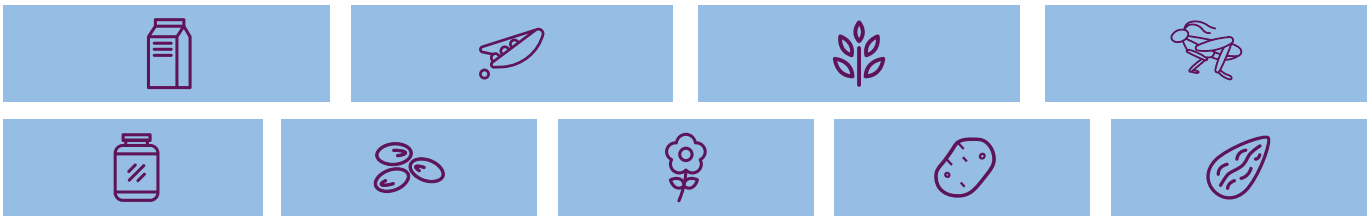
Research Brief

Comparing commercial processing of dairy and plant protein ingredients



High protein food launches are on the rise globally,[1] and this demand growth is fueling innovations in protein processing alongside enhancements in protein functionality. Protein ingredients play an integral role in formulating food products by providing nutrition, taste and functionality which are all key for a great consumer experience. Differences in protein nutritional quality between dairy and plant protein ingredients are well documented in the scientific literature, utilizing measures such as the Protein Digestibility-Corrected Amino Acid Score (PDCAAS) and Digestible Indispensable Amino Acid Score (DIAAS).

Yet, the manufacturing perspective for how these different sources of proteins are isolated, concentrated and dried into powders during commercial processing had yet to be compiled and assessed on a comparative basis. Having this fact-based information is important to scientifically establish how dairy compares to alternative protein counterparts in terms of the degree of processing and influence on environmental resources, such as water. This is especially critical at a time when increasingly sustainable food production is paramount to addressing the challenge of providing valuable nutrition to the growing global population.

Objective

Systematic comparison of the processing of dairy and selected proteins.

Benchmark and understand how different protein ingredients are processed.

Methodology

The review was conducted by RTI Innovation Advisors and funded by the National Dairy Council, Dairy Management, Inc.[2]

Landscape survey comparing commercial processing methodologies
of post-harvest raw material into dry protein powders.

Compilation of science-based insights
from scientific journals, equipment manufacturers, protein processing company websites, patents, trade journals and consumer research studies.

Mapped processing steps and key inputs/outputs for four dairy proteins
(milk protein concentrate/isolate, whey protein concentrate/isolate) and 13 alternative proteins (soy protein concentrate/isolate, rice, pea, wheat, almond, chickpea, lupine, potato, chia, algae, canola, cricket).

Multiple metrics associated with protein processing and sustainability
including raw material inputs, resource utilization, number of processing steps, yield, value-added by-products, water and energy usage were evaluated.

Key Learnings

1 Commercial processing of mainstream and emerging protein ingredients involves a variety of processing steps and techniques which complicates direct comparison.

The **starting materials** for proteins vary.

Some come from the whole raw material such as:

 MILK

 PEA

 WHEAT

 CRICKET

Whereas others are co-products of another production stream:

 WHEY

 SOY

 CANOLA

 POTATO

 ALMOND

Protein flours typically require the **fewest processing steps** of the proteins examined.

Isolation/purification and drying steps **are common to almost all** protein ingredients.

In general, the number of processing steps **increases with rising protein content** of the final ingredient, whether concentrate or isolate.

2 Protein ingredients differ in terms of usage of water and processing aids such as solvents (e.g., hexane, ethanol and alcohol), salts, acids (e.g. 1-2 N HCL), caustic agents (e.g. 1-2 N NaOH), bases, etc.

Depending on the starting raw material, processing of **some plant-based protein** concentrates and isolates such as soy, potato, canola, pea and almond **may require the use of processing aids during processing** in order to extract the protein.

Dairy protein processing primarily uses physical separation, via filtration methods, that **do not require the use of processing aids.**

*The only exception is ion exchange WPI.

Protein processing schematics of select protein concentrates made from whole raw materials

Milk Proteins

Cream Separation → Filtration → Concentration → Drying

Pea Proteins

Pre-Processing (Splitting/Dehulling/ Grinding) → **Acid-Base Extraction** → Decanting/Filtration/ Separation → Precipitation → **Decanting/ Washing/ Neutralization** → Drying

Rice Protein

Enzyme Addition → Extraction → Filtration/ Separation → Drying → Screening and Milling

Wheat Protein

Dough Forming → Extraction/Dough Washing → Concentration → Purification → Drying → Grinding

Chickpea Protein

Pre-Processing/ Preparation → **Extraction** → Filtration/ Separation → Purification → Concentration → Drying

Protein processing schematics of select protein concentrates made from co-product

Whey Proteins

Clarification and Cream Separation → Filtration → Concentration → Drying

Soy Proteins

Extraction (may be multistage) → **Neutralization** → Drying (may include ultra-filtration) → Grinding

Almond Proteins

Defatted Almond Meal Extraction (can be multistage) → **Concentration** → Purification → Drying (may include ultra-filtration) → Grinding/Crushing/ Screening

Potato Proteins

Pre-Processing/ Preparation → **Acid Precipitation** → Filtration/Separation → Purification → Concentration → Drying

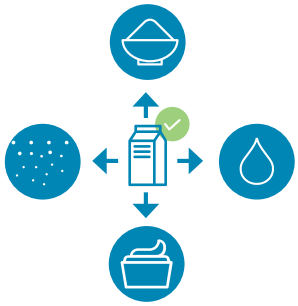
Canola Proteins

Pre-Processing / Preparation → **Extraction** → Filtration/ Separation → Concentration → Purification → Drying

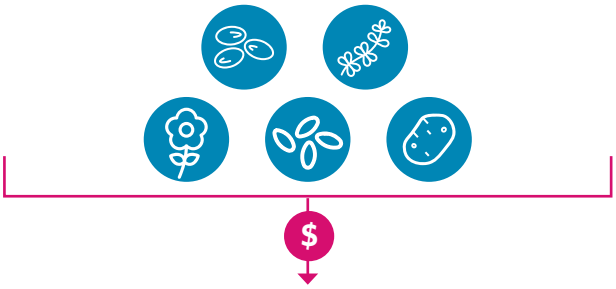
KEY:

Steps that use solvents, salts, acid, bases, etc.

3 During protein isolation/purification, co-products are produced which must be utilized or disposed.



Co-products of dairy protein processing (e.g., permeate, lactose, minerals, whey cream) are versatile and tend to **find more value-added uses in food applications than plant proteins.**



Soy protein co-products are typically sold as animal feed ingredients (low value) while other **alternative protein sources** such as lupine, canola, chia and potato **have limited or no identified uses for co-products.**

4 U.S. dairy proteins may have a similar environmental impact to plant proteins when normalized according to nutritional quality rather than according to the food's raw weight or caloric content.

Land surface use and greenhouse gas emissions, for amounts sufficient to match the recommended dietary allowance of essential amino acids, **are comparable between dairy and most plant proteins.**

Nutritionally, dairy proteins and soy proteins contain all the essential amino acids, whereas many other plant proteins are generally considered incomplete as they lack one or more of the essential amino acids and/or have them in insufficient quantity relative to the body's need.

Summary/Implications

Dairy proteins are clean/ clear label friendly.

They are produced using physical (not chemical) separation and, unlike many plant proteins, generally do not require the use of processing aids.

Dairy ingredients can play a role in sustainable food formulations.

They help support reduced food waste thanks to multiple value-added usage opportunities for their co-products which are used in a variety of food applications.

Data, related to yield, water and energy usage between different sources of protein, were either unavailable or insufficient for further conclusions.

SOURCES:
Innova Database. 2019. [1] | RTI Innovation Advisors Consulting Report. 2020. Unpublished. [2]

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