UNLOCKING PLANT PROTEIN POTENTIAL

Transforming pea protein into a complete egg and hydrocolloid replacement

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For decades, eggs have been considered irreplaceable in the bakery world – the 'gold standard' for aeration, binding, emulsification and that elusive, rich mouthfeel. Yet the industry has spent just as many years wrestling with the fragility of that dependence: volatile pricing, unpredictable availability, food safety risks, allergen management and mounting sustainability pressures.

In recent years, as sustainability trends intensified and global supply chains faced unprecedented shocks, many formulators turned to hydrocolloids to stabilise recipes. Xanthan gum, carrageenan, guar gum, CMC and methylcellulose became the hidden scaffolding of modern baked goods. Useful, certainly – but far from natural, economical or consumer-friendly. Today's bakers face a complex equation: consumers seek cleaner labels with fewer additives, regulators push for transparency and manufacturers need supply chains that deliver stability, affordability and sustainability. The challenge for the industry is clear: how can we move beyond traditional dependencies while maintaining the quality standards that define successful baking?

Why eggs are so hard to replace: understanding the complexity

In the egg, nature provided the ideal, texturising ingredient for baking. It performs gelation, emulsification and foaming functions, with behaviour that varies depending on processing methods and recipe composition. The range of baked products utilising eggs spans cakes, muffins, meringues, custards, waffles and pancakes – each requiring specific textural contributions where egg plays a defining role.[1]

This multifunctionality stems from egg's intricate composition: proteins with diverse physicochemical properties combined with lipids, divided between egg white and yolk. Both components can function independently or →

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synergistically. Egg white excels at gelation and foaming, while yolk forms stable gels and robust oil-in-water emulsion systems. Pre-baked batters and doughs are highly complex matrices containing both hydrophobic and hydrophilic ingredients that must integrate seamlessly. The multifunctional nature of eggs has proven critical for achieving desired texture and volume.

In cake systems, for example, eggs initially facilitate the integration of all ingredients into a uniform batter. Yolk components create stable emulsions, incorporating flour, fats, oils and water-soluble ingredients uniformly. During mixing and whipping, air becomes entrapped in the batter, with egg white proteins preventing bubble coalescence and air loss. Beyond interface stabilisation, egg proteins increase viscosity and enhance film elasticity around air bubbles, improving overall foam stability.[2,3]

During baking, as temperatures rise, trapped air expands and volume increases, supplemented by water evaporation and gas generation from leavening agents. The elastic protein gel film surrounding air bubbles accommodates expansion while preventing coalescence or disproportionation. Between approximately 60°C and 85°C, egg proteins denature and the semi-liquid gel transforms into a semi-solid structure, entrapping gas bubbles within an increasingly solid matrix. This thermal gelation leads to foam setting, preventing collapse and delivering the desired final texture.

The thermal gelation profile (how gel structures evolve with rising temperature) profoundly influences final product characteristics. An appropriate profile allows the cake to rise during baking, followed by effective entrapment of air bubbles within the solidifying matrix, yielding proper height and the characteristic light, airy texture. Suboptimal profiles typically result in dense, low-volume products.

This intricate interplay of functions explains why, despite decades of research and development efforts, finding equivalent egg replacements has remained a persistent challenge in food science.

Exploring new possibilities in plant proteins

Pea protein isn't new to the food industry, but for years, its potential was underestimated. Confined to shakes and meat alternatives, limited by flavour and performance, it rarely lived up to its promise. Recent advances in protein science have opened new perspectives on plant protein functionality. Research has revealed that under specific conditions and with appropriate processing approaches, plant proteins can exhibit texturising behaviours that more closely parallel the structural and functional properties of whole eggs. The central question became: how to consistently activate and optimise these inherent capabilities.

Through systematic investigation, it became possible to develop methods that enhance plant proteins' natural capacity for binding, emulsification, gelation, foaming, viscosity modification and texture formation – while maintaining clean label status and allergen-free profiles.

This represents a meaningful evolution in approach – moving from compensating for functional gaps toward leveraging the intrinsic potential within plant protein systems.

Unlocking the texturising capabilities of plant proteins

Meala's proprietary, IP-protected biotechnology platform unlocks distinct texturising capabilities within plant proteins, transforming them into sophisticated texturing ingredients. The process begins with careful selection of plant-based protein sources – such as pea – chosen for their nutritional profiles and functional versatility. Using advanced biotechnology methods, these proteins are processed to enhance specific texturising properties. Following functional optimisation, proteins undergo controlled drying designed to preserve structural integrity, functionality and shelf stability, accomplished without fermentation, chemical additives or harsh processing conditions.

The outcome is a single-ingredient solution with versatile texturising capabilities that simplifies formulation while delivering texture, mouthfeel and clean label advantages across diverse baking applications.

Meala's egg and hydrocolloid replacer, Groundbaker, commercially known as LASENOR VP-100, enables formulators to reproduce the lift, volume and textural properties typically provided by eggs across a range of baked applications, including cakes, muffins, scones, choux pastry, pancakes and enriched doughs. The ingredient allows for clean label formulation using 'pea protein' as the sole functional component, creates significant cost reduction and contains no allergens.

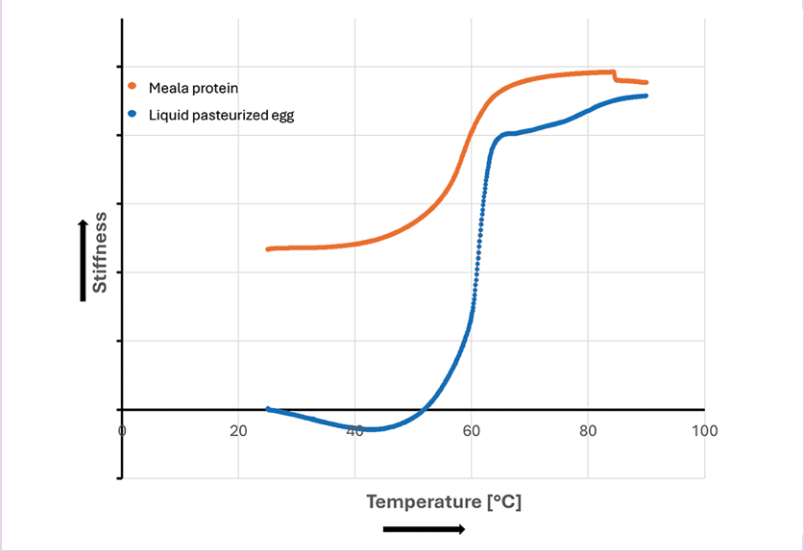

FIGURE 1: Rheological behaviour of liquid pasteurised egg and Meala protein during heating.

Figure 1 illustrates the thermal gelation profile of liquid pasteurised egg (LPE) compared with Meala protein during heating. LPE, which exhibits liquid-like gel texture before baking, demonstrates a pronounced increase in gel strength from approximately 50°C to 65°C, followed by a secondary solidification phase between 80°C and 90°C. Meala protein displays similar behaviour, beginning to gel around 50°C with rapid strength development until 65°C, completing solidification near 85°C.

During baking, numerous temperature-dependent processes occur simultaneously. A critical functional requirement is system 'setting' at specific temperature points. The similar thermal gelation profile exhibited by Meala's protein, combined with effective emulsification and foaming properties, enables comparable performance to egg across various baking applications.

Market drivers: timing and industry needs

Several converging factors have increased industry interest in functional plant proteins. Egg costs have risen significantly in many markets over recent years, while food safety considerations around *Salmonella*, avian influenza and contamination events continue to require careful management. Concurrently, consumer preference for clean labels has strengthened, making concise ingredient lists increasingly valued. →

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Supply chain challenges from climate events, geopolitical factors and disease outbreaks have highlighted vulnerabilities in animal-based ingredient systems, while corporate sustainability commitments drive interest in reducing carbon emissions and water usage. Plant-based protein solutions can address these multiple pressures while offering cost efficiency and production reliability benefits.

Sustainability considerations in ingredient systems

Transitioning from egg and hydrocolloid systems toward plant proteins carries notable environmental implications. Pea protein production requires substantially less water (up to 98% reduction), generates fewer greenhouse gas emissions (up to 90% reduction) and utilises significantly less land compared to conventional egg production systems. Developing ingredients that can scale sustainably – both economically and environmentally – while maintaining performance standards represents an important consideration for long-term bakery manufacturing.[4]

Looking forward: New directions in bakery formulation

Egg and hydrocolloid replacers like Groundbaker represent an evolution in bakery ingredient strategy: utilising a single, clean label ingredient to deliver performance traditionally requiring multiple additives and animal-derived inputs.

As the category continues to develop, applications are expanding beyond bakery and savoury into dressings, sauces and additional categories, enabling manufacturers to simplify ingredient lists across broader product portfolios. The baking industry continues to explore new possibilities in ingredient innovation, investigating how single-source plant proteins can replicate the functional complexity of animal-derived ingredients while meeting evolving clean label and sustainability expectations.

References

1. Kiosseoglou et al., *Bakery Products Science and Technology*, 2nd Edition, chapter 13, 243, 2014.
2. Godefroidt et al., Ingredient Functionality During Foam-Type Cake Making: A Review, *Comprehensive Reviews in Food Science and Food Safety*, 18, 1550, 2019.
3. Aguilar et al., *Carbohydrate Polymers*, 161, 172, 2017.
4. FAO, 2020. Environmental performance data on animal and plant proteins: https://www.fao.org/sustainability/en/

FOR MORE INFORMATION

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Hadar Ekhoiz Razmovich brings extensive leadership experience in the global food industry, with focus on driving innovation and R&D across traditional food sectors. Throughout her career, she has led complex, multidisciplinary projects from early concept development to full commercial launch, consistently bridging technological capabilities with market needs.

Oded Halevi, PhD, combines expertise in chemistry, materials science and food innovation. With a doctorate in chemistry from the Hebrew University in Jerusalem and NTU Singapore, Oded leads scientific development at Meala Foodtech, translating fundamental research into breakthrough protein technologies. His work bridges academic rigour with practical application, developing functional ingredients that transform how manufacturers approach texture, performance and clean label formulation.