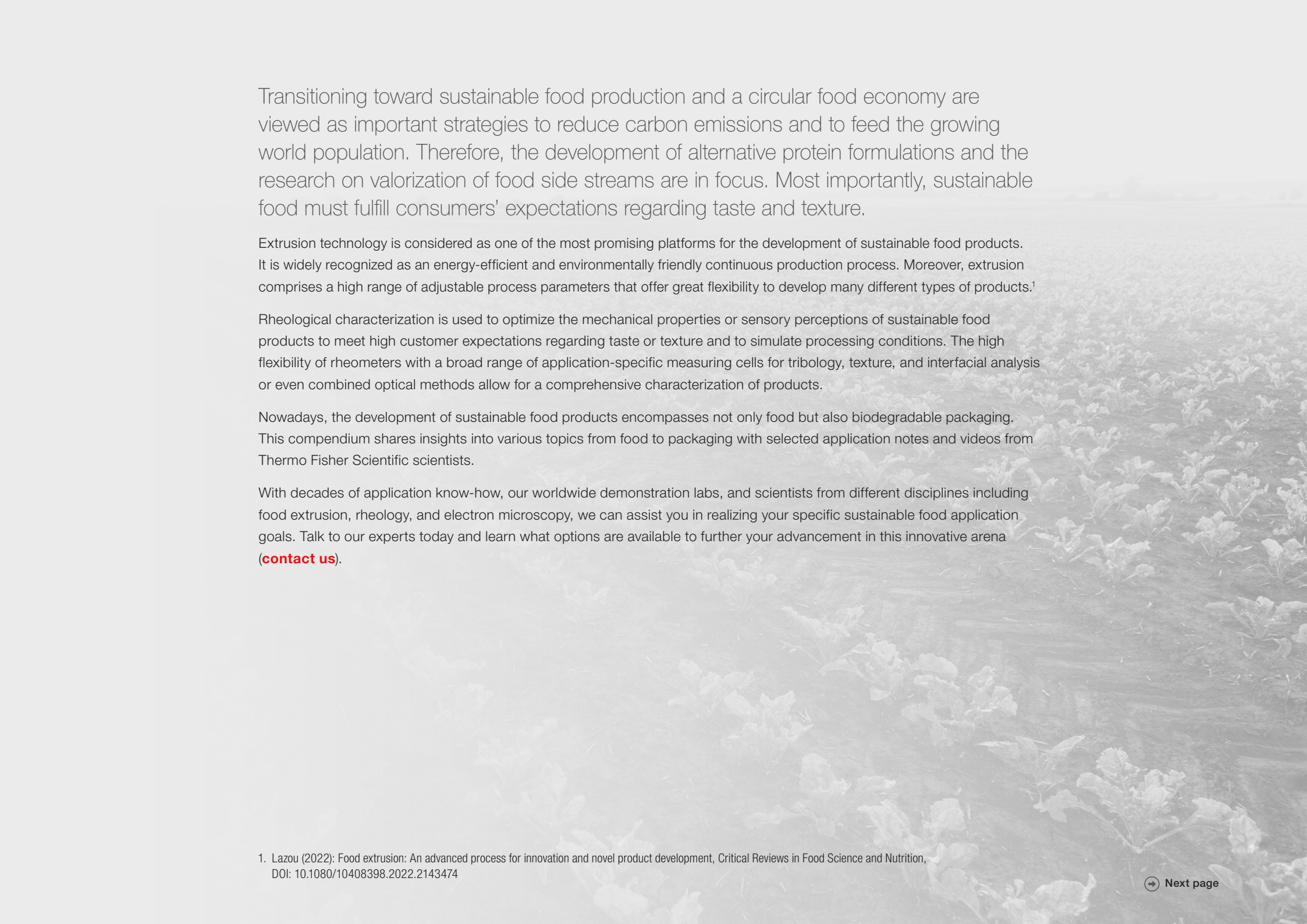


# Food sustainability applications compendium

Alternative protein formulations  
and valorization of food side-streams





Transitioning toward sustainable food production and a circular food economy are viewed as important strategies to reduce carbon emissions and to feed the growing world population. Therefore, the development of alternative protein formulations and the research on valorization of food side streams are in focus. Most importantly, sustainable food must fulfill consumers' expectations regarding taste and texture.

Extrusion technology is considered as one of the most promising platforms for the development of sustainable food products. It is widely recognized as an energy-efficient and environmentally friendly continuous production process. Moreover, extrusion comprises a high range of adjustable process parameters that offer great flexibility to develop many different types of products.<sup>1</sup>

Rheological characterization is used to optimize the mechanical properties or sensory perceptions of sustainable food products to meet high customer expectations regarding taste or texture and to simulate processing conditions. The high flexibility of rheometers with a broad range of application-specific measuring cells for tribology, texture, and interfacial analysis or even combined optical methods allow for a comprehensive characterization of products.

Nowadays, the development of sustainable food products encompasses not only food but also biodegradable packaging. This compendium shares insights into various topics from food to packaging with selected application notes and videos from Thermo Fisher Scientific scientists.

With decades of application know-how, our worldwide demonstration labs, and scientists from different disciplines including food extrusion, rheology, and electron microscopy, we can assist you in realizing your specific sustainable food application goals. Talk to our experts today and learn what options are available to further your advancement in this innovative arena (**contact us**).

1. Lazou (2022): Food extrusion: An advanced process for innovation and novel product development, Critical Reviews in Food Science and Nutrition, DOI: 10.1080/10408398.2022.2143474



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## Food resource center

### Comprehensive food development and testing solutions

- Food applications from extrusion, spectroscopy, rheology, electron microscopy, and more techniques. Find more application information and support from our food scientists



# Create a wide-range of meat-like textures that consumers will enjoy

## Twin-screw extrusion of plant-based meat

### Overview

Twin-screw extrusion processing is considered a key technology for the continuous production of plant-based meat products. The main goal of this process is to impart a fibrous, muscle meat-like texture into plant protein-based formulations. Two different types of products can be produced with this technology: HMMA and texturized vegetable protein (texturized proteins).

This application overview demonstrates practical extrusion process setups for producing HMMA and texturized vegetable protein (texturized proteins).

[View the application overview](#)



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# Flash talk

## Extrusion of plant-based meat

### Advantages of small-scale twin-screw extrusion for product development and material testing

#### Overview

What you will learn during this talk (7 minutes):

- How twin-screw compounders are a flexible solution for the development of plant-based proteins
- Range of textures achieved with a modular die design
- Workflow for plant-based meat characterization

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# Scaffolding and formulation development of cultivated meat

## Revolutionizing meat production with extrusion technology

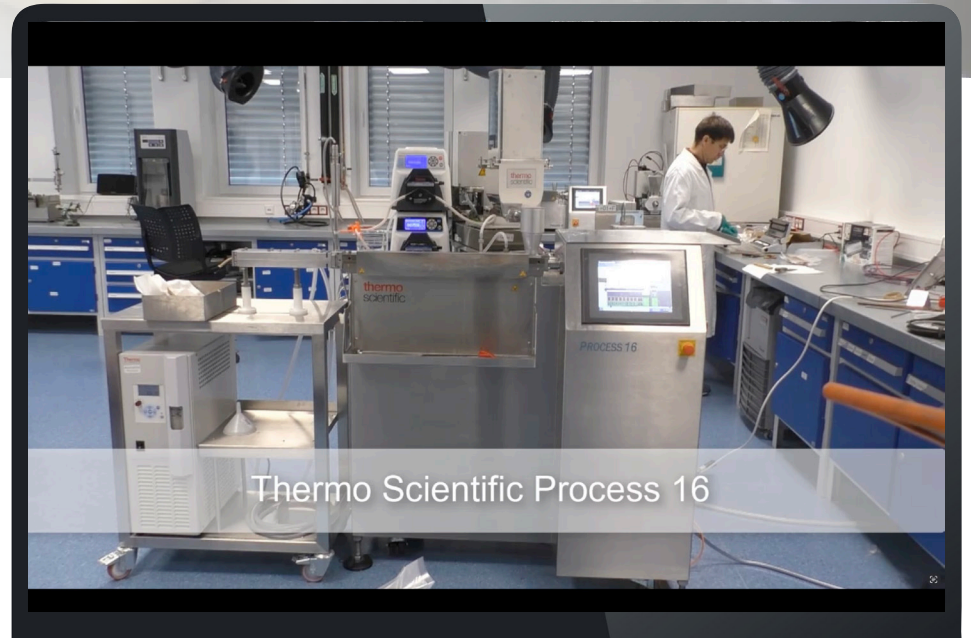
### Overview

Cultivated meat, grown from animal cells in a controlled environment, offers a sustainable and ethical alternative to traditional meat, reducing environmental impact and promoting better animal welfare.

Extrusion technology can be applied to create scaffolds for muscle cell growth or blend cultivated meat cells with plant-based proteins.

Extrusion enables scalable, efficient production, reducing costs and producing meat that closely resembles traditional meat in taste and texture.

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# Analysis of meat and alternative meat products

## Create the right texture and taste

### Overview

Analysis techniques are crucial for developing next-generation plant-based meat products with optimal texture and taste. To meet consumer expectations, these products must replicate muscle fiber texture and authentically mimic meat's taste, aroma, and juiciness.

To obtain plant-based products with a texture perception like that of muscle meat, the extrusion aims to impart an anisotropic, fibrous, and gel-like structure into plant proteins. Scanning Electron Microscopy (SEM) is the ideal tool to assess the structure of plant-based meats by visualizing and evaluating these important characteristics.

➔ View application note

The primary technological challenge is to achieve the organoleptic properties, texture, juiciness, and sensory perception in meat substitutes that are comparable to those of animal products to mimic taste and texture. Lipids play a crucial role in the quality of meat products and are closely associated with the consumer's perception of juiciness. Therefore, the addition of lipids to meat analogs is of utmost importance. In this context tribology is a valuable tool to measure mouth feel properties.

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# What do you do with nutrient-rich food waste?

## Upcycling of food side streams

### Overview

Food side streams, although rich in nutrients, have poor techno-functional properties, which limits their use in food applications. For example, apple pomace, which is the major by-product of the juice industry, is hardly used for pectin extraction or as animal feed. Most of it ends as waste, as its poor solubility does not allow for its further use as a food ingredient.

This application note showcases the functionalization of apple pomace from commercial fruit juice production by twin-screw granulation.

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# Is it cheese?

## Rheology and texture of cheese and a vegan cheese analogue

### Overview

The texture is an important part of a cheese's properties. Depending on the kind of cheese and its age this can range from creamy to solid. Rheological measurements can be used to quantify the viscoelastic properties of cheese and cheese formulations. A modern rheometer can also be used to run texture analysis tests. In the case of a cheese, this could be used to quantify its bite or its cutting properties.

This application note demonstrates how to measure and the results of various rheological measurements and a penetration test on a milk-based cheese and a vegan cheese substitute.

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# Development of biodegradable packaging materials

## Case studies packaging made from Alginate or Pectin

### Overview

Finding new ways to use food side streams is an important strategy of a circular economy. This video introduces a small-scale extruder process setup transforming fruit pectin into biodegradable packaging film.

[→ View the video](#)

### Alginate-based biodegradable films

Alginate films are typically made by time-consuming casting methods. Twin-screw extrusion offers a faster, modular, and flexible approach. This note covers hot-melt extrusion process design using a co-rotating twin-screw extruder for biodegradable alginate films

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# Food and beverage resources

## Application laboratories

Our fully equipped application laboratories are in constant demand for testing customer samples and developing and optimizing pioneering applications. We provide a broad range of product and application solutions, and our team of application scientists and interdisciplinary technique specialists is on hand to answer your questions (contact us).

Register for application and product information at [thermofisher.com/specoptin](https://thermofisher.com/specoptin) to gain access to latest resources to accelerate your research and improve laboratory productivity.

## Seminars and trainings

Comprehensive training programs, in-house seminars, and **practical rheology** and **extrusion courses** in various locations around the world. We support our customers with comprehensive on-demand trainings (**webinars, videos, and application notes**) from our experts, benefit from our interdisciplinary knowledge in food science and technologies.

## Innovation starts with knowledge

For additional resources on food innovations, explore our **food extrusion publications**.

These studies cover extrusion technology applications in cereals, snacks, alternative proteins, and biodegradable films. We're proud that Thermo Scientific equipment was used in this research to advance the potential of extrusion technology in creating innovative foods.

Food extrusion in plant-based meat development and production: [thermofisher.com/plantbasedmeat](https://thermofisher.com/plantbasedmeat)  
Food rheology: [thermofisher.com/foodrheology](https://thermofisher.com/foodrheology)