Overview: Research priorities in plant-based

Plant-based meat, eggs, and dairy are made directly from plants. Like animal products, they are composed of protein, fat, vitamins, minerals, and water. Next-gen plant-based options look, taste, and cook like conventional meat, and offer complex carbohydrates and fibre.

Plant-based meat formulation is focused on getting plant proteins to replicate the texture and experience of animal-based ones. Much of this relies on the production method, but advancements can also be made in the source raw materials and ingredients themselves.

Image: Juicy Marbles

Key research priorities for plant-based:

Better raw materials through breeding of crops and increased use of underutilised protein crops for higher protein yields and functionality.

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Improved protein fractionation and functionalisation to achieve higher quality ingredients, better energy-efficiency, and a lower degree of processing.

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Novel ingredients to mimic animal fat properties, augment nutritional profiles, and enhance the sensory experience of plant-based meat.

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Novel texturization methods in addition to extrusion, electrospinning, 3D printing, enzymatic processing to match the texture of animal protein.

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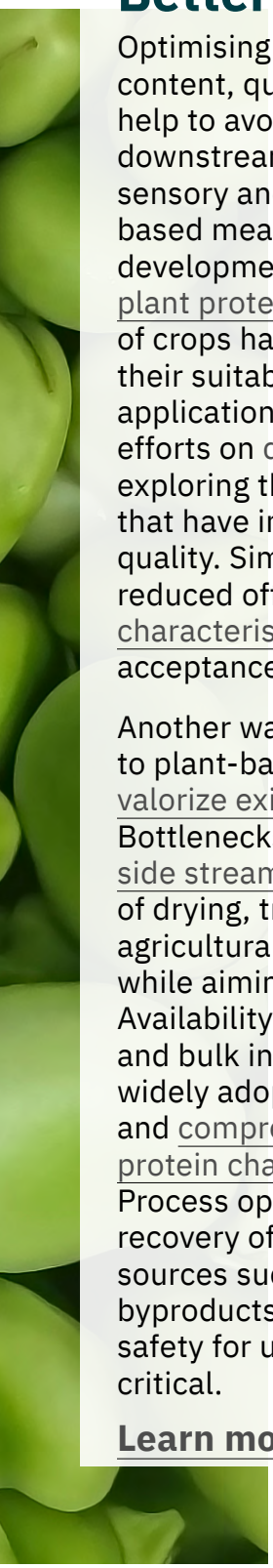
Deep dive: research priorities in plant-based



Better raw materials

Optimising crops for improved protein content, quality and functionality can help to avoid costly and time-consuming downstream processing and improve the sensory and nutritional profiles of plant-based meat products. Very little crop development has focused on optimising plant protein sources and the vast majority of crops have not yet been explored for their suitability in plant-based meat applications. Crop breeders should focus efforts on developing new crop varieties and exploring the potential of other organisms that have increased protein content and quality. Simultaneously breeding for reduced off-flavours and improved sensory characteristics can increase consumer acceptance of plant-based meat.

Another way to add diversity and scale to plant-based meat raw materials is to valorize existing agricultural side streams. Bottlenecks associated with upcycling of side streams include driving down costs of drying, transportation, and processing agricultural and food side streams, while aiming for improved functionality. Availability of appropriate raw materials and bulk ingredients would be improved if widely adopted standards were established and comprehensive methods for plant protein characterization were available. Process optimisation for maximised recovery of high-value ingredients from sources such as plant biomass and food byproducts, alongside evaluations of their safety for use in food production, are critical.

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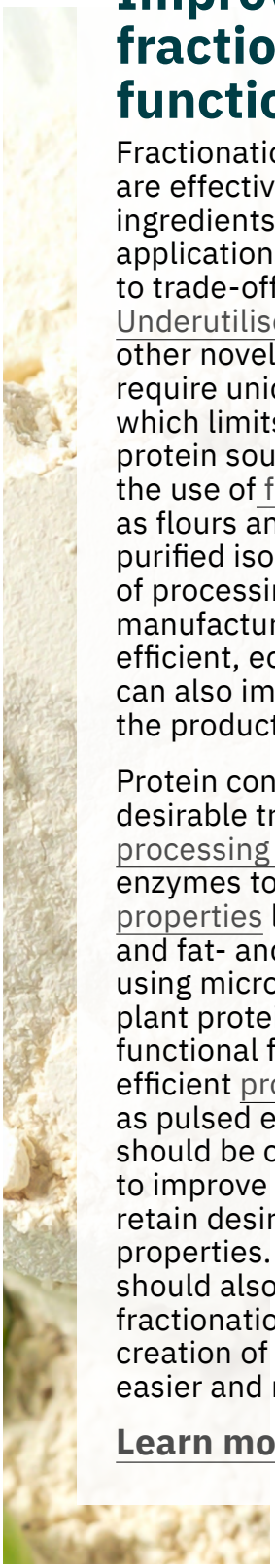

Improved protein fractionation and functionalisation

Fractionation and reconstitution are effective processes for creating ingredients for a wide variety of applications but create challenges due to trade-offs between purity and yield. Underutilised crops like pulses and other novel plant protein sources often require unique methods of fractionation which limits the number of cost-effective protein sources available. Moving towards the use of functional fractions such as flours and slurries instead of highly purified isolates can reduce the degree of processing required and make the manufacture of plant-based meat more efficient, economical, and sustainable. It can also improve the sensory profiles of the products themselves.

Protein conditioning can enhance the desirable traits of the protein. Biological processing techniques include using enzymes to fine-tune functional properties like solubility, gelling capacity, and fat- and water-binding capacity, or using microbial fermentation to convert plant protein feedstocks into more functional forms. Gentler and more efficient processing technologies such as pulsed electric fields and sonication should be optimised and scaled to help to improve texture and functionality and retain desirable nutritional and sensory properties. Sourcing optimised crops should also allow for a less intensive fractionation process, making the creation of functional fractions even easier and more efficient.

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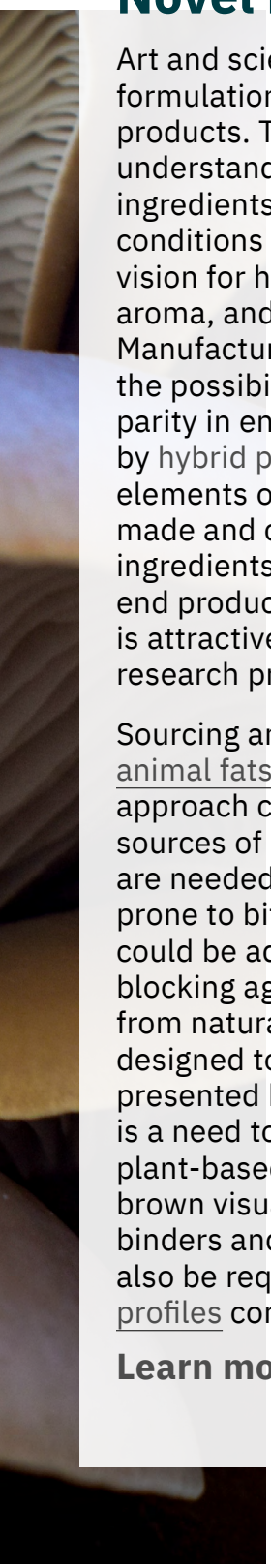

Novel ingredients

Art and science come together in the formulation of plant-based meat end products. Turning plants into meat requires understanding each ingredient, how these ingredients interact, how manufacturing conditions create meat-like texture, and a vision for how to deliver on the appearance, aroma, and taste consumers want. Manufacturers are increasingly exploring the possibilities to achieve taste and texture parity in end product formulation presented by hybrid products which incorporate elements of plant-based, fermentation-made and cultivated proteins. Functional ingredients which can deliver improved end product performance at a price that is attractive to consumers are a major research priority.

Sourcing and incorporating alternatives to animal fats is an example of how this hybrid approach can bridge the taste gap and novel sources of plant and microbial-derived fats are needed. Plant-based proteins are often prone to bitter or "beany" off-flavours which could be addressed by creating new bitter-blocking agents, particularly those derived from natural sources and specifically designed to address the challenges presented by plant-based proteins. There is a need to develop colour indicators for plant-based meat which deliver the red-to-brown visual cue during cooking. Clean label binders and gelling agents alternatives will also be required to deliver the nutritional profiles consumers expect.

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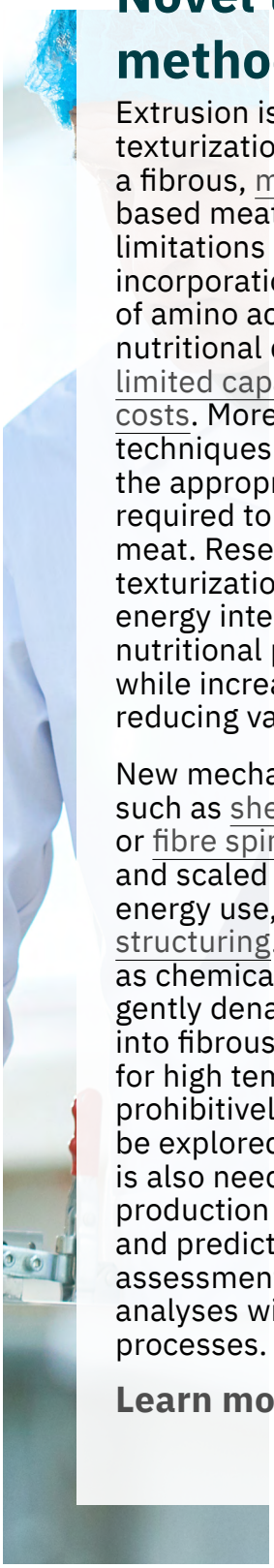

Novel texturization methods

Extrusion is currently the most popular texturization method used to produce a fibrous, meat-like texture for plant-based meat. However, extrusion has limitations including difficulties with fat incorporation, differential breakdown of amino acids resulting in a loss of nutritional quality, operational variation, limited capacity, and high capital costs. Moreover, novel manufacturing techniques may be required to process the appropriate plant-based ingredients required to replicate a specific kind of meat. Researchers should strive for texturization methods which are less energy intensive and can retain the nutritional properties of end products while increasing application flexibility and reducing variability.

New mechanical texturisation methods such as shear cell method, 3D printing or fibre spinning must be optimised and scaled to reduce capital costs and energy use, and enable gentler protein structuring. Non-extrusion methods such as chemical or biological processes to gently denature and crosslink proteins into fibrous structures without the need for high temperature, high pressure, and prohibitively expensive equipment should be explored. Software development is also needed to model plant-based production to allow for systems analysis and predictive capability and life cycle assessments and techno-economic analyses will be required for novel processes.

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