. Taking the risk and investing in an improvement of their processing lines is one of the main hurdles for the industry, especially for small and medium-sized enterprises (SME) in food processing. There is neither the time nor the resources available that are needed for the implementation of new non-standard processes.

The overall objective of i³-food is the implementation of three prioritized innovative food processing technologies by validation of optimum process control under industrial conditions.

Three technologies prioritized in i³-food are:

- Pulsed Electric Field preservation (PEF-P) of liquid food products (e.g. fruit juices or smoothies)
- High Pressure Thermal Sterilization (HPTS) for ready-to-eat-meals
- Low Shear Extrusion of cold food products (ice cream).

A connatural set of both, technical (missing online sensors) and process-conditioned bottlenecks exists, which hinders their uptake by industry and into the market.

Therefore, optimum process control will be achieved in i³-food leading to application under real life operating conditions by demonstrating and piloting in a near to operational environment of applicable validation systems, for each technology.

For rapid and easy market penetration an analysis of the innovation environment and identification of opportunities have been performed, leading to roadmaps for market uptake (one roadmap per technology). This integrated approach is providing maximal synergies in between the three afore-mentioned technologies. The summary of one roadmap is shown in this brochure.

THE HPTS-TECHNOLOGY

High pressure processing is a food stabilizing technology that is based on a cold pasteurization method. Food products packed in appropriate films are subjected to high level of hydrostatic pressure in a vessel filled with water. For ten to twelve years high pressure pasteurisation (HPP) has been applied in the food industry worldwide. High pressure pasteurisation is performed at ambient temperatures and with pressures ranging from 200 to 600 Megapascal. The main characteristics of high pressure pasteurisation are:

- Treatment times: between one and ten minutes at ambient temperature.
- Shelflife: more than one month in cold chains.

High pressure pasteurisation has only limited effect on bacterial spores which are highly resistant to temperature. Refrigerated storage or additional preservation is necessary for ambient storage. High pressure pasteurisation products are already available on the market, including as guacamole, vegetable-paste meals, fruit salads, juices, salsa, oysters, filets of salmon and tuna, chicken breasts, ham, tapas, rice, sandwich fillings and smoothies.

Compared to high pressure pasteurisation, High Pressure Thermal Sterilisation (HPTS) is a more advanced technology that extends the shelf life and safety of the food products. Products are pre-heated to 70–90 °C and pressurised up to 800 Megapascal, reaching an actual temperature of (up to) 120 °C. The main characteristics of HPTS are:

- Treatment times: less than three minutes at elevated temperature.
- Throughput: 80 liters per hour at the largest pilot-scale equipment currently available.
- Shelflife: up to months for ambient stable products.

HPTS inactivates enzymes and microorganisms including spores, resulting in ambient stable products, which are highly attractive for consumers and the food industry alike. However, in Europe there are no high pressure thermal sterilised products currently on the market and equipment for production is not yet available commercially.

Intensive and continuous discussions with potential users of this technology as well as with enterprises open to innovation has shown that one of the major bottlenecks for implementation is the need for validation of the temperature during the HPTS process at different locations in the vessel. Temperature is the key parameter for a reliable and safe process control.

Therefore, the basic but nonetheless ground-breaking objective for HPTS is the validation of temperature as the missing main processing factor, in order to optimise pressure, duration of pressure and total processing time. As this technology is a discontinuous batch process, it is essential to verify for each batch that the sterilisation conditions have been reached without overtreatment. Validation and process control on an industrial level will be provided. Therefore, the Hazard Analysis Critical Control Point (HACCP) concept applies, and online-measure-

ment of temperature and pressure needs to be demonstrated for and in an industrial vessel by sensor(s) placed within the vessel. A pre-stage sensor has been developed on a prototype level but it needs to be further developed and validated on pilot and industrial scale.

Summarizing, the purpose is to prove that the sensor is validated, the actual temperature and pressure are measured, and the entire process is controlled, can be optimised and is safe.

The innovation potential in the field of HPTS is the use of this process for ambient stable packed food products, such as ready-to-eat meals with much higher quality compared to existing thermal sterilisation processes. HPTS can produce less processed foods of high quality, better than heat sterilization alone, where the high quality is due to a lower thermal impact on the product. High pressure allows homogenous and rapid heating as well as cooling due to adiabatic effects during pressure build-up and release. Less thermal intensity results in fresher products with better colour, texture, taste, nutrient content compared to heat sterilization. As this process is based on sufficient heat impact, homogeneity of temperature and monitoring of it is crucial importance. Developing and validating a temperature sensor for online evaluation will bring this technology forward towards an implementation in the food industry.

ROADMAP HIGH PRESSURE THERMAL STERILISATION (HPTS)

TIME ▶ 2017 | PREDICTABLE | 2020 | FORE

DRIVERS & BARRIERS

MARKET

- **M-D1:** Consumer attitude towards HPTS
- **M-D2:** New products (soups, smoothies)
- **M-B2:** Strong cultural and market differences between the countries
- **M-B3:** Lack of valida food safety and qua
- **M-B1:** Consumer under-standing and acceptance of HPTS-methodology (unnatural technique)
- **M-D3:** Clean label (organic)
- **M-D5:** Sensory quality
- **M-B4:** Abs the market
- **M-D4:** New mixtures of food ingredients in the ready-to-eat meals
- **M-D7:** One-way packaging

TECHNOLOGY

- **T-B1:** Insight in what happens in the product under pressure and tem-perature (e.g. pH)
- **T-B2:** Only limited validated system yet
- **T-B5:** No adequ
- **T-B3:** Temperature uniformity during entire process
- **T-D5:** Suitable for ization for a wide of food products semi-solid, liquids
- **T-D1:** Possibility of new textures (e.g. meat)
- **T-B4:** Integration of the equip-ment into the existing production facilities
- **T-B6:** Adjustment need installation parameter
- **T-D2:** Shorter processing time and cycle time for in-pack steril-ization of the 'solid' foods
- **T-D4:** No post-contamination
- **T-D7:** Suitable for batch processing
- **T-D3:** High product quality (e.g. baby)

POLICY

- **P-B1:** Approval of the Novel Food Regulation
- **P-D1:** Sustainability
- **P-B3:** Lots patents on
- **P-B2:** Unfamiliarity with HPTS in general

MEASURES

INDUSTRY

- Integration in current processes (T-B6)
- Potential benefits of the technology (M-B4)
- Adjustmen tion (T-B6)

RESEARCH

- Good sensor for temperature inside product (T-B1, T-B3)
- Research on packaging → real packages (T-B5)
- Business Case (eco-nomic feasibility) (T-B1, T-B9, M-B5)
- More knowledge: temperature distribution vessel and product (T-B3)
- Material scien vessel, temper and pressure, of cycles (T-B8

POLICY

- Label HPTS as special thermal treatment
- Disseminate i³-food results on critical point control concept
- Voluntarily labeling (P-B1)

Driver
Barrier
(M-Measures) adressed Driver/Barrier

MARKET LAYER includes Customers, Competitors, Users
TECHNOLOGY LAYER includes Features, Processes, Costs, Performance
POLICY LAYER includes Regulation, Legislation, Investment, Funding

ESEEABLE | 2025 | PROBABLE | 2030 ▶

ation of the lity

M-B5: Very high costs of HPTS-adopting

M-D8: High nutritional quality

ence of big players at

M-D6: Product convenience in terms of storage, delivery and consuming

uate HPTS packaging

T-D6: One facility can be used for processing all food products

T-B9: Very high operational costs

steril- range (solid, s)

T-B7: Huge weight of the HPTS facility

T-B10: Batch

of the

T-B8: Maintenance (pumps, seals, vessel)

T-B12: Small operational capacity

T-B11: Huge investment

of HPTS-related the market

P-D2: Healthier food

nt of installa-)

Durability of technology (T-B8)

Temperature control and register (T-B2, T-B3)

To identify the potential market (P-B2)

High cost investment (T-B9, T-B11)

ce HP rature number s)

Effect of high pressure and temperature on pH; TTI's also for pH (T-B1, T-B3, M-B3)

Show case of very good products (M-D2)

Research on integration in processing line (T-B4)

Make new products/ textures etc (M-B2)

More evidence on validation, both safety and quality (M-B3)

HPTS packaging migration data

i³ FOOD
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FOOD VALUE CHAIN AND POSSIBLE MEASURES

For a deeper understanding of the opportunities and hurdles of the technology, the food value chain for HPTS was investigated. A schematic picture is shown in the figure below.

Possible measures to address drivers and barriers are shown in the roadmap. These items show options for industry, research and policy stakeholders to improve and foster a faster market uptake of the technology. These measures are described briefly in the following paragraphs:

INDUSTRY DIMENSION

- **Integration in current processes**
  HPTS becomes the factory's bottleneck. To balance the flow of the process between the preheating system (90 °C) with the HPTS.

- **Potential benefits of the Technology**
  The development of completely new products is possible. New concepts could be the key of success.

- **Adjustment of installation**
  Some specific data of the product requires a handbook and/or database prevision (e.g. pH).

- **Durability of technology**
  Durability is not defined due to the combination of thermal and HP process. How many cycles can be reached?

- **Temperature control and register**
  Industry should invest in process control and new projects to get reliable process results.

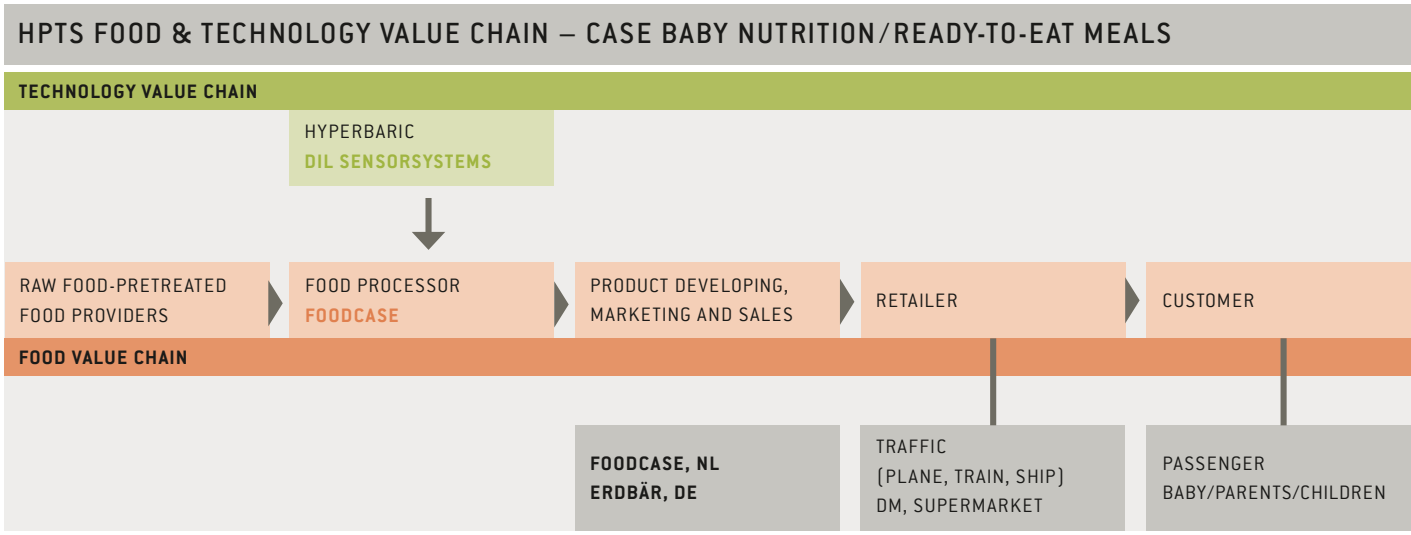
- **To identify the potential market**
  Advantages are known and recognized, but markets for its application are unclear. Applications are limited. Probably there is much more interest for research.

- **High cost investment**
  The high investment cots are a barrier for many SMEs. Need to process products with this technology (new products/ innovation, healthy trends, low processed products).

RESEARCH DIMENSION

- **Sensor**
  Development of a good sensor for measuring the temperature inside the product.

- **Research on packaging vs. real packages**
  Reality Check: Multi layer packaging, 3-D packages. Shelf life studies of packaging (light, oxygen) should be carried out. Packaging should be robust & stable during more than one year.



- **Business Case (economic feasibility)**
  Research should provide more data and be compared with other technologies. Can we make a good comparison towards equipment costs, maintenance, packaging benefits, shelf life, quality, and cost of ingredients?

- **More knowledge on temperature distribution in vessel and product**
  More insight T-differences, the impact of food matrix on this and impact of equipment designs on this.

- **Material science on high pressure vessel, temperature and pressure, number of cycles**
  More insight of P&T on resistance of materials, maintenance, duration of vessels, inspection guidelines.

- **Effect of high pressure and temperature on pH; TTI's also for pH**
  Change in pressure, temperature, time during process. Temperature-time-indicators (TTI); indicators for the treatment, methods for measure during pressure treatment.

- **Show case of very good products**
  Showing benefits, which currently are not possible with 'normal' treatment, e.g. baby food. High quality product for malnutrition, also during long storage should be underlined.

- **Research on integration in processing line**
  Preheating and impact of that on quality. Different methods of preheating. Handling of hot packages. In and outside vessel. Water safety. Cooling.

- **Make new products / textures etc.**
  Allergenicity: new options are possible, new food applications, added values, other applications outside food, tenderization of meat.

- **More evidence on validation (safety and quality)**
  More challenge studies, different food matrix, fair comparison with e.g. retort, real products, what is good strain?, impact of pressure and temperature.

POLICY DIMENSION

- **Label HPTS as special thermal treatment**
  Use existing approvals for thermal treatments (e.g. micro wave, RF-heating, ohmic heating) to explain HPTS as 'special way' with significant resource advantages in sterilization. No novel food.

- **Disseminate i³-food results on critical point control concept**
  Being prepared for requests by regulatory bodies.

- **Voluntarily labeling**
  Voluntarily labelling to add positive food attribute.

- **HPTS packaging migration data**
  Proof that there are no substances released to food.

ROADMAPPING METHODOLOGY

Roadmaps are increasingly used as a management technique for supporting innovation, strategy, and policy at firm, sector, national and international levels. Throughout its long history the roadmapping approach has evolved, firms and other organizations have adapted the concept to address their particular needs and the changing business context. Roadmaps provide decision-makers from business, science and politics with a structured overview of market developments and framework conditions, such as drivers and barriers, along with information on relevant products, technologies, and competences representing state of knowledge and their corresponding relationships.

The outcomes of a roadmapping process are graphical representations of these objects along the timeline, which links the current development trends to the future. Furthermore, roadmaps include measures and activities to address the relationships between market developments and technologies. The most important benefits of roadmapping processes are:

- The roadmap is an ideal form to display a lot of complex and interrelated information in a single picture.
- Certain patterns of interpretation are typical and unique for a roadmap. If inconsistencies are detected solutions can be discussed directly, thus 'hot topics' and 'blind spots' become visible. All these interpretations allow to define actions and to design a strategy accordingly.
- Roadmaps support strategic communication within and between firms and organizations, and the inherent flexibility of the method, which can be readily customized.

For this project, an approach of a roadmapping process was conducted based on workshops with consortium members and technology as well as marketing experts from the involved industry partners. The experts discussed assumptions about market demands and further relevant developments as well as identified opportunities and barriers and their future developments. Finally, they identified the most important measures to enable a successful market penetration. This was done in two steps:

SCOPING WORKSHOPS

- Assessment of the opportunities and barriers as well as gaps or further requirements.
- Identification of the most relevant technology applications, which are not yet obvious but could possibly occur in the future.

ROADMAPPING WORKSHOPS

- Assumptions about the future development of market demands and further relevant developments.
- Identification of the most important measures to enable a successful market penetration of the technologies.

ROADMAPPING METHODOLOGY

SCOPING WORKSHOPS

- Assessment of the opportunities and barriers as well as gaps or further requirements
- Identification of the most relevant technology applications, which are not yet obvious but could possibly occur in the future

OBJECTIVE:

REACHING A CONSESUS ON THE CRUCIAL FRAME CONDITIONS THAT HAVE TO BE CONSIDERED IN THE ROADMAPS IN ORDER TO ENABLE A SUCCESSFUL MARKET PENETRATION

ROADMAPPING WORKSHOPS

- Assumptions about the future development of market demands and further relevant developments
- Identification of the most important measures to enable a successful market penetration of the technologies

OBJECTIVE:

ENSURING A COMMON UNDERSTANDING AS A BASIS FOR A STRAIGHT IMPLEMENTATION OF THE IDENTIFIED MARKET UPTAKE STRATEGIES

ROADMAPS

PULSED ELECTRIC FIELD PRESERVATION (PEF-P) OF LIQUID FOOD PRODUCTS

HIGH PRESSURE THERMAL STERILIZATION (HPTS) OR PRESSURE ASSISTED THERMAL STERILIZATION (PATS)

LOW SHEAR EXTRUSION OF COLD FOOD PRODUCTS (LS-EXTRUSION)

IMPRINT

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