



Application of Proteins to Make Healthier Food Products

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Agenda

Introduction

Protein Quality

Protein Functionality & Applications

Summary



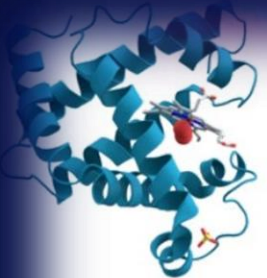
Introduction



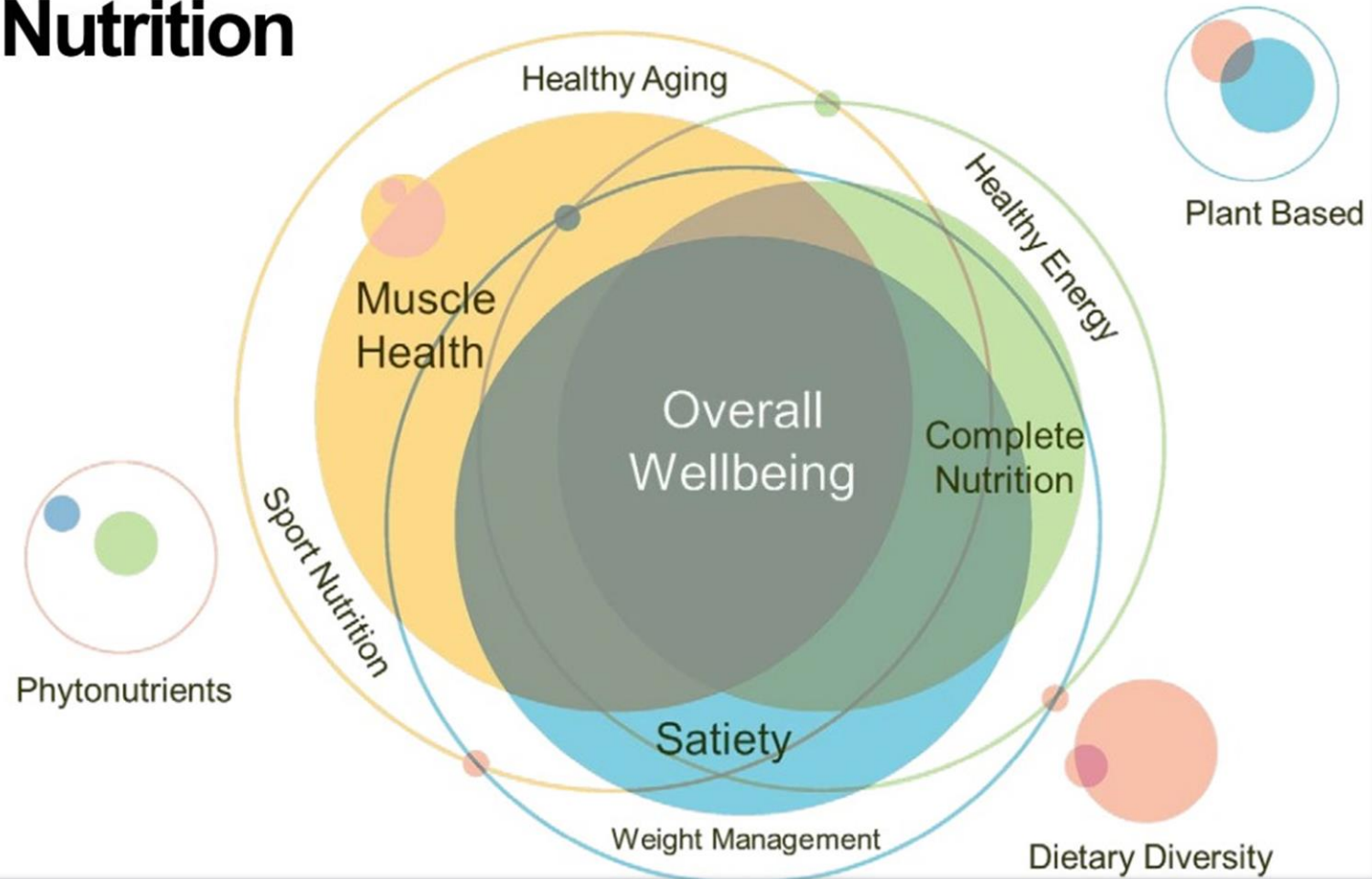
“Man's health and well-being depends upon, among many things, the proper functioning of the myriad proteins that participate in the intricate synergisms of living systems.”

— Stanford Moore

Nobel Prize Banquet Speech (10 Dec 1972).



Protein Nutrition



Roles of Protein

Nutrition	Structure	Catalysts	Functional properties	Browning
<ul style="list-style-type: none">▪ Energy and essential amino acids▪ May cause allergies and be toxic/ carcinogenic	<ul style="list-style-type: none">▪ Provide structure in living organisms and also foods	<ul style="list-style-type: none">▪ Enzymes catalyze chemical reactions in living tissue and foods	<ul style="list-style-type: none">▪ Gelation▪ Emulsifiers▪ Water bonding▪ Increase viscosity▪ Texture	<ul style="list-style-type: none">▪ Have amino acids that can react with reducing sugars▪ Some enzymes can also cause browning

Protein Quality

What are Proteins made of?

Amino Acids: Building Blocks of Protein

- Proteins are linear heteropolymers of α -amino acids
- Amino acids (AA) have properties that are well-suited to carry out a variety of biological functions

Amino Acids Classification

Essential (indispensable) amino acids

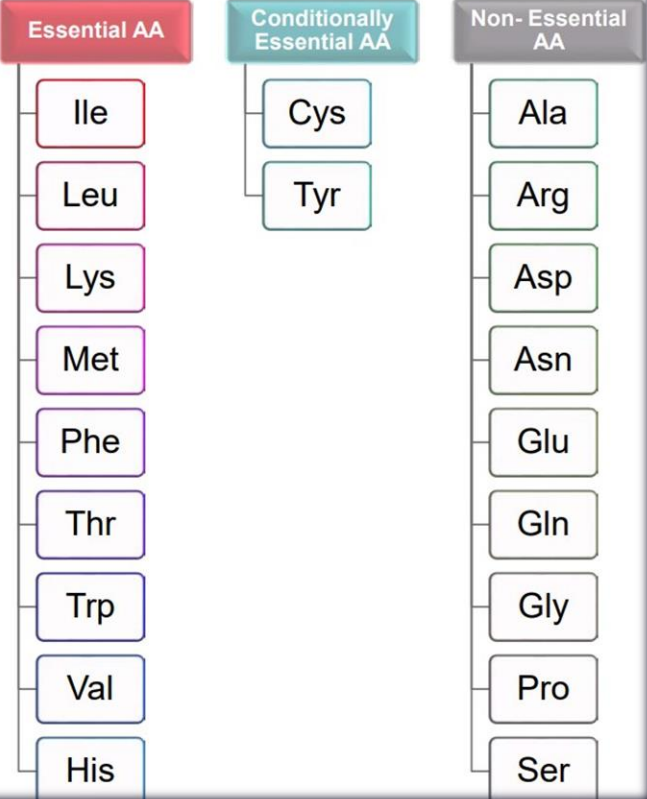
- Body **cannot synthesize** sufficient amounts
- Must include in diet

Nonessential (dispensable) amino acids

- Body **can synthesize**

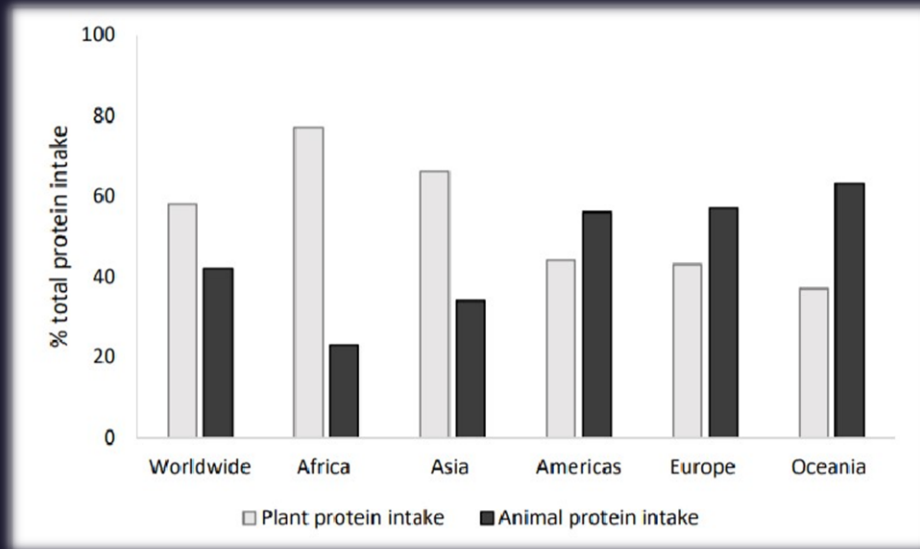
Conditionally essential amino acids

- Require a dietary source when metabolic need not meet endogenously



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Protein Quality: Animal vs. Plant



Food	PDCAAS	DIAAS	Limiting AA
MPC ^a	1.00	1.18	Met + Cys
WPI ^a	1.00	1.09	Val
SPI ^a	0.98	0.90	Met + Cys
PPC ^a	0.89	0.82	Met + Cys
RPC ^a	0.42	0.37	Lys
Whole milk ^b	1.00	1.14	Met + Cys
Chicken breast ^b	1.00	1.08	Trp
Egg (hard boiled) ^b	1.00	1.13	His
Cooked peas ^a	0.60	0.58	Met + Cys
Cooked rice ^a	0.62	0.59	Lys
Almonds ^b	0.39	0.40	Lys
Chickpeas ^b	0.74	0.83	Met + Cys
Tofu ^b	0.56	0.52	Met + Cys
Corn-based cereal ^a	0.08	0.01	Lys
Hydrolyzed collagen ^c	0.0	0.0	Trp

PDCAAS, protein digestibility-corrected amino acid score; DIAAS, digestible indispensable amino acid score; MPC, milk protein concentrate; WPI, whey protein isolate; SPI, soy protein isolate; PPC, pea protein concentrate; RPC, rice protein concentrate; Trp, tryptophan.

^aValues from Ref. (26).

^bValues from Ref. (24).

^cHydrolyzed collagen has a PDCAAS and DIAAS of 0 since it contains no Trp and is very low in methionine (27).

Dairy Proteins

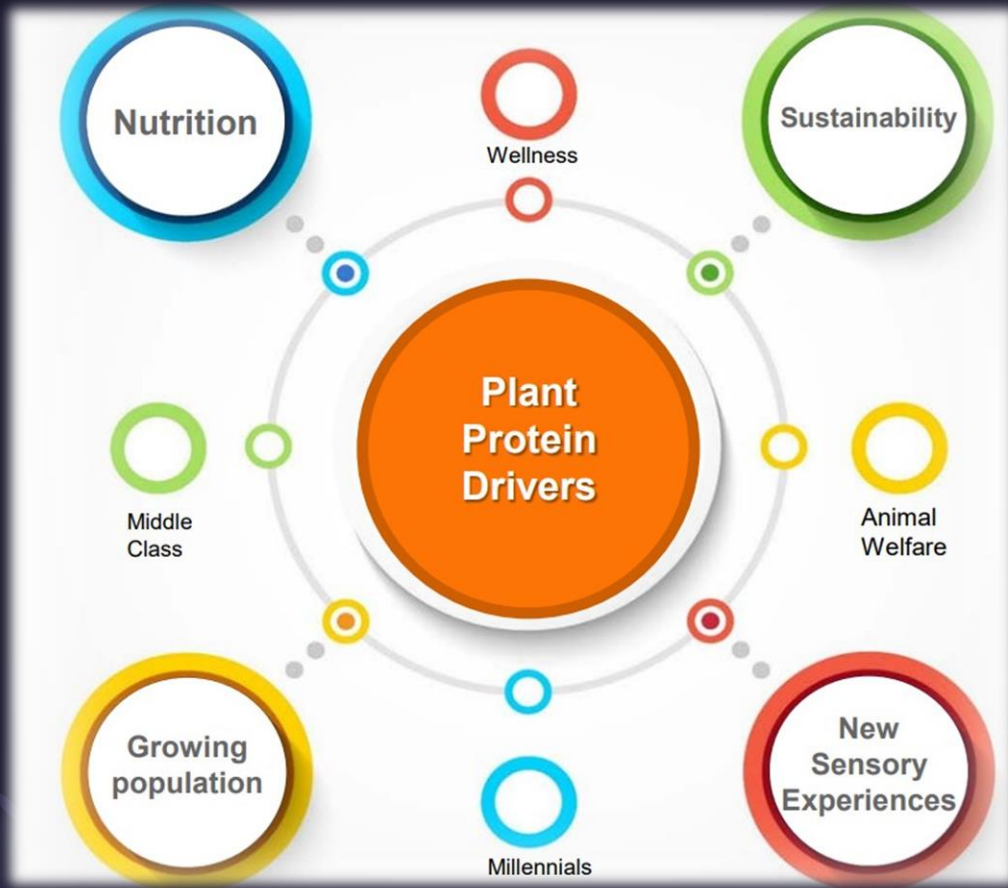
Milk-Derived

- **Milk Protein Concentrate (MPC)** – Ultrafiltration and diafiltration of milk results in 39.5% to 84.5% protein content.
- **Milk Protein Isolate (MPI)** – Ultrafiltration and diafiltration of milk results in a minimum of 89.5% protein content.
- **Milk Whey Protein** – This protein is obtained from bovine milk or skim milk by the removal of casein and non-protein constituents so that the finished dry product contains not less than 25% protein.
- **Micellar Casein** – This is a protein produced by microfiltration that has a higher casein-to-whey protein ratio than that found in milk.

Whey-Derived

- **Whey Protein Concentrate (WPC)** – A certain percentage of nonprotein constituents are removed from pasteurized whey through physical techniques such as precipitation, filtration, or dialysis. The finished dry product contains a minimum of 25% protein.
- **Whey Protein Isolate (WPI)** – Nonprotein constituents are removed from whey by physical or chemical separation techniques so the finished dry product contains not less than 90% protein on a dry matter basis.
- **Whey Protein Hydrolysate (WPH)** – Whey proteins are enzymatically hydrolyzed into smaller functional peptides for increased bio-availability and absorption.
- **Sweet Whey Powder** – Pasteurized fresh whey is dried, retaining all constituents except moisture in the same relative ratio.
- **Whey Permeate** – The high-lactose ingredient is produced when protein and other solids are physically separated from whey.

Emergence of Plant Protein



In replacing beef with plants in the US (per person per year):

Source: "Environmentally Optimal, Nutritionally Aware Beef Replacement Plant-Based Diets"



Croplands



1,273 m³

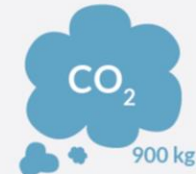


90%



126 m³

Greenhouse gas emissions



900 kg



96%



33 kg

Nitrogen fertilizer



12 kg



94%



0.7 kg

*Note: Icons are not to scale, because a 90% decrease would be ridiculously small.

Plant Proteins

Pulse protein



Cereal protein



Potato protein



Water lentil protein



Nuts protein




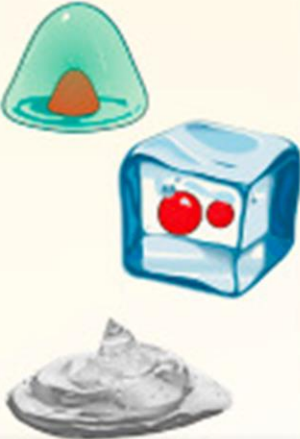
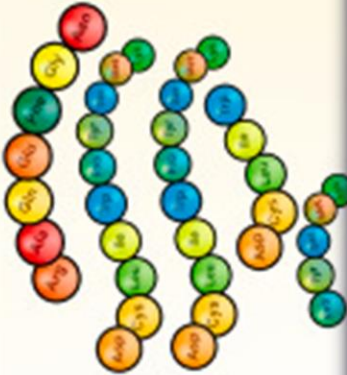


Oilseed protein











Protein Functionality & Applications

Broad spectrum application

Protein supplements	Edible films and coatings	Emulsion stabilizer or Emulsifier	Hydrogels	Bioactive peptides
				

Food Formats

<p>Dry blended beverages</p> 	<p>Protein-enriched baked goods (e.g. granola)</p> 	<p>Vegan foamed confectionery</p> 	<p>Fresh dairy-free foods</p> 
<p>Gluten-free baked goods</p> 	<p>Protein Bars</p> 	<p>Protein-enriched snacks</p> 	<p>Meat analogues</p> 

Application vs. Functionality

Food	Functionality
Processed meats	Emulsification, water binding, gelation, texture, dispersibility
Cream soups & sauces	Viscosity, emulsification, moisture retention, whiteness
Bakery products	Film formation, texture, gelation, water binding, foaming, browning
Beverages	Solubility, viscosity, heat stability
Dairy products	Emulsification, viscosity, foaming, gelation, texture
Egg substitutes	Foaming, gelation
Confectionary products	Dispersibility, emulsification
Nutrition bars	Very low water binding, texture

Challenges & Solutions

Plant Proteins

Pulse protein



Cereal protein



Potato protein



Water lentil protein



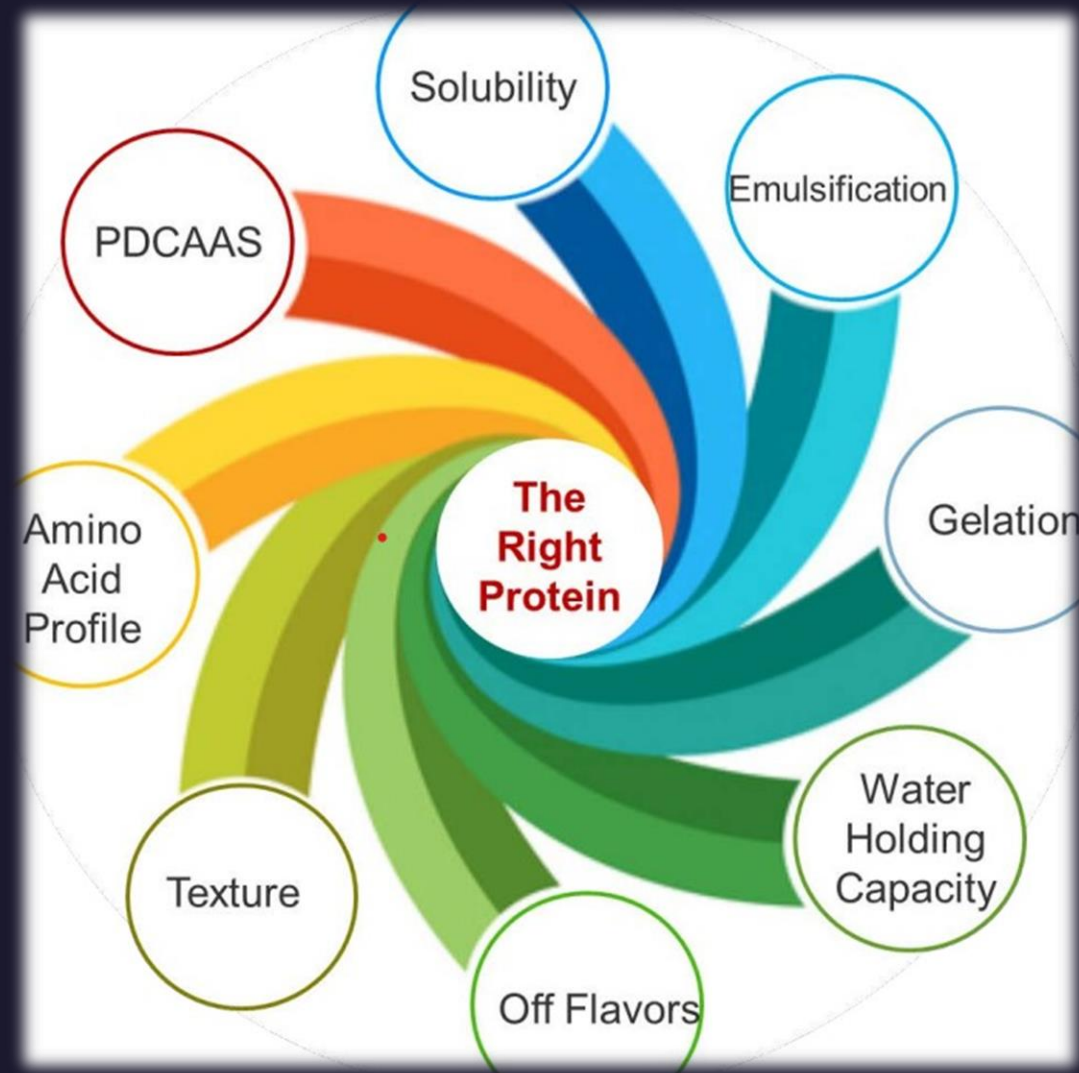
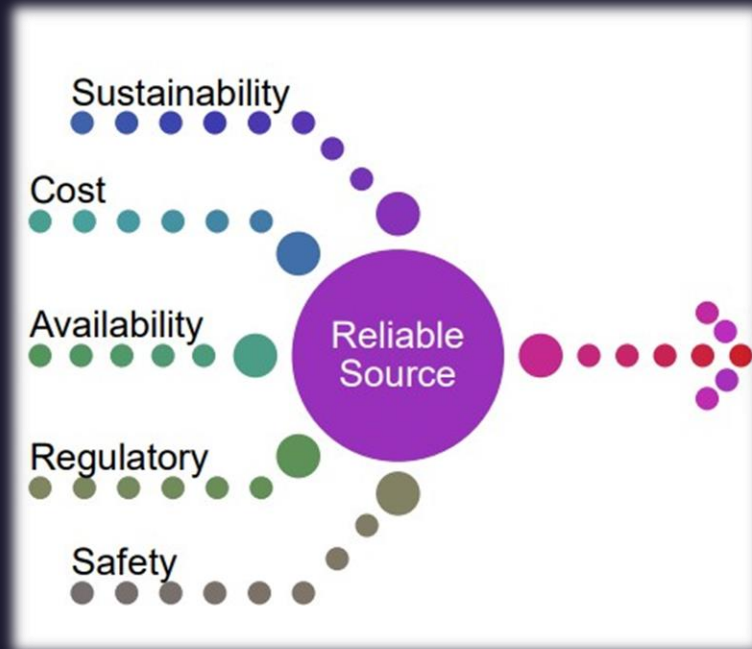
Nuts protein



Oilseed protein



Challenges



How do Proteins work?

Function	Mechanism	Food Systems
Solubility	Hydrophilic interactions	Beverages, soups
Gelation	Water entrapment & immobilization, network formation	Processed meats, gelled products, cakes, cheeses, baked goods
Water binding	Hydrogen bonding, ion hydration	Processed meats, breads, cakes
Emulsification	Adsorption at interfaces	Emulsified meats, cream soups, cakes, dressings
Viscosity	Water binding, hydrodynamic size & shape	Beverages, soups, sauces, salad dressings
Texture (cohesion, elasticity, adhesion)	Hydrophobic, ionic & hydrogen bonding, disulfide cross-links	Processed meats, baked goods, pasta
Foaming	Interfacial adsorption, film formation	Whipped toppings, ice creams, cakes, meringues

Solutions

Protein modification

Hydrolysis /Texturizing

Particle size reduction

Nanoscience

Oleo/Hydrogels

Product development

Choice & Combination of protein

Additives, Fillers, stabilizers, maskers

Order of addition, pH & temperature

Quantitative & Qualitative assessment

Rheology: texture, viscosity

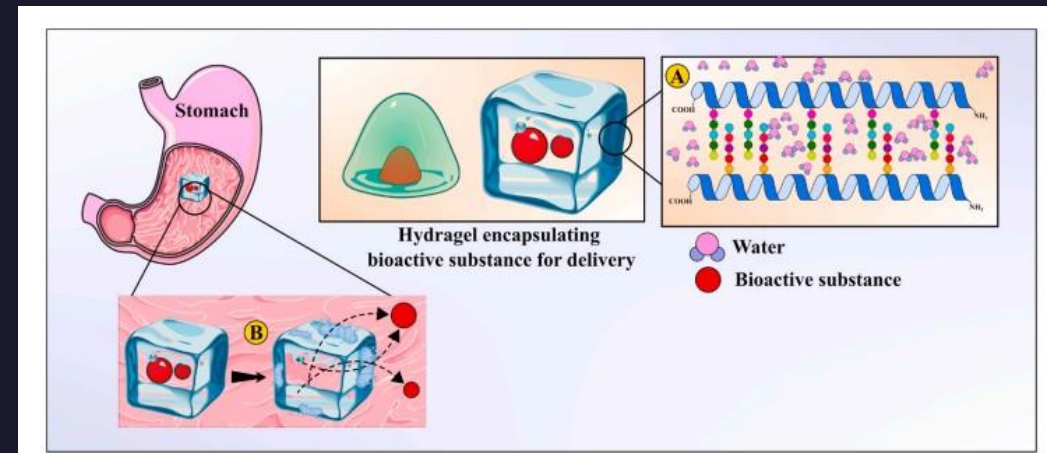
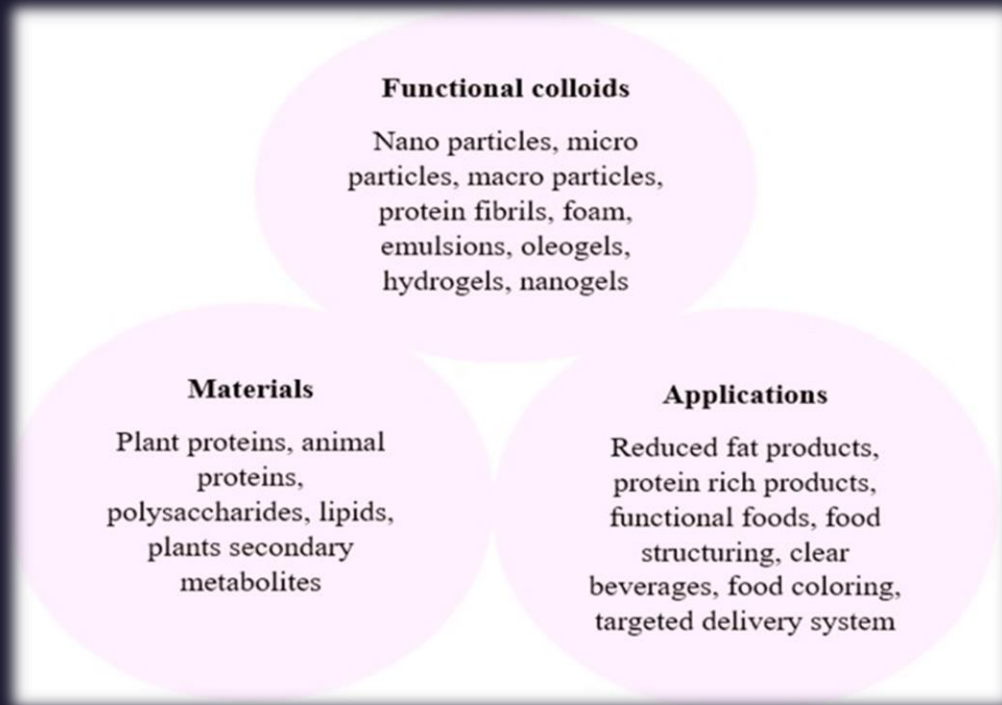
Physico-chemical

Sensory

Stability & Shelf life



New Age Products



Hydrogel

We at Amway develop healthy, plant forward, solution-based, clean label technologies and products in foods



Summary

Consumer need is increasing for high quality clean label protein rich products. New age proteins are in the rise with excellent functionality to meet consumer need. Understanding the functionality of protein is key to choose the right protein for successful application in food.

Thank You

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