PULSES 101

PEA PROTEIN

PULSE CANADA

ABOUT PULSE CANADA

Pulse Canada is the national, not-for-profit association representing over 25,000 growers and 100 companies involved in the trading and processing of Canadian pulses, including peas, lentils, dry beans, faba beans, and chickpeas.

Our Market Innovation team drives pulse innovation and ingredient adoption by facilitating research and creating conditions to showcase the quality, functionality, nutritional, and sustainability benefits of Canadian pulses.

WHAT IS PULSE CANADA'S ROLE IN ADVANCING PEA PROTEIN USE?

Pulse Canada works directly with ingredient suppliers, food manufacturers and research groups to advance science-based solutions that address challenges and grow demand for pea protein. Examples include:

- Understanding impacts of genetics and growing environment
- Striving towards standardized industry methods of analysis
- Performance optimization based on food product category
- Structure-function studies
- Data on quality, sustainability and nutrition
- Addressing sensory challenges
- Applied research and proof-of-concept trials

OUR EXPERTISE

MARKET INNOVATION AT PULSE CANADA

- CANADIAN PULSE QUALITY
- PULSE PROCESSING TECHNOLOGIES
- FUNCTIONALITY & FORMULATION
- PULSE CONTAMINANTS & FOOD SAFETY
- METHODS & STANDARDS
- NUTRITION, HEALTH RESEARCH & REGULATORY GUIDANCE
- REGENERATIVE AGRICULTURE PRINCIPLES
- ENVIRONMENTAL IMPACT ANALYSES
- CONSUMER INSIGHTS, PRODUCT TRENDS, & MARKET OPPORTUNITIES

TABLE OF CONTENTS

MARKET & CONSUMER INSIGHTS

WHAT OPPORTUNITIES ARE THERE FOR PEA PROTEIN?

Pea protein is gaining momentum globally, driven by consumer demand for clean-label, allergen-friendly, and sustainable ingredients. From 2020 to 2024, global pea protein consumption grew at a CAGR of 10%, with North America accounting for over 75% of total demand, followed by Western Europe at 19% (Euromonitor 2020-24).

While soy and wheat proteins lead in overall usage, pea protein is now the third most common plant-based protein in new product innovations globally. Top applications include plant-based dairy alternatives, ready meals and pet food, with functional uses also in alt meat, snacks and bakery (Mintel, 2024).

HOW DO CONSUMERS FEEL ABOUT PEA PROTEIN?

A 2024 study conducted by Pulse Canada revealed that pea protein is an emerging ingredient where 49% of U.S. consumers are already familiar with the ingredient and 36% have tried it in one form or another (n=500). While pea protein is still considered an emerging ingredient, it is quickly penetrating the food and pet food markets. Today (July 2025), pea protein appears in 1% of all new global food product launches and 4% of pet food launches, a marked increase from just 0.3 and 2%, respectively, 8 years ago (Mintel, 2024).

Consumer insights show that pea protein is viewed as "modern" and "trendy", making it a unique and appealing ingredient that motivates consumers to include it in their diets. In fact, 70% of protein consumers would consider purchasing products that contain pea protein. Health and nutrition are key sentiments behind consideration and/or using pea protein in their diet.

When asked about current consumption trends for products with pea protein, top categories were protein drinks, pasta and salty snacks which will continue to be purchased, while future trends reside in meat products (burgers, meatballs), breads and flatbreads. **The positive news is that consumers understand pea protein to be plant based, healthy and a high quality protein that's easily digestible and can satisfy hunger.** Further, pea protein has a strong alignment with the traditional pea which provide opportunity for pea protein to halo positive sentiments onto manufactured brands.

As food manufacturers look to diversify protein sources and meet evolving consumer expectations, pea protein presents a valuable opportunity for innovation across both human and pet food categories.

NUTRITION & COMPOSITION

WHAT ARE THE HEALTH & NUTRITIONAL BENEFITS OF PEA PROTEIN?

Pea protein is considered a high-quality, plant-based protein. Although not classified as a complete protein (due to limiting methionine), it provides all nine essential amino acids and can complement cereal and nut proteins to achieve a complete profile. Recent studies have demonstrated the ability of pea protein to stimulate muscle protein synthesis comparably to animal proteins, especially when protein intake is adequately increased (Pinckaers et al, 2024; Babault et al, 2015; Singh et al, 2024). The addition of pea protein to carbohydrate foods can also limit the glycemic effect (Kadam et al, 2025; Johnston et al, 2021).

WHAT ARE THE DIFFERENCES BETWEEN THE TYPES OF PEA PROTEIN AVAILABLE?

Pea protein is produced through dry or wet fractionation processes, each yielding different ingredient profiles and functional properties. Pea protein concentrates typically contain 45-65% protein on a dry matter basis. As they are derived largely through physical means of separation, the proteins retain their native protein structure and functionality, and water-soluble proteins rich in sulfur containing amino acids that are commonly lost during the wet extraction processes are retained. Protein isolates generally contain >80% protein and are priced higher due to their level of purity. Pea protein isolates are partially denatured during the extraction process which significantly alters their functional properties, but also increases protein digestibility. Depending on the applied extraction conditions, protein isolates may also contain lower levels of common antinutritional factors found in the whole pea seed.

RANGE IN NUTRITIONAL CHARACTERISTICS FOR PEA PROTEIN SAMPLES

Characteristic	Pea Protein Concentrate (n = 5)	Pea Protein Isolate (n = 10)
Moisture (%)	3.7 - 7.2	5.9 - 7.5
Protein (%db)	53.6 - 56.6	83.1 - 92.6
Total Dietary Fibre (%db)	14.6 - 16.7	2.5 - 8.3
Starch (%db)	3.7 - 8.5	0.2 - 2.6
Fat (%db)	2.0 - 2.6	0.2 - 5.0
Ash (%db)	5.0 - 5.7	3.1 - 5.6
Limiting Amino Acid	TRP or SAA	TRP or SAA
Amino Acid Score	0.85 - 0.93	0.55 - 0.90
In-Vitro Protein Digestibility	91 - 93	97 - 99
In-Vitro PDCAAS	77 - 86	53 - 88

Adapted from Carlin et al. (2025)
PDCAAS = Protein digestibility corrected amino acid score

FOOD INDUSTRY APPLICATIONS

HOW CAN PEA PROTEIN BE USED IN FOODS?

While pea protein's role in meat analogues is well established, emerging use cases in bakery, beverages, pasta and meat products highlight broader functional and nutritional potential.

Food Product Category	Applications
Meat Analogs	**Primary structuring agent, binder, increase cooking yields**
Animal-Based Meats	**Binder, increase cooking yield, reduce cooking losses**
Beef products	Enhance red colour, retard colour fading, oxidative stability
Deli meats	Alkaline phosphate substitute
Pâté products	Decrease free water, improve water holding capacity, improve texture
Hybrid	Partial replacement of animal protein and/or fat
Plant-Based Beverages	**Emulsifier, increase protein content, increase protein quality, fortification aid[a], fat globule mimetic[a]**
Dairy Analogs	**Base ingredient, increase protein content**
Cheese analogs	Stabilize emulsion-filled gels, filler in polysaccharide-structured gels
Yogurt analogs	Fermentation-induced gels, control viscosity
Frozen desserts	Lower melting rates, increase viscosity
Whipping cream	Foam stabilizer[b]
Animal-Based Dairy	
Hybrid products	Partial replacement of dairy proteins
Milk	Promote probiotic culture growth
Yogurt	Promote probiotic culture growth, increase water holding capacity, control viscosity, encapsulation agent[c]
Cheese	Fat replacer[d]
Ice cream	Fat replacer[a]
Whipping cream	Fat replacer[e]
Bakery Products	**Increase protein content, increase protein quality, fortification aid[f], egg replacement**
Frozen dough	Cryoprotectant[a]
Gluten-free	Increase protein content, contribute to dough viscoelasticity, egg replacement, lower water activity

Food Product Category	Applications
Pasta & Noodles	**Increase protein content, increase protein quality**
Gluten-free	Reduce cooking losses, enhance water uptake
Functional Beverages	**Increase protein content, fortification aid[af], probiotic encapsulation agent[c]**
Nut Spreads	**Improve spreadability[c], and promote ease of processing via extrusion and pumping[c]**
Sauces	**Control viscosity and moisture content**
Tomato Sauce	Egg replacement[c]
Mayonnaise	Increase protein content, increase viscosity
Soup	**Increase protein content, increase viscosity**

Applications that are denoted with a letter superscript indicate where functionality was observed when pea protein is pre-processed a) into an emulsion, b) via ultrasonication, c) into complexes with polysaccharides, d) into hydrolysates, e) into complexes with flavonoids, f) into complexes with minerals.

MEAT ANALOGS

Pea protein is applied as a **primary structuring agent** or **binder** in meat analogs, providing high water and fat retention with **increased cooking yields** in finished products that are derived from texturized proteins prepared via low and/or high moisture extrusion. Heat-induced gelation, with or without the addition of enzymes (i.e transglutaminase) and other gelling agents (i.e polysaccharides/starches) has also been explored to produce analog products within silicon molds that model the desired end-product shapes, (e.g.: scallops) (Baig et al., 2024; Bhuiyan et al., 2025; Dinani et al., 2023; Zhang et al., 2022). Compared to products derived from soy protein, pulses including pea provide bean-like, salty, sweet, umami and heated-oil sensory notes (Kim et al., 2021).

Influence of Pea Protein Ingredient Variability:	
High Moisture Extrusion	**Low Moisture Extrusion**
Pea protein legumin (11S) is associated with cross-linked network formation (Osen et al. 2014). 7S/11S ratio and protein dispersion viscosity during heating are useful tools for predicting their processing behaviour (Osen et al., 2014; Zhang et al., 2025). Pea protein ingredients with lower solubility have shown greater texturization potential, in contrast to ingredients with high heat-gelation capacity (Plattner et al., 2024).	Pea proteins with high water absorption capacity and cold swelling viscosity show higher porosity, and greater cross-linking potential (Flory et al., 2023; Webb et al., 2023). Concentrates have produced harder, more porous structures with greater odor and taste intensity than isolates (De Angelis et al., 2020). Interactions between ingredients during extrusion processing have a higher impact on texturization and microstructure, more so than variability in raw material (Webb et al., 2022).

Influence of Formulation	
High Moisture Extrusion	**Low Moisture Extrusion**
Increasing pea protein inclusion to 50-60% of formulation increases cross-linking potential, resulting in increased hardness, firmness and overall texturization (Plattner et al., 2024). Blending with other proteins as structuring agents can enhance amino acid profiles (gluten, oat, sunflower), texturization/structure (soymeal, gluten), and sensory attributes (lentil) (Arshard et al., 2022; Dubey et al, 2024; Richter et al., 2023; Wang et al., 2024). Zein protein addition only contributed to improved texture and structure of pea protein extrudate when added in combination with rice starch, at which point its performance was comparable to gluten (Rolandelli et al., 2024). Both wet milled oat protein and rice protein have been reported to detract from the processability and overall quality when combined with pea protein, creating more porous and less cross-linked networks (Dubey et al, 2024) Other ingredients offer potential to modify the structure and texture of meat analogs made with pea protein. Transglutaminase promotes crosslinking, thereby increases hardness and fibrous structure formation. Starch ingredients (rice, corn) promote softness (Dahl et al., 2025; Rolandelli et al., 2024.) Hydrocolloids contribute to a stronger, more tensile structure (Moll et al., 2023). Fatty acids can contribute positively or negatively depending on the fatty acid composition, where a higher concentration of unsaturated fatty acids inhibiting legumin aggregation and crosslinking by increasing exposure of hydrophobic protein groups, weakening hydrogen bonding, and coalescing to form aggregated gel structure. This suggests fats higher in saturated fatty acids are more favourable in generating fibrous protein structure (Chen et al., 2023) Blending with other ingredients also introduces new applications for pea protein. Homogenized pea protein and pectin functioned as a glue, binding texturized vegetable protein and fat mimetics together in the development of a bacon-type analog (Moll et al., 2023). The addition of laccase to the pea protein-pectin blends increased binding strength higher than a methylcellulose hydrogel control.	Increasing pea protein content influences extrusion machineability, where 70% protein obtained through blends of concentrates and isolates demonstrated the most promise for meat analog applications (Chan et al., 2024). The addition of legume flours to pea protein created a more layered, dense product (Webb et al., 2022). Fibre and other polysaccharides impact lightness, texture profiles, and cooking yields due to their water holding properties (Han et al., 2023; Penaranda et ala., 2023). Overall, the interactions between ingredients in formulation during extrusion processing are reported to have the highest impact on texturization and structure, more so than variability in raw material (Webb et al., 2022).

Influence of Extrusion Processing Parameters Under High Moisture Conditions:

Moisture content has been cited as the most important processing factor influencing textural quality of extrudates, provided temperatures are sufficient to denature proteins and induce fibrous structure formation (>120°C) (Barnes-Calle et al., 2024; Hogg and Rauh, 2023; Zahari et al. 2021; Zhang and Ryu 2023). 55% moisture appears sufficient for most proteins to texturize, however these conditions may produce tough/brittle structures, while higher moisture contents (60-65%) were found more optimal, producing flexible and anisotropic structures (Dhal et al, 2025; Hogg and Rauh, 2023). Screw speed influences microstructure of texturized products (Wu et al., 2023).

ANIMAL MEAT PRODUCTS

Pea protein isolate serves as a **binder** at 2-6% inclusion, increasing the cooking yield and reducing cooking losses, water and fat exudation of beef, mortadella, and lean turkey breast products (Barbut et al., 2023; Pinton et al., 2024; Shen et al, 2022). In turkey breast formulations, pea protein isolates outperformed rice protein, whey protein concentrates and faba bean protein concentrate (Barbut et al., 2023).

Pea protein isolates also contribute to **oxidative stability** of meat products (Sun and Xiong, 2015; Trindade et al., 2023), showing promise as an **alkaline phosphate substitute** in low-sodium, phosphate-free mortadella, particularly if combined synergistically with other natural antioxidants (Pinton et al., 2024). The improved oxidative stability also allows for heme to maintain its reducing status, where pea protein isolates were reported to **enhance red colour and retard colour fading** in cooked, nitrite-cured beef during refrigerated storage (Sun and Xiong, 2015).

In canned pâté products derived from pork, duck or fish, up to 50% pea protein inclusion **decreases free water and improves water holding capacity** of the batters and gels, promoting a network described as a "soft, pleasant texture with good spreadability" (Trindade et al., 2023; Zhu et al., 2022). Replacement of 25% pork meat even resulted in **superior texture and taste** compared to 100% pork pâté controls, although color remained a more sensitive attribute, associated with a yellow hue that was less acceptable (Trindade et al., 2023). Fish gels formulated with 50-80% of protein derived from pea highlighted the opportunity to create a soft texture **suitable for elderly consumers or those with slight-to-serious swallowing difficulties**, where the resulting changes in gel network allowed for **increased amino acid release and protein bioavailability** (En et al., 2025).

Hybrid beef/chicken products containing 4-43% pea protein isolate and texturized pea protein have been formulated to **partially replace animal protein and/or fat.** Most studies on hybrid/extended comminuted meat products were able to successfully reduce fat content while maintaining protein levels, with **minimal differences in product texture and decreased cooking losses** (Chan et al., 2024; Miao et al., 2023; Shoaib et al., 2018).

BEVERAGES

Beverages containing pea protein are typically available as a pre-packaged colloidal, oil-in-water system, or consumer-ready powders to be dispersed in water. Pea protein isolate can function as an **emulsifier** or is leveraged to **increase protein content** and **enhance protein quality** by providing more of the essential amino acids when blended with a nut/cereal base. As a result, pea protein needs to be soluble in formulation and able to adsorb to the surface of the oil and water interface to form a viscoelastic, interfacial layer (McClements et al., 2019; Hadidi et el., 2022).

Other uses:

- Pea protein stabilized nanoemulsions have been leveraged as **fortification aids** for their ability to increase cell uptake, transport efficiency, and delivery of vitamin D when compared to free vitamin D suspensions in formulation (Schoener et al., 2019; Walia & Chen, 2020).
- Emulsions prepared with 0.5-2% pea protein in 10% flaxseed oil solutions demonstrated potential to serve as milk **fat globule mimetics** in plant-based milks, with smaller particle size, more negative surface charge, and no difference in shear viscosity compared to dairy milk fat under the tested conditions (Chen et al., 2024)

Influence of Pea Protein Ingredient Variability

Protein composition and structure play an important role in determining pea protein functionality in beverage applications; where globular, legumin proteins have a rigid, hydrophobic structure compared to the flexible and more soluble nature of pea vicilin and albumin proteins, respectively (Hadidi et al., 2022). As a result, albumins and vicilin proteins move more quickly and preferentially adsorb to the surface of the oil-water interface where legumin proteins will be slower to diffuse. However, once absorbed, legumins confer stronger mechanical stability and are considered better emulsifiers (Hadidi et al., 2022). Sulfur-containing amino acid (and sulfydryl groups) content is also important as these are involved in covalent bonding to form aggregates or complexes with other ingredients in solution, thereby impacting pea protein's ability to dissolve in beverage applications. Because the composition, conformation, particle size, and denaturation states of pea proteins is highly dependent on the pea variety and extraction conditions used to derive the ingredient, there can be significant performance variability between suppliers. A protein is considered most soluble when the exposure of hydrophobic regions is minimized, as seen when in its globular state (Vogelsand-Odwyer et al., 2022). Other functional properties such as zeta potential and surface activity influence dissolution of pea protein into solutions by affecting attractive/repulsive forces between droplets.

Influence of Formulation

The protein-to-oil ratio plays a key role in emulsion stability. Adequate protein levels are required to fully coat oil droplet surfaces and prevent destabilization. Therefore, increasing the protein content within a certain range improves emulsion stability by minimizing unabsorbed protein in the continuous phase (Gumus et al., 2017). Formulations with protein-to-fat ratios of 1:1 or 2:1 are commonly used to replicate the characteristics of whole or low-fat milk, respectively. In low-fat systems, excess protein may promote flocculation or aggregation due to insufficient oil surface area for adsorption.

Emulsifier type and interactions also affect emulsion performance. Stable systems typically feature thick, hydrophilic interfacial layers that resist environmental stressors. Charged emulsifiers enhance repulsive forces between droplets, maintaining separation and preventing coalescence. Smaller droplet sizes are preferred, as they reduce gravitational separation and improve physical stability. Inclusion of co-emulsifiers has been shown to reduce droplet diameter and enhance overall emulsion stability (Li et al., 2023).

Polysaccharides (e.g.: cellulose, dextrans, xanthan gum, guar gum, gellan gum, gum arabic, pectin, glucomannan, carboxymethylceullose, etc.) are commonly used alongside pea protein to stabilize emulsions due to their ability to form soluble complexes through electrostatic attractions and hydrogen bonding with pea protein that create protective films at the oil and water interface (Liu et al., 2010; Yin et al., 2015). As polysaccharides increase the viscosity of the system, their addition helps to inhibit gravitational separation and the stronger electrostatic repulsion and steric hindrance conferred further improves stability (Lan et al., 2018; Wei et al., 2020; Wei et al., 2022). As a result, when combined with pea protein, studies have shown increased solubility and performance under higher ionic strength, neutral and acid pH conditions (Guldiken et al., 2023; Lan et al., 2018; Liu et al., 2010; Shen et al., 2022; Wei et al., 2020; Wei et al, 2022; Yin et al, 2015). Calcium ions (i.e calcium chloride) can further assist with enhancing the solubility of pea protein-polysaccharide complexes by promoting cross linking and providing electrostatic shielding (Li et al., 2024).

Other additives which may improve the stability of the system include surfactants (i.e phospholipids) that synergistically absorb to the interface alongside pea protein (Shen et al., 2023). Flavonoid compounds (i.e quercetin, epigallocatechin-3-gallate) have been shown to spontaneously complex with pea protein via hydrogen bonding and Van der Wal forces, resulting in conformational changes that increase the hydrophilicity of pea protein to improve foaming and emulsification properties (Han et al., 2022). Due to their antioxidant properties, flavonoids and other additives such as ascorbic acid or reduced glutathione can also minimize the oxidation of fatty acids in solution, reducing the development of undesirable volatiles (Bi et al., 2022). Another approach to reduce the off notes associated with pea protein is to introduce ingredients with a strong affinity to bind to the compounds responsible. Bi et al. (2022) reported a significant decrease in hexanal and/or hexanol content (associated with raw bean/grassy notes) when an additional 1-5% pea protein was included in pea seed milks alone, or in combination with sodium sulfate or propylene glycol.

Influence of Processing Conditions

High shear mixing (i.e homogenization) plays a critical role in decreasing the overall size of oil droplets suspended in aqueous solutions and disrupting any insoluble pea protein aggregates that are formed during the protein extraction process. High shear mixing generally improves solubility and heat stability by altering protein structure and aggregation tendencies, where changes to the shearing rate, number of homogenization cycles, and/or pressurized conditions introduce opportunities to minimize droplet particle size, as well as improve solubility and emulsion stability (Bogahawaththa et al., 2019; Moll et al., 2021; Oliete et al., 2019; Ong et al., 2022).

High temperature or pressure treatments that are sufficient to inactivate lipoxygenase enzyme inhibit the formation of lipid oxidation products that are commonly associated with off-flavours in pea. As a result, these can be tailored to improve the sensory profile of pea-based beverages (Trikusuma et al., 2020). However, careful consideration of the time, pressure, and temperature must be considered to prevent the formation of insoluble aggregates (Bogahawaththa et al., 2019; Qamar et al., 2019). Optimized heat treatments have even been shown to increase the heat stability of pea protein dispersions through the formation of soluble protein aggregates linked by thiol disulfide bonds (Bogahawaththa et al., 2019; Wu et al., 2020). Fermentation with LAB and yeast has also been applied to alleviate off-flavours, where both introduce the opportunity to generate new desirable flavour descriptors such as yogurt-like, milk-like, beer/yeasty, and umami (Spaccasassi et al., 2024; Youssef et al., 2020).

DAIRY ANALOGS

Pea protein ingredients form gels via heat, enzymatic cross linking (i.e transglutaminase), fermentation-induced acidic conditions, or a combination of these treatments, to **form the base for yogurt, cheese, or frozen dessert-style dairy analogs.** Gel formation is primarily driven by hydrophobic interactions and disulfide bond formation between proteins as they unfold as a result of the treatment conditions (Tang et al., 2024; Rios et al., 2025; Yang et al., 2021). Pea protein's gelling capacity has been correlated to its solubility and concentration of β-sheet structures (Li et al., 2022; Rodriguez and Beyrer, 2023).

Yogurt Analogs

Pea protein dispersions are leveraged as the **base ingredient** to produce yogurt-style products, forming gels as a result of fermentation. In fermented systems, the selection of bacterial strains and/or blends is critical as each uniquely affect product quality, differing in their acidification rates, ability to remove off-flavours, and contribution to gel firmness (Masia et al., 2023). Depending on the starter culture selected, both increases and decreases in bitterness, beany, pea-intensity, or green aromas have been reported (Ben-Harb et al., 2022; Masia et al., 2023; Yang et al., 2021), in addition to the development of new flavour notes such as cheesy, fruity, and dairy-associated compounds (Ben-Harb et al., 2020). Co-application of enzymes (i.e transglutaminase, proteases) can be tailored optimize rheological properties and lubrication behaviour (Lin et al., 2024).

The presence of other ingredients in formulation will alter the rheological properties of pea protein-based products. Increasing the oil and/or fibre content in the formulation led to higher levels of pea protein found in the aqueous phase, accelerating gel structure formation making it stronger and more resistant to stirring (Klost and Drusch 2019). Similarly, inclusion of 3% oat, citrus or pea fibre in pea protein-based yogurts increased gel strength and decreased water holding capacity (WHC) without impact final product flavour (Matysek et al., 2024). Oat β-glucans have also been leveraged to replace fat in formulation (up to 60%), also providing functional benefits by increasing LAB fermentation time, WHC, and providing fruity/sweet/creamy flavours following fermentation (Zhao et al., 2023)

Pea protein may alternatively be added to **increase the protein content** and **control viscosity** of yogurt-analogs derived from other base ingredients. The inclusion of 2% pea protein concentrates in oat-based yogurt allowed for the development of products with intermediate viscosities, where the consistency was otherwise similar to that of a Greek-yogurt style product (Drositi et al., 2026). At this inclusion level, no adverse sensory effects were detected (Demir et al., 2023). In soymilk yogurt formulations, increasing the content of pea protein improved viscosity, flowability and water holding capacity maximized at an optimal concentration of 4% (Shin et al., 2022).

Cheese Analogs

Emulsion-filled gels stabilized by pea protein are commonly used to develop cheese analogs. These products may or may not include a fermentation stage to induce gelation and develop desirable dairy-like flavour profiles (Masia et al., 2023). D'Alessio et al. (2014) produced creamy-viscous characteristics (i.e spreadable cheese) by high pressure homogenization of 10-20% pea protein concentrate dispersions.

Other mechanisms to create harder textures include polysaccharide-structured gels. These formulations are typically limiting in protein content; therefore, inclusion of pea protein is beneficial from a nutritional perspective. In polysaccharide structured matrices, pea protein does not actively participate in network structure (Silvia et al., 2024). However, Sanders et al. (2024) noted increased melt, decreased oil loss, and increased hardness in starch-structured plant-based cheese products, indicating the potential for pea protein inclusion (3-10%) to enhance the functionality of formulations.

Oil content is a critical variable affecting textural performance. Increasing lipid content leads to softer and weaker gels (Masia et al., 2022). An investigation of different plant oil sources indicated that the protein/polysaccharide network is the dominant factor determining gel firmness, where fat source has a lesser effect on rheological properties (Masia et al., 2023). However, Masign et al. (2023) did note a lower peak gel force and stability for products formulated with sunflower oil versus coconut oil. Optimizing oil ratios (e.g., coconut:sunflower) improved melt, stretch, and oil release properties in formulations containing pea protein isolates (Sanfers et al., 2025).

Functional additives also support quality enhancement. Blending pea protein with zein protein highlighted a synergistic interaction between the two, maximizing the lubrication and melting properties contributed by each of the proteins, respectively (Sutter et al., 2023). Inulin was used to replace up to 15% fat in formulations (Mefleh et al., 2022). The inclusion of potassium ions had a positive effect on end-product stability, decreasing syneresis and water loss, and resulted in a more compact structure (Silva et al., 2024). Natural flavourings such as dried oregano and rosemary may successfully mask undesirable legume-notes (Mefleh et al., 2022).

Frozen Desserts

Pea protein beverages or biopolymer mixtures with other ingredients can be processed to create dairy-free frozen desserts. Compared to milk proteins, pea protein frozen desserts demonstrate lower melting rates, higher viscosities, and better shape retention (Hasan et al., 2024; Ng et al., 2024). Inulin has been evaluated as a prebiotic or fat replacer in formulations, with added benefit of improving overrun (Vikram et al., 2022; Narala et al., 2022)

Whipped Cream

Kim et al (2024) evaluated native and ultrasonicated pea protein for its use to produce plant-based whipped creams in combinations with cocoa butter and canola oil. The ultrasonication treatment had a favourable effect, significantly reducing whipping time and foam draining as well as increasing overrun, fat destabilization and hardness compared to native pea protein and dairy whipped cream controls.

ANIMAL-BASED DAIRY

Hybrid Products

The evaluation of pea-milk protein mixed gel models has been conducted to determine the feasibility of developing hybrid dairy formulations. Ben-Harb et al. (2019) demonstrated the ability for pea-dairy mixes to form gels under thermal, acid, and enzymatic treatment conditions. It appears that pea protein and milk proteins form networks independent from one another, where the rheological behaviour is determined by whichever is the major protein fraction in the mixture (Ma et al., 2024; Nascimento et al., 2025). Janahar et al. (2022) also highlighted the importance of fat content in the dairy, where pea protein dispersions blended with skim or raw milk demonstrated shear thinning behaviour, as opposed to the gel-like characteristics derived from pea protein cream blends. Ben-Harb et al (2018) highlighted the ability of fat to strengthen the mechanical properties of pea-mixed gels. Processing technology will also impact final product quality, where ultra shear technology successfully produced stable pea-milk suspensions with no sedimentation up to 15 days under refrigerated conditions due to a reduced particle size - where this effect was not observed with high-pressure or thermal-processing treatments (Janahar et al., 2023).

Milk

Inclusion of 2% pea protein into dairy milk demonstrated its ability to **promote growth of probiotic cultures** in formulation, where the dairy matrix played a critical, protective role in preserving probiotic viability during simulated gastrointestinal digestion compared to oat beverages (Pawlos et al., 2024)

Yogurt

Pea protein is added as a functional ingredient (0.1–0.5%) **increasing water holding capacity and thickness** of yogurt gels, or to **enhance acidification rate of probiotic cultures** (Qin et al., 2025; Zare et al., 2012). Pea protein substitution of 25% milk proteins was also successfully demonstrated to have minimal effects on stability and product quality in **hybrid, high-protein yogurt** formulations (Silva et al., 2024). Pea protein combined with gellan gum demonstrated their potential as an **encapsulation agent to promote delayed release** of flaxseed oil in yogurt formulations (Comunian et al., 2024).

Cheese

Hydrolysates of pea protein isolates have been successfully leveraged as **fat replacers** to develop low-fat or fat-free cheese with acceptable rheological properties (Limit et al., 2024; Zhang et al., 2024). A pizza bake test of low-fat mozzarella cheese containing pea protein hydrolysates showed increased bake, stretch and sensory performance with decreased hardness, stickiness and stretch force (Zhang et al., 2024).

Ice Cream

Pickering emulsions stabilized by pea protein-isolate microgels demonstrated suitability to successfully **replace up to 60% of cream** in reduced saturated-fat ice-cream formulations, with high structural stability, overrun, melting and sensory properties when compared to the 100% cream control (Qin et al., 2024).

Whipped Cream

Pea protein-rutin complexes served as a functional additive in low-fat whipped cream formulations, functioning as an interfacial stabilizer by synergistically absorbing to and reducing the interfacial tension of the air-water interface (Xia et al., 2025). Formulations in which 10% of cream was substituted by this complex demonstrated nearly identical texture, microstructure and stability to full fat whipped cream.

BAKERY APPLICATIONS

Pea protein concentrates and isolates are incorporated into bakery products to increase the content and quality of protein. The complementary amino acid profile to wheat flour expands opportunities to establish protein content claims on packaged foods. Enrichment of wheat bread containing 5% pea protein concentrate **increased the protein content** from 10 to 13g/100g and resulted in **increased *in vitro* protein digestibility** under simulated adult and elderly GI conditions compared to control wheat bread (Moretton et al., 2024). While the dilution of the gluten network typically results in smaller volumes, harder texture, darker crust and detectable pea-like aroma flavour and notes, acceptable products with minimal differences to controls have been formulated at inclusion levels ≤5%. Where a higher inclusion level is desired, there are many opportunities to improve product quality through additions to the formulation (dough strengtheners, vital wheat gluten, hydrocolloids, emulsifiers, fats, and flavour masking ingredients like molasses, honey, or malt) and/or processing conditions (optimize water addition, extended mixing times, lower mixing speeds, reduce baking temperature, extend baking time).

Some functional advantages to pea protein inclusion have emerged in bakery applications. Pea protein concentrate solutions containing zinc were found to be more effective at fortifying biscuits compared to zinc sulfate alone; demonstrating **increased cellular transport, retention and uptake of zinc** (Jindal et al., 2024). Emulsions prepared from butter and water containing 2-4% pea protein isolates added to frozen dough formulations demonstrated ability to serve as **cryoprotectants in frozen doughs** by reducing free water content, inhibiting ice crystal formation, and maintaining the integrity of the gluten network over 4 weeks of frozen storage (Li et al, 2024). As a result, breads produced from frozen doughs containing pea protein exhibit improved loaf volumes and textural properties with minimal baking loss. Research by Pulse Canada indicates the potential for pea protein concentrates to function as binders and browning agents in egg-free formulations.

GLUTEN-FREE BAKING

Pea protein concentrates and isolates are leveraged in gluten-free blends to **develop flour mixtures with comparable nutritional composition to conventional wheat flours** (protein content 10-14%). Compared to gluten-free doughs comprised solely of starch-rich ingredients, **pea protein inclusion significantly enhances the viscoelastic properties of dough**, increasing air bubble retention capacity, resulting in improved crumb textures and volumes (Kumar and Singh, 2024; Shevkani and Singh, 2014). Rolandelli et al. (2024) were able to provide a gluten-free dough from a blend of rice starch, zein, and pea protein isolate containing 1% calcium hydroxide that displayed good rheological properties – similar to gluten at room temperature. It was important to note that this was a synergistic effect between pea protein + zein + alkalinization treatment, where neither pea protein or zein alone under normal or alkalinized conditions demonstrated sufficient rheological performance. Pea protein isolates in combination with xanthum gum have also been demonstrated as suitable **egg replacers** in gluten-free muffins, simultaneously contributing **lower water activity** levels which has potential positive implications on the shelf life (Kumar and Singh, 2024).

PASTA & NOODLES

Pea protein isolates and concentrates have been incorporated into both wheat-based and gluten-free pasta to enhance protein content and modulate textural properties. In wheat noodle formulations, pea protein isolates (2.5–12.5%) interact with starch granules and surface proteins, restricting starch hydration and limiting protein–protein bond formation (Wee et al., 2019). These interactions contributed to increased noodle hardness detected instrumentally but not perceived by sensory panels. Partial substitution of wheat flour with pea protein isolates (0–35%) yielded higher protein noodles with varied sensory attributes depending on inclusion level (Yang et al., 2024). At low levels (<15%), noodles were easier to chew and showed reduced hardness and cohesiveness, whereas at 25%, a decrease in chewing time and increase in stickiness were noted. Structurally, isolates formed fibrous networks with disorganized clumps (Yang et al., 2024). In semolina pasta, inclusion of 3–9% pea protein isolates or concentrates resulted in a more porous microstructure, elevated cooking losses, and increased adhesiveness and firmness; where no major differences were observed between pea protein isolates and concentrates aside from water activity and color (Nguyen et al., 2024).

For gluten-free pasta applications, combining pea protein isolates with inner pea fibre produced al dente sheets with reduced cooking losses and enhanced water uptake (Muneer et al., 2018). However, fibre inclusion diluted protein crosslinking, lowering network strength and extensibility, thus optimal levels were limited to <20%. Processing at 130°C promoted protein–protein interactions necessary for forming cohesive gluten-free structures (Muneer et al., 2018). In blended flour formulations, inclusion of 10–60% isolates with soy flour reduced cooking time and total solids loss, indicating improvements in cooking quality with increasing PPI levels (Rout and Srivastav, 2025).

OTHER APPLICATIONS

- **Functional Beverages:** Pea protein isolate supplementation at 1-2% in apple/orange juices gave relatively acceptable products when compared to control (Zare et al., 2015). Pea protein nanoemulsions served as an effective carrier and stabilizer for vitamin D in non-fat cow milk, canned orange juice, orange juice powder, banana milk and infant formula with minimal impacts on taste or colour (Akkam et al, 2021). Microencapsulation of probiotics using pea protein was discussed as a promising application in infant formulas in Kent and Doherty (2014).
- **Butters/Spreads:** 0.4-0.7% inclusion of pea protein isolate-pectin-pterostilbene complexes in walnut butter promoted a gel network with good spreadability, indicating potential benefits towards the sensory experience and processibility of spreads by promoting smooth extrusion and pump stability (Tang et al., 2025).
- **Sauces:**
    - **Tomato Sauce:** 1-2% pea protein isolate combined with tomato peel powder allowed for optimization of rheological properties, Brix, and moisture content of tomato sauces (Bal et al., 2024).
    - **Egg-free Mayonnaise:** Pea protein isolates conjugated with hydrocolloids, such as xanthan gum and guar gum, show promise serving as functional alternatives to egg yolk in mayonnaise formulations. Studies have shown improved textural and rheological properties of plant-based mayonnaise, where pea protein isolate-conjugates contribute to structural integrity and reduced phase separation, with rheological behaviour, appearance and microstructure closely resembling egg-yolk based mayonnaise (Choi et al., 2023; Shen et al., 2022).
- **Soups:** 2.5-3% inclusion of pea protein isolate in tomato soups was leveraged to meet leucine content for daily older adults' requirements in one serving, its inclusion also increased apparent viscosity, pH, lightness and yellowness (Jamshidvant et al., 2023).

REFERENCES

1. Akkam, Y., Rababah, T., Costa, R., Almajwal, A., Feng, H., Laborde, J. E. A., Abulmeaty, M. M., & Razak, S. (2021). Pea Protein Nanoemulsion Effectively Stabilizes Vitamin D in Food Products: A Potential Supplementation during the COVID-19 Pandemic. Nanomaterials, 11(4), 887. https://doi.org/10.3390/nano11040887

2. Fabiszewska A, Wierzchowska K, Dębkowska I, Śliczniak W, Ziółkowska M, Jasińska K, Kobus J, Nowak D, Zieniuk B. Plant-Based Alternatives to Mold-Ripened Cheeses as an Innovation among Dairy Analogues. Foods. 2024 Jul 22;13(14):2305. doi: 10.3390/foods13142305. PMID: 39063389; PMCID: PMC11275504.

3. Abigail Krentz, Israel García-Cano, Rafael Jiménez-Flores,Functional, textural, and rheological properties of mixed casein micelle and pea protein isolate co-dispersions, JDS Communications,Volume 3, Issue 2, 2022, Pages 85-90, https://doi.org/10.3168/jdsc.2021-0157.

4. Sanders, C., Dobson, S. & Marangoni, A.G. Influence of protein addition in plant-based cheese. MRS Bulletin 49, 998–1004 (2024). https://doi.org/10.1557/s43577-024-00737-2

5. Oliveira, I. C., de Paula Ferreira, I. E., Casanova, F., Cavallieri, A. L. F., Lima Nascimento, L. G., de Carvalho, A. F., & Nogueira Silva, N. F. (2022). Colloidal and Acid Gelling Properties of Mixed Milk and Pea Protein Suspensions. Foods, 11(10), 1383. https://doi.org/10.3390/foods11101383

6. Yang Qin, Shuqin Xie, Shichu Zhou, Hongning Jiang, Xin Wang, Huawei Yin, Zhuping Yu, Rongbo Fan, Rongwei Han, Yongxin Yang, Incorporation of various pea components in goat yogurt: Microstructure and physicochemical characteristics, LWT, Volume 218, 2025, 117432, https://doi.org/10.1016/j.lwt.2025.117432

7. Robert M. Kent, Sinéad B. Doherty, Probiotic bacteria in infant formula and follow-up formula: Microencapsulation using milk and pea proteins to improve microbiological quality, Food Research International, Volume 64, 2014, Pages 567-576, https://doi.org/10.1016/j.foodres.2014.07.029.

8. Carmen Masiá, Raquel Fernández-Varela, Poul Erik Jensen, Saeed Rahimi Yazdi, The impact of different bacterial blends on texture and flavour development in plant-based cheese, Future Foods, Volume 8, 2023, 100250, ISSN 2666-8335, https://doi.org/10.1016/j.fufo.2023.100250.

9. F.G. Silva, A.B.S. Passerini, L. Ozorio, C.S.F. Picone, F.A. Perrechil, Interactions between pea protein and gellan gum for the development of plant-based structures, International Journal of Biological Macromolecules, Volume 255, 2024,128113, https://doi.org/10.1016/j.ijbiomac.2023.128113

10. Qi Tang, Yrjö H. Roos, Nooshin Vahedikia, Song Miao, Evaluation on pH-dependent thermal gelation performance of chickpea, pea protein, and casein micelles, Food Hydrocolloids, Volume 149, 2024, 109618, https://doi.org/10.1016/j.foodhyd.2023.109618.

11. Cameryn Sanders, Jarvis A. Stobbs, Stacie Dobson, Alejandro G. Marangoni; Impact of protein sources on the functionality of plant-based cheeses formulated with saturated and unsaturated fat. Physics of Fluids 1 January 2025; 37 (1): 011913. https://doi.org/10.1063/5.0238556

12. Julie Frost Dahl, Matteo Carrara, Marcello Alinovi, Ruifen Li, Milena Corredig, Production of novel pasta filata analogs containing pea protein isolate using a direct steam injection cooker stretcher: Changes in microstructure and texture, Food Structure, Volume 44, 2025, 100430, https://doi.org/10.1016/j.foostr.2025.100430.

13. Masia, C., Ong, L., Logan, A., Stockmann, R., Gambetta., J., Jensen, P.E., Yazdi, S.R., Gras, S. (2024) Enhancing the textural and rheological properties of fermentation induced pea protein emulsion gels with transglutaminase. Soft Matter, 20, 133-143. DOI: 10.1039/D3SM01001E

14. Rout, S., Srivastav, P.P. Impact of cold-plasma on the nutritional, textural and structural properties of soy and pea protein isolate for the development of plant-based noodles. J Food Sci Technol (2025). https://doi.org/10.1007/s13197-025-06233-y

15. Thanakorn Wongprasert, Pakavit Mathatheeranan, Panatthida Siripitakpong, Tirayut Vilaivan, Utid Suriya, Thanyada Rungrotmongkol, Keith Cadwallader, Inthawoot Suppavorasatit,

16. Thanakorn Wongprasert, Pakavit Mathatheeranan, Panatthida Siripitakpong, Tirayut Vilaivan, Utid Suriya, Thanyada Rungrotmongkol, Keith Cadwallader, Inthawoot Suppavorasatit, Effect of functional groups in strawberry flavoring on pea protein-flavor interactions: Potential applicable in flavor formulation for plant-based protein aqueous foods, Food Chemistry: X, Volume 23, 2024, 101702,https://doi.org/10.1016/j.fochx.2024.101702.

17. Bianca Dimas Rios, Luísa Ozorio, Fabiana Perrechil, Pea protein gels crosslinked with transglutaminase with multiple textures for food formulations, Applied Food Research, Volume 5, Issue 1, 2025, 100931, https://doi.org/10.1016/j.afres.2025.100931.

18. Ben-Harb, S., Saint-Eve, A., Irlinger, F., Souchon, I., & Bonnarme, P. (2022). Modulation of Metabolome and Overall Perception of Pea Protein-Based Gels Fermented with Various Synthetic Microbial Consortia. Foods, 11(8), 1146. https://doi.org/10.3390/foods11081146

19. Chunyang Xia, Fangxiao Lou, Shuo Zhang, Tianfu Cheng, Zhaodong Hu, Zengwang Guo, Ping Ma, The stabilization mechanism of the pea protein and rutin complex at the gas/liquid interface and its application in low-fat cream, Food Chemistry: X, Volume 25, 2025, 102140, https://doi.org/10.1016/j.fochx.2024.102140.

20. Carmen Masiá, Raquel Fernández-Varela, Vera Kuzina Poulsen, Poul Erik Jensen, Kim Ib Sørensen, Composition of bacterial blends for fermentation-induced pea protein emulsion gels using multi-property screening of lactic acid bacteria, Food Bioscience, Volume 56, 2023,103333, https://doi.org/10.1016/j.fbio.2023.103333.

21. Julia Matysek, Anne Baier, Ann-Marie Kalla-Bertholdt, Sandra Grebenteuch, Sascha Rohn, Cornelia Rauh, Effect of ultrasound and fibre enrichment on aroma profile and texture characteristics of pea protein-based yoghurt alternatives, Innovative Food Science & Emerging Technologies, Volume 93, 2024, 103610, https://doi.org/10.1016/j.ifset.2024.103610.

22. Giulia D'Alessio, Francesco Iervese, Luca Valbonetti, Marco Faieta, Paola Pittia, Carla Daniela Di Mattia, Tailoring pea proteins gelling properties by high-pressure homogenization for the formulation of a model spreadable plant-based product, LWT, Volume 207, 2024, 116627, https://doi.org/10.1016/j.lwt.2024.116627.

23. Salma Ben-Harb, Françoise Irlinger, Anne Saint-Eve, Maud Panouillé, Isabelle Souchon, Pascal Bonnarme, Versatility of microbial consortia and sensory properties induced by the composition of different milk and pea protein-based gels, LWT, Volume 118, 2020, 108720, https://doi.org/10.1016/j.lwt.2019.108720.

24. Zhao, P., Li, N., Chen, L., Guo, Y., Huang, Y., Tong, L., Wang, L., Fan, B., Wang, F., & Liu, L. (2023). Effects of Oat β-Glucan on the Textural and Sensory Properties of Low-Fat Set Type Pea Protein Yogurt. Molecules, 28(7), 3067. https://doi.org/10.3390/molecules28073067

25. Demir, H., Aydemir, L. Y., Özel, M. Ş., Koca, E., & Şimşek Aslanoğlu, M. (2023). Application of plant-based proteins for fortification of oat yogurt storage stability and bioactivity. Journal of Food Science, 88, 4079–4096. https://doi.org/10.1111/1750-3841.16729

26. Towhid Hasan, Yin Yin Thoo, Lee Fong Siow, Effect of plant proteins on the physical and thermal properties of dairy-free frozen dessert mix, Food Chemistry Advances, Volume 3, 2023, 100408, https://doi.org/10.1016/j.focha.2023.100408.

27. Structure and physical stability of plant-based food gel systems: Impact of protein (mung bean, pea, potato, soybean) and fat (coconut, sunflower) Masijn, Quinten et al. 2023 Heliyon, Volume 9, Issue 9, e18894

28. Zhitong Zhou, Yalin He, Yanfeng Liu, Yang Deng, Jian Chen, Xiao Liu, Improving the interfacial performance of pea protein via mild fractionation for enhanced lubrication behavior in plant-based emulsions, Food Hydrocolloids, Volume 164, 2025, 111214, https://doi.org/10.1016/j.foodhyd.2025.111214.

29. Luis Gustavo Lima Nascimento, Raiane Rodrigues da Silva, Davide Odelli, Amandine Descamps, Xavier Trivelli, Federico Casanova, Rodolphe Marie, Evandro Martins, Antônio Fernandes de Carvalho, Guillaume Delaplace, Paulo Peres de Sá Peixoto Junior, Impact of protein ratio and thermal treatment on the aggregation and rheological properties of high-concentrated milk and pea protein suspensions, Food Research International, Volume 206, 2025, 116024, https://doi.org/10.1016/j.foodres.2025.116024.

30. Ysamar Rodriguez, Michael Beyrer, Impact of native pea proteins on the gelation properties of pea protein isolates, Food Structure, Volume 37, 2023, 100340, https://doi.org/10.1016/j.foostr.2023.100340.

31.Nunes, M.C., Raymundo, A. & Sousa, I. Gelled vegetable desserts containing pea protein, β-carrageenan and starch. Eur Food Res Technol 222, 622–628 (2006). https://doi.org/10.1007/s00217-005-0170-3

32. Zhang, D., Ling, X., Jiang, K., Zhao, X. and Gan, Y. (2024), Development of low-fat Mozzarella cheeses enriched with soy or pea protein hydrolysates: Composition, texture and functional properties during ageing. Int J Dairy Technol, 77: 165-182. https://doi.org/10.1111/1471-0307.13021

33. Jamshidvant, M., Gallen, N., Dermiki, M. (2023) Development of high protein tomato soup using milk protein concentrate and pea protein isolate. Chemical Engineering Transactions. 103, 43-48. DOI:10.3303/CET23102008

34. Shen, Y., Babu, K.S., Amamcharla, J., Li, Y. (2022) Emulsifying properties of pea protein/guar gum conjugates and mayonnaise application. International Journal of Food Science and Technology. 57, 3955-3966. doi:10.1111/ijfs.15564

35. Choi, H.W., Ham, S.H., Hahn, J., Choi, Y.J. (2023). Developing plant-based mayonnaise using pea protein-xantham gum conjugates: a maillard reaction approach. LWT – Food Science & Technology. 185, 115137. https://doi.org/10.1016/j.lwt.2023.115137

36. Bal, M., Ates, E.G., Erdem, F., Karsli, G.T., Karasu, M.C., Ozarda, O., Mert, B., Oztop, M.H. (2024) Rheological and sensorial behaviour of tomato product enriched with pea protein and olive powder. Frontiers in Sustainable Food Systems. 8, 1358520. DOI 10.3389/fsufs.2024.1358520

37. Tang, Z., Fang, P., Tao, Y., Huang, Q., Xu, X., Cheng, X., Huassain, F., Li, X., Liang, J., Ye, S., Sun, Y. (2025). Enhancing walnut butter with a pea protein isolate-pectin-pterostilbene complex: physicochemical properties and stability analysis. Food Research International. 201, 115541. https://doi.org/10.1016/j.foodres.2024.115541

38. Zare, F., Orsat, V., Boye, J.I. (2015) Functional, physical, and sensory properties of pulse ingredients incorporated into orange and apple juice beverages. Journal of Food Research. 4, 5, 143-156. doi:10.5539/jfr.v4n5p143

39. Muneer, F., Johansson, E., Hedenqvist, M. S, Plivelic, T.S., Markedal, K.E., Peterson, I.L., Sorensen, J.C., Kuktaike, R (2018). The impact of newly produced protein and dietary fiber rich fractions of yellow pea on the structure and mechanical properties of pasta like sheets. Food Research International, 105, 607-618. https://doi.org/10.1016/j.foodres.2018.01.020

40. Wee, M.S.M., Loud, D.E., Tan, V.W.K., Forde, C.G. (2019). Physical and sensory characterisation of noodles with added native and denatured pea protein isolate. Food Chemistry. 294, 152-159. https://doi.org/10.1016/j.foodchem.2019.05.042

41. Yang, C., Leong, S.Y., King, J., Kim, E.H.J., Morgenstern, M.P., Peng, M., Agyeim D. Sutton, K., Oey, I. (2024). Texture evaluation and in vivo oral tactile perceptions of cooked wheat pasta sheets partially substituted with pea protein. Foods. 13, 3798. https://doi.org/10.3390/foods13233798

42. Nguyen, N.P.M, Marzec, A. (2024). Effect of microwave-vacuum drying and pea protein fortification on pasta characteristics. Processes. 12, 2508. https://doi.org/10.3390/pr12112508

43. Rolandelli, G., Ozturk, O.K., Giraldo, A.M.V., Hamaker, B.R., Campanella, O.H. (2024). Textural improvement of pea protein-based high-moisture extrudates with corn zein and rice starch. International Journal of Biological Macromolecules. 281, 135960. https://doi.org/10.1016/j.ijbiomac.2024.135960

44. Shevkani, K., Singh, N. (2014). Influence of kidney bean, field pea and amaranth protein isolates on the characteristics of starch-based gluten-free muffins. International Journal of Food Science and Technology. 49, 2237-2244. doi:10.1111/ijfs.12537

45. Kumar, A., Singh, N. (2024). Comparing gluten-free eggless muffins' viscoelastic, rheological, and textural properties after combining seven plant-based protein isolates with wheat, corn, and rice starches.

46. Li, D., Shi, Y., Ouyand, Z., Teng, Y., Chen, B., Chen, Y., Luo, Y., Zhang, N., Kumar, N., Li, Y., Li, B., Zhu, X. (2024) Pea protein stabilized emulsion as a high performance cryoprotectant in frozen dough: effects on the storage stability and baking performance. Foods. 13, 3940. https://doi.org/10.3390/foods13233840

47. Jindal, A., Patil, N.D., Bains, A., Sharma, M., Kumar, A., Ali, N., Chawla, P., Sridhar, K. (2024). Development of sustainable vegan pea protein-zinc complex: characterization, in vitro cellular mineral uptake and application in functional biscuit production. Journal of Food Biochemistry. 5520236. https://doi.org/10.1155/2024/5520236

48. Moretton, M., Casertano, M., Pellegrini, N., Anese, M., Fogliano, V., Capuano, E. (2024) Effect of high pressure homogenization on in vitre digestibility and colon fermentability of pea protein-rich bread designed for elderly consumers. Food & Function. 15, 10459. DOI: 10.1039/d4fo02767a

49. Shoaib, A., Sahar, A., Sameen, A., Saleem, A., Tahir, A.T. (2018). Use of pea and rice protein isolates as source of meat extenders in the development of chicken nuggets. Journal of Food Processing and Preservation. 42, e13763. DOI: 10.1111/jfpp.13763

50. Miao, X., Hastie, M., Ha, M., Shand, P.J., Warner, R.D. (2023) Physicochemical and compositional properties of blended beef patties formulated with pea and faba protein isolates and texturized pea protein. Sustainable food proteins. 1, 175-186. DOI: 10.1002/sfp2.1021

51.Chan, E., Rodas-Gonzalez, A., Tulbek, M., Koksel, F. (2024). Effects of protein formula and extrusion cooking conditions on the techno-functional properties of texturised pea proteins. International Journal of Food Science and Technology. 59, 584-595. doi:10.1111/ijfs.16593

52. En, Y., Lee, J., Goh, H.M., Huang, D. (2025) Pea protein soften surimi gels and improve in vitro digestibility: Potential high protein foods for elderly. Food Hydrocolloids. 110664. https://doi.org/10.1016/j.foodhyd.2024.110664

53. Zhu, X., Tan, B., Li, K., Liu, S., Gu, Y., Xia, T., Bai, Y., Wang, P., Wang, R. (2022). The impacts of different pea protein isolate levels on functional, instrumental, and textural quality parameters of duck meat batters. Foods. 11, 1620. https://doi.org/10.3390/foods11111620

54. Trindade, P.C.O., dos Santos, B.A., Hollweg, G., Correa, L.P., Pinton, M.B., Padilha, M., Payeras, R.H.Z., Rosa, S.C., Cichoski, A.J., Campagnol, P.C.B. (2023). Pea protein isolate as a meat substitute in canned pork pate: nutritional, technological, oxidative, and sensory properties. Foods. 12, 3486. https://doi.org/10.3390/foods12183486

55. Sun, W., Xiong, Y.L. (2015). Stabilization of cooked cured beef color by radical scavenging pea protein and its hydrolysate. LWT – Food Science and Technology. 61, 352-358. http://dx.doi.org/10.1016/j.lwt.2014.12.048

56. Shen, Y., Hong, S., Du, Z., Chao, M., O'Quinn, T., Li, Y. (2022). Effect of adding modified pea protein as functional extender on the physical and sensory properties of beef patties. LWT- Food Science and Technology. 154, 112774. https://doi.org/10.1016/j.lwt.2021.112774

57. Pinton, M.B., Lorenzo, J.M., dos Santos, B.A., Correa, L.P., Padilha, M., Trindade, P.C.O., Cichoski, A.J., Bermudez, R., Purrinos, L., Cezar, P., Campagnol, B. (2024). Evaluation of nutritional, technological, oxidative, and sensory properties of low-sodium and phosphate-free mortadellas produced with bamboo fiber, pea protein, and mushroom powder. Meat Science. 216, 109588. https://doi.org/10.1016/j.meatsci.2024.109588

58. Barbut, S. (2023). Effects of plant and dairy proteins on the texture and microstructure of lean turkey meat batters. Poultry Science. 102, 102387. https://doi.org/10.1016/j.psj.2022.102387

59. Wu, Q., Zhang, X., Gao, F., Wu, M. (2023). Study on the residence time and texture prediction of pea protein extrusion based on image analysis. Foods. 12, 4408. https://doi.org/10.3390/foods12244408

60. Zhang, Y., and Ryu, G.H. (2023). Effects of process variables on the physicochemical, textural and structural properties of an isolated pea protein-based high-moisture meat analog. Foods. 12, 4413. https://doi.org/10.3390/foods12244413

61. Zahari, I., Ferawati, F., Purhagen, J.K., Rayner, M., Ahlstrom, C., Helstad, A., Ostbring, K. (2021). Development and characterization of extrudates based on rapeseed and pea protein blends using high-moisture extrusion cooking. Foods. 10, 2397. https://doi.org/10.3390/foods10102397

62. Hogg, E., Rauh, C. (2023). Towards a better understanding of texturization during high-moisture extrusion (HME) – Part I: Modeling the texturability of plant-based proteins. Foods. 12, 1955. https://doi.org/10.3390/foods12101955

63. Barnes-Calle, C., Matas, G., Claret, A., Guerrero, L., Fulladosa, E., Goi, P. (2024). High moisture extrusion of pea protein isolate to mimic chicken texture: Instrumental and sensory insights. Food Hydrocolloids. 154, 110129. https://doi.org/10.1016/j.foodhyd.2024.110129

64. Webb, D., Dogan, H., Li, Y., Alav, S. (2022). Use of legume flours and fiber for tailoring structure and texture of pea protein-based extruded meat alternatives. Journal of Food Science. 1-15. DOI: 10.1111/1750-3841.16397

65. Nana Li, Mei Yang, Yahong Guo, Li-Tao Tong, Yongquan Wang, Shuo Zhang, Lili Wang, Bei Fan, Fengzhong Wang, Liya Liu, Physicochemical properties of different pea proteins in relation to their gelation ability to form lactic acid bacteria induced yogurt gel, LWT, Volume 161, 2022, 113381, https://doi.org/10.1016/j.lwt.2022.113381.

66. Chan, E., Rodas-Gonzalez, A., Tulbek, M., Koksel, F. (2024). Effects of protein formula and extrusion cooking conditions on the techno-functional properties of texturised pea proteins. International Journal of Food Science and Technology. 59, 584-595. doi:10.1111/ijfs.16593

67. Moll, P., Salminen, H., Stadtmueller, L., Schmitt, C., Weiss, J. (2023). Comparison of binding properties of a laccase-treated pea protein-sugar beet pectin mixture with a methylcellulose in a bacon-type meat analogue. Foods. 12, 85. https://doi.org/10.3390/foods12010085

68. Chen, Q., Zhang, J., Zhang, Y., Liu, H., Li, T., Wang, Q., Kaplan, D.L. (2023). Microscopic insight into the interactions between pea protein and fatty acids during high-moisture extrusion processing. Food Chemistry. 404, 124176. https://doi.org/10.1016/j.foodchem.2022.134176

69. Dahl, J.F., Bouche, O., Schlangen, M., van Der Goot, A., Corredig, M. (2025). Relationship between rheological parameters and structure formation in high moisture extrusion of plant protein biopolymers. Food Hydrocolloids. 160, 110843. https://doi.org/10.1016/j.foodhyd.2024.110843

70. Dahl, J.F., Bouche, O., Schlangen, M., van Der Goot, A., Corredig, M. (2025). Relationship between rheological parameters and structure formation in high moisture extrusion of plant protein biopolymers. Food Hydrocolloids. 160, 110843. https://doi.org/10.1016/j.foodhyd.2024.110843

71.Rolandelli, G., Ozturk, O.K., Giraldo, A.M.V., Hamaker, B.R., Campanella, O.H. (2024). Textural improvement of pea protein-based high-moisture extrudates with corn zein and rice starch. International Journal of Biological Macromolecules. 281, 135960. https://doi.org/10.1016/j.ijbiomac.2024.135960

72. Wang, Z., Tian, Y., Lou, F., Guo, Z. (2024). Effect of pea protein isolate-soybean meal ratio of fiber structure and texture properties of high-moisture meat analogs. Foods. 13, 3818. https://doi.org/10.3390/foods13233818

73. Richter, J.K., Montero, M.L., Ikuse, M., Wagner, C.E., Ross, C.F., Saunders, S.R., Ganjyal, G.M. (2023). The interaction between wheat and pea protein influences the final chemical and sensory characteristics of extruded high moisture meat analogs. Journal of Food Science. 1-17. DOI: 10.1111/1750-3841.16815

74. Dubey, A., Mateen, A., Singh, N. (2024). Exploring textural, solubility, and rheological characteristics of high-moisture extruded meat analogues: effects of wheat gluten and rice protein incorporation in pea protein isolate and feed moisture levels. International Journal of Food Science and Technology. 59, 5560-5575. doi:10.1111/ijfs.17279

75. Webb, D., Dogan, H., Li, Y., Alav, S. (2022). Use of legume flours and fiber for tailoring structure and texture of pea protein-based extruded meat alternatives. Journal of Food Science. 1-15. DOI: 10.1111/1750-3841.16397

76. De Angelis, D., Kaleda, A., Pasqualone, A., Vaikma, H., Tamm, M., Tammik, M.L., Squeo, G., Summo, C. (2020). Physicochemical and sensorial evaluation of meat analogues produced from dry-fractionated pea and oat proteins.

77. Webb, D., Dogan, H., Li, Y., Alavi, S. (2023). Physico-chemical properties and texturization of pea, wheat, and soy proteins using extrusion and their application in plant-based meat. Foods. 12, 1586. https://doi.org/10.3390/foods12081586

78. Flory, J., Xiao, R., Li, Y., Dogan, H., Talavera, M.J., Alavi, S. (2023). Understanding protein functionality and its impact on quality of plant-based meat analogues. Foods. 12, 3232. https://doi.org/10.3390/foods12173232

79. Plattner, B.J. Hong, S., Li, Y., Talavera, M.J., Dogan, H., Plattner, B.S., Alavi, S. (2024). Use of pea proteins in high-moisture meat analogs: physicochemical properties of raw formulations and their texturization using extrusion. Foods. 13, 1195. https://doi.org/10.3390/foods13081195

80. Zhang, Y., Wang, S., Gao, Y., Sun, C., Zhao, Y., Cao, Y., Lu, W., Zhang, Y., Fang, Y. (2025). High moisture extrusion of pulse proteins: Texture, structure, and in vitro digestion characteristics of extrudates. Food Hydrocolloids. 159, 110676, https://doi.org/10.1016/j.foodhyd.2024.110676

81. Osen, R., Toelstede, S., Wild, F., Eisner, P., Schweiggert-Weisz, U. (2014). High moisture extrusion cooking of pea protein isolates: raw material characteristics, extruder responses, and texture properties. Journal of Food Engineering. 127, 67-74. http://dx.doi.org/10.1016/j.jfoodeng.2013.11.023

82. Baig, M.A., Mostaga, H., Sivapragasam, N., Aslam, R., Zhou, W., Maqsood, S. (2024). Investigating the role of starch in the structuring of meat alternatives from mung bean and pea protein isolates via heat-induced gelation. Frontiers in Sustainable Food Systems. 8, 1473663. doi: 10.3389/fsufs.2024.1473663

83. Bhuiyan, M.H.R., Liu, L., Samaranayaka, A., Ngadi, M. (2025) Characterization of pea composites and feasibility of heaet-modulated meat analogs production. Food Chemistry. 463, 141282. https://doi.org/10.1016/j.foodchem.2024.141282

84. Dinani, S.T., Carrillo, M.F.C., Boom, R., van der Goot, A.J. (2023) Quality improvement of plant-based meat alternatives by addition of ioata carrageenan to pea protein-wheat gluten blend. European Food Research and Technology. 249, 1637-1654. https://doi.org/10.1007/s00217-023-04244-7

85. Zhang, Z. Kobata, K., Pham, H., Kos, D., Tan, Y., Lu, J., McClements, D.J. (2022) Production of plant-based seafood: scallop analogs formed by enzymatic gelation of pea protein-pectin mixtures. Foods, 11, 851. https://doi.org/10.3390/foods11060851

86. Kim, T., Miller, R., Laird, H., Riaz, M.N. (2021). Beef flavor vegetable hamburger patties with high moisture meat analogs (HMMA) with pulse proteins- peas, lentils, and faba beans. Food Science & Nutrition. 00, 1-9. DOI: 10.1002/fsn3.2172

87. Carlin, J., Wang, N., Asavajaru, P., Polley, B., Kompany-Zareh, M., Bhowmik, P., Berrué, F. and Samaranayaka, A. (2025), Proximate Composition, In Vitro Protein Digestibility, and Micronutrient Density of Commercial Pea, Faba Bean, and Lentil Protein Isolates and Concentrates. Sust Food Prot, 3: e70006. https://doi.org/10.1002/sfp2.70006

88. Johnston AJ, Mollard RC, Dandeneau D, MacKay DS, Ames N, Curran J, Bouchard DR, Jones PJ. Acute effects of extruded pea fractions on glycemic response, insulin, appetite, and food intake in healthy young adults, results of a double-blind, randomized crossover trial. Appl Physiol Nutr Metab. 2021 Sep;46(9):1126-1132. doi: 10.1139/apnm-2020-0571. Epub 2021 Mar 4. PMID: 33661714.

89. Kadam A, Ozkan K, Du P, Koksel H, Sagdic O, Koksel F. Impact of Pea Protein Isolate Enrichment on the Nutritional, Functional, and Glycemic Properties of Tarhana. Plant Foods Hum Nutr. 2025 Jan 6;80(1):30. doi: 10.1007/s11130-024-01281-9. PMID: 39760797.

90. Thondre PS, Achebe I, Sampson A, Maher T, Guérin-Deremaux L, Lefranc-Millot C, Ahlström E, Lightowler H. Co-ingestion of NUTRALYS® pea protein and a high-carbohydrate beverage influences the glycaemic, insulinaemic, glucose-dependent insulinotropic polypeptide (GIP) and glucagon-like peptide-1 (GLP-1) responses: preliminary results of a randomised controlled trial. Eur J Nutr. 2021 Sep;60(6):3085-3093. doi: 10.1007/s00394-021-02481-8. Epub 2021 Jan 29. PMID: 33515092.

91. Singh RG, Guérin-Deremaux L, Lefranc-Millot C, Perreau C, Crowley DC, Lewis ED, Evans M, Moulin M. Efficacy of Pea Protein Supplementation in Combination with a Resistance Training Program on Muscle Performance in a Sedentary Adult Population: A Randomized, Comparator-Controlled, Parallel Clinical Trial. Nutrients. 2024 Jun 26;16(13):2017. doi: 10.3390/nu16132017. PMID: 38999765; PMCID: PMC11243455.

92. Babault N, Païzis C, Deley G, Guérin-Deremaux L, Saniez MH, Lefranc-Millot C, Allaert FA. Pea proteins oral supplementation promotes muscle thickness gains during resistance training: a double-blind, randomized, Placebo-controlled clinical trial vs. Whey protein. J Int Soc Sports Nutr. 2015 Jan 21;12(1):3. doi: 10.1186/s12970-014-0064-5. PMID: 25628520; PMCID: PMC4307635.

93. Pinckaers PJM, Smeets JSJ, Kouw IWK, Goessens JPB, Gijsen APB, de Groot LCPGM, Verdijk LB, van Loon LJC, Snijders T. Post-prandial muscle protein synthesis rates following the ingestion of pea-derived protein do not differ from ingesting an equivalent amount of milk-derived protein in healthy, young males. Eur J Nutr. 2024 Apr;63(3):893-904. doi: 10.1007/s00394-023-03295-6. Epub 2024 Jan 16. PMID: 38228945; PMCID: PMC10948472.

94. Shin, JS., Kim, BH., Kim, HS. et al. Optimization of pea protein and citrus fiber contents for plant based stirred soymilk yogurt using response surface methodology. Food Sci Biotechnol 31, 1691–1701 (2022). https://doi.org/10.1007/s10068-022-01180-2

95. Mefleh, M., Pasqualone, A., Caponio, F., De Angelis, D., Natrella, G., Summo, C. and Faccia, M. (2022), Spreadable plant-based cheese analogue with dry-fractioned pea protein and inulin–olive oil emulsion-filled gel. J Sci Food Agric, 102: 5478-5487. https://doi.org/10.1002/jsfa.11902

96. Masiá, C., Jensen, P. E., Petersen, I. L., & Buldo, P. (2022). Design of a Functional Pea Protein Matrix for Fermented Plant-Based Cheese. Foods, 11(2), 178. https://doi.org/10.3390/foods11020178

97. Yufeng Lin, Katherine Maloney, MaryAnne Drake, Haotian Zheng, Synergistic functionality of transglutaminase and protease on modulating texture of pea protein based yogurt alternative: From rheological and tribological characterizations to sensory perception, Food Hydrocolloids, Volume 150, 2024, 109652, https://doi.org/10.1016/j.foodhyd.2023.109652

98. Vikram Reddy Narala, Madara Asnate Jugbarde, Ivars Orlovs, Markus Masin, Inulin as a prebiotic for the growth of vegan yoghurt culture in pea protein-based vegan yoghurt-ice cream, while improving the textural properties, Applied Food Research, Volume 2, Issue 2, 2022, 100136, https://doi.org/10.1016/j.afres.2022.100136.

99. Túlio Henrique Batista Silva, Débora Parra Baptista, Kívea Kássia de Paiva e Silva, Paulo Henrique Mariano Marfil, Mirna Lúcia Gigante, Hybrid high-protein yogurt made with partial replacement of milk proteins by pea proteins, International Journal of Food Science and Technology, Volume 59, Issue 11, November 2024, Pages 8806–8815, https://doi.org/10.1111/ijfs.17556

100. Kim, I., & Moon, K.-D. (2024, February). Quality characteristics of plant-based whipped cream with ultrasonicated pea protein. Food Science and Preservation. The Korean Society of Food Preservation. https://doi.org/10.11002/fsp.2024.31.1.64

101. Hasan, T., Thoo, Y. and Siow, L. (2024), Influence of Brown Rice, Pea, and Soy Proteins on the Physicochemical Properties and Sensory Acceptance of Dairy-Free Frozen Dessert. Food Sci Nutr, 12: 9391-9402. https://doi.org/10.1002/fsn3.4494

102. Ilianna Drositi, Giovanni Barone, Claus Heiner Bang-Berthelsen, Lilia Ahrné, Processability and physicochemical properties of plant-based dispersions formulated with oat, pea, and potato concentrates intended for the production of yoghurt analogues, Journal of Food Engineering, Volume 402, 2026, 112673, https://doi.org/10.1016/j.jfoodeng.2025.112673.

103. R. Sutter, M. Assad-Bustillos, E. Windhab, Zein improves desirable melt-stretch properties in plant-based cheeses made from pea protein, Food Hydrocolloids, Volume 144, 2023, 108981, https://doi.org/10.1016/j.foodhyd.2023.108981.

104. Vikram Reddy Narala, Ivars Orlovs, Madara Asnate Jugbarde, Markus Masin, Inulin as a fat replacer in pea protein vegan ice cream and its influence on textural properties and sensory attributes, Applied Food Research, Volume 2, Issue 1, 2022, 100066, https://doi.org/10.1016/j.afres.2022.100066.

105. Ettinger, L., Stright, A., Frampton, K., Baxter, L., Dabas, T., Gorman, M., Moss, R., & McSweeney, M. B. (2024). Sensory properties of thickened and protein-enriched plant-based frozen desserts. Journal of Texture Studies, 55(2), e12825. https://doi.org/10.1111/jtxs.12825

106. Jerish Joyner Janahar, V.M. Balasubramaniam, Rafael Jimenez-Flores, Osvaldo H. Campanella, Israel García-Cano, Da Chen, Pressure, shear, thermal, and interaction effects on quality attributes of pea–dairy protein colloidal dispersions, Food Hydrocolloids, Volume 131, 2022, 107811, https://doi.org/10.1016/j.foodhyd.2022.107811.

107. Sun, J., Yang, X., Diao, J., Wang, Y., & Wang, C. (2025). Exploration of Pea Protein Isolate–Sodium Alginate Complexes as a Novel Strategy to Substitute Sugar in Plant Cream: Synergistic Interactions Between the Two at the Interface. Foods, 14(6), 991. https://doi.org/10.3390/foods14060991

108. Laura Bäuerle, Sabine Kühn, Development of a protein supplemented fruit smoothie using pea protein isolate as a plant-based protein alternative, Future Foods, Volume 5, 2022, 100145, https://doi.org/10.1016/j.fufo.2022.100145.

109. M. Klost, S. Drusch, Structure formation and rheological properties of pea protein-based gels, Food Hydrocolloids, Volume 94, 2019, Pages 622-630, https://doi.org/10.1016/j.foodhyd.2019.03.030.

110. Cheryl Kwoek Zhen Ng, Wei Qi Leng, Churn Hian Lim, Juan Du, Physicochemical property characterization, amino acid profiling, and sensory evaluation of plant-based ice cream incorporated with soy, pea, and milk proteins, Journal of Dairy Science, Volume 107, Issue 12, 2024, Pages 10268-10279,https://doi.org/10.3168/jds.2024-25008.

111. Carmen Masiá, Shaghayegh Keshanidokht, Lærke Due Preisler, Jens Risbo, Poul Erik Jensen, Plant lipid sources in fermented pea protein gels: Emulsion stability and gel microstructure, LWT, Volume 182, 2023, 114890, ISSN 0023-6438, https://doi.org/10.1016/j.lwt.2023.114890.

112. Qin, X., Guo, Y., Zhao, X., Liang, B., Sun, C., Li, X., & Ji, C. (2024). Fabricating Pea Protein Micro-Gel-Stabilized Pickering Emulsion as Saturated Fat Replacement in Ice Cream. Foods, 13(10), 1511. https://doi.org/10.3390/foods13101511

113. Pawlos, M.; Szajnar, K.; Znamirowska-Piotrowska, A. Probiotic Milk and Oat Beverages with Increased Protein Content: Survival of Probiotic Bacteria Under Simulated In Vitro Digestion Conditions. Nutrients 2024, 16, 3673. https://doi.org/10.3390/nu16213673

114. S. Ben-Harb, M. Panouillé, D. Huc-Mathis, G. Moulin, A. Saint-Eve, F. Irlinger, P. Bonnarme, C. Michon, I. Souchon, The rheological and microstructural properties of pea, milk, mixed pea/milk gels and gelled emulsions designed by thermal, acid, and enzyme treatments, Food Hydrocolloids, Volume 77, 2018, Pages 75-84, https://doi.org/10.1016/j.foodhyd.2017.09.022.

115. F. Zare, C.P. Champagne, B.K. Simpson, V. Orsat, J.I. Boye, Effect of the addition of pulse ingredients to milk on acid production by probiotic and yoghurt starter cultures, LWT - Food Science and Technology, Volume 45, Issue 2, 2012, Pages 155-160, https://doi.org/10.1016/j.lwt.2011.08.012.

116. Zhang, D., Ling, X., Jiang, K., Zhao, X., Gan, Y. (2024) Development of low-fat Mozzarella cheeses enriched with soy or pea protein hydrolysates: composition, texture and functional properties during ageing. International Journal of Dairy Technology. 77, 1, 165-182 doi: 10.1111/1471-0307.13021

117. Manhal Yousseef, Céline Lafarge, Dominique Valentin, Samuel Lubbers, Florence Husson. Fermentation of cow milk and/or pea milk mixtures by different starter cultures: Physico-chemical and sensorial properties. LWT - Food Science and Technology, Elsevier, 2016, 69, pp.430-437. 10.1016/j.lwt.2016.01.060.

118. Omrani Khiabanian N, Motamedzadegan A, Naghizadeh Raisi S, Alimi M. Chemical, textural, rheological, and sensorial properties of wheyless feta cheese as influenced by replacement of milk protein concentrate with pea protein isolate. J Texture Stud. 2020; 51: 488–500. https://doi.org/10.1111/jtxs.12508

119. Talita A. Comunian, Daniela Freitas, Gaetan Drouin, Audrey Maudhuit, Guillaume Roelens, Denis Poncelet, Stephan Drusch, André Brodkorb, Microencapsulation of flaxseed oil in pea protein-gum arabic complex coacervates delays lipid digestion in liquid yoghurt, Food Research International, Volume 187, 2024, 114307, https://doi.org/10.1016/j.foodres.2024.114307.

120. Xingfa Ma, Ran Feng, Lilia Ahrné, Vibeke Orlien, Pressure-induced gelation of blended milk and pea protein suspensions, Food Hydrocolloids, Volume 146, Part A, 2024, 109284, https://doi.org/10.1016/j.foodhyd.2023.109284.

121. Jerish Joyner Janahar, V.M. Balasubramaniam, Rafael Jiménez-Flores, Osvaldo H. Campanella, Bhavesh Patel, Joana Ortega-Anaya, Impact of ultra-shear technology on quality attributes of model dairy-pea protein dispersions with different fat levels, Current Research in Food Science, Volume 6, 2023, 100439, https://doi.org/10.1016/j.crfs.2023.100439.

122. Teng, C., & Campanella, O. H. (2023). A Plant-Based Animal Fat Analog Produced by an Emulsion Gel of Alginate and Pea Protein. Gels, 9(5), 393. https://doi.org/10.3390/gels9050393 Wenjie Xia, Ilianna Drositi, Tomasz Pawel Czaja, Matias Via, Lilia Ahrné, Towards hybrid protein foods: Heat- and acid-induced hybrid gels formed from micellar casein and pea protein, Food Research International, Volume 198, 2024, 115326, https://doi.org/10.1016/j.foodres.2024.115326.

123. Mei Yang, Nana Li, Litao Tong, Bei Fan, Lili Wang, Fengzhong Wang, Liya Liu, Comparison of physicochemical properties and volatile flavor compounds of pea protein and mung bean protein-based yogurt, LWT, Volume 152, 2021, 112390, https://doi.org/10.1016/j.lwt.2021.112390.

124. Dian W. Ningtyas, Bhesh Bhandari, Sangeeta Prakash, Modulating the fat globules of plant-based cream emulsion: Influence of the source of plant proteins, Innovative Food Science & Emerging Technologies, Volume 74, 2021, 102852, https://doi.org/10.1016/j.ifset.2021.102852.

125. Bing-Fan Chuang, Sheng-Yi Chen, Jer-An Lin, Gow-Chin Yen, Modifying pea protein by cold plasma for the development of functional vegan cheese, Food Bioscience, Volume 65, 2025, 106017, https://doi.org/10.1016/j.fbio.2025.106017.

126. Nana Li, Mei Yang, Yahong Guo, Li-Tao Tong, Yongquan Wang, Shuo Zhang, Lili Wang, Bei Fan, Fengzhong Wang, Liya Liu, Physicochemical properties of different pea proteins in relation to their gelation ability to form lactic acid bacteria induced yogurt gel, LWT, Volume 161, 2022, 113381, https://doi.org/10.1016/j.lwt.2022.113381.

127. Tanger, C., Utz., F., Sapaccasassi, A., Kreissl, J., Dombrowski, J., Dawid, C., Kulozik, U. (2021). Influence of pea and potao protein microparticles on texture and sensory properties in a fat reduced model milk dessert. ACS Food Science & Technology. 2, 1, 169-179. https://doi.org/10.1021/acsfoodscitech.1c00394