



Protein from different Plant Sources

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What are proteins?

- Proteins are large, complex molecules found in cells of all living things
- Contain carbon, hydrogen, oxygen, nitrogen
- Made from 20 different amino acids

OBTAINED FROM NUTRITION

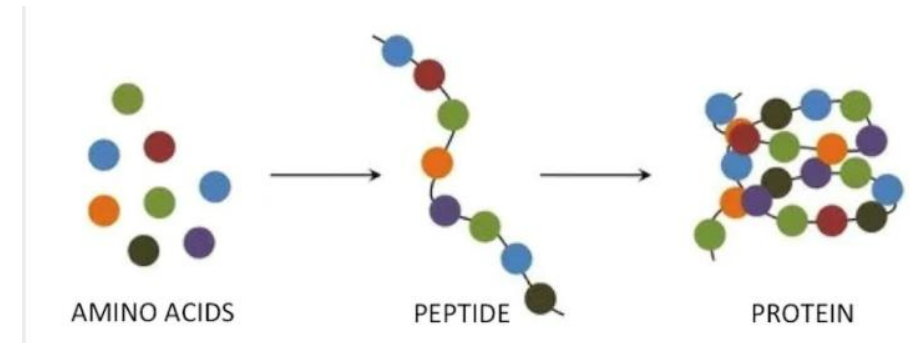
Essential Amino Acid

*Leucine
*Isoleucine
*Valine
Histidine
Lysine
Methionine
Phenylalanine
Threonine
Tryptophan

SYNTHESIZED BY THE BODY

Non-Essential Amino Acid

Alanine
Arginine
Asparagine
Aspartic Acid
Cysteine
Glutamic Acid
Glutamine
Glycine
Proline
Serine
Tyrosine



When a protein has all nine of the essential amino acids, we call it a **complete protein**. When a protein is missing any of these essential amino acids, it's considered an **incomplete protein**. Most plant foods are considered incomplete proteins.

COMPLETE PROTEINS VERSUS INCOMPLETE PROTEINS	
Complete proteins are proteins that contain all essential amino acids in the correct ratio for humans	Incomplete proteins are proteins that are lacking in one or more essential amino acids in correct proportions as required by humans and other animals
Contain all essential amino acids	Contain some of the essential amino acids
Sources: Animal sources such as fish meat, poultry, eggs, and dairy products, and soybeans and quinoa	Sources: Plant sources such as nuts, beans, legumes, and tofu

Protein Quality

What is the Protein Quality of a food?

Protein quality is an index of how well a protein meets the requirements of essential amino acids, as well as the physiological needs, of the organism.

Quality of protein is dependent on amino acid content, interference of non-available carbohydrates, influence of heat processing & antinutritional factors.

It is calculated by comparing the essential amino acid content of the protein with the highest quality protein

Protein Digestibility Corrected Amino Acid Score (PDCAAS)

- PDCAAS is a method for evaluating protein quality adopted by the FAO, USFDA, WHO in 1993.

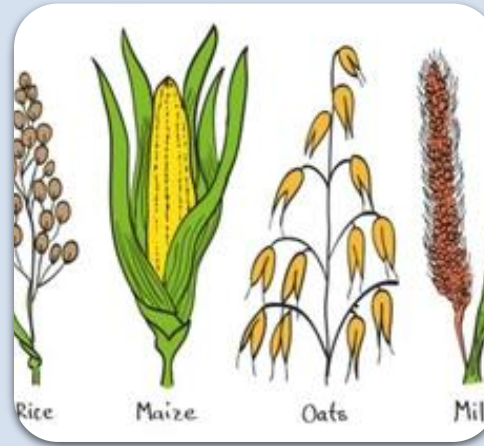
- PDCAAS = $\text{True faecal protein digestibility} \times \frac{\text{Limiting amino acid in test protein (mg/g)}}{\text{Same amino acid in reference protein (mg/g)}}$

- Lentil (0.51) = 0.91 X 0.56 (Limiting amino acid : Tryptophan)
- A protein of a high quality will have a PDCAAS of 1.0 : Egg white, whey, casein and soy protein.

- Limitations of PDCAAS
- The value can be overestimated as it does not consider antinutritional factors present in food and the non-absorptive losses occurring in the large intestine.
- Hence, FAO proposed changing the estimation of protein quality to DIAAS (Digestible Indispensable Amino Acid Score which measures digestibility at the end of the small intestine.

Different Plant based Proteins





Legumes/Pulses

Soy
Pea
Chickpea
Fava Bean
Lentil
Mung Bean
Navy Bean

Nuts/oilseeds

Peanut
Sunflower seeds
Almond
Canola

Cereal Proteins

Wheat
Oat
Corn
Quinoa
Rice
Sorghum

Vegetables

Broccoli
Potato
Artichokes

Plant protein sources summary

Protein	Protein Concentration	PDCAAS	Allergen Risk	Commercial Stage	Flavor	Functionality	Cost (/kg protein)	Global Crop Volume (MMT)
Soy	●	●	●	●	●	●	●	●
Pea	●	●	●	●	●	●	●	●
Wheat	●	●	●	●	●	●	●	●
Canola	●	●	●	●	●	●		●
Chickpea	●	●	●	●	●	●	●	●
Fava Bean	●	●	●	●	●	●	●	●
Lentil	●	●	●	●	●		●	●
Lupin	●	●	●	●	●	●		●
Mung Bean	●	●	●	●	●	●	●	●
Navy Bean	●	●	●	●	●	●		●
Peanut	●	●	●	●	●	●		●
Sunflower	●	●	●	●	●	●	●	●
Almond	●	●	●	●	●	●	●	●
Corn	●	●	●	●	●	●	●	●
Oat	●	●	●	●	●	●		●
Potato	●	●	●	●	●	●	●	●
Quinoa	●	●	●	●	●	●	●	●
Rice	●	●	●	●	●	●	●	●
Sorghum	●	●	●	●	●	●		●

SOY (Legume/ Pulses)

Protein Nutrition					●
Allergenicity	●				
Flavor		●			
Functionality					●
Cost				●	
Crop Supply					●

Advantages

- PDCAAS Value : 0.99-1
- Protein content : 40%
- Phytoestrogens
- Viscosity and water binding capacity.
- Emulsification and foaming.
- Flavour Binding capacity.

Available Formats

- Flour (50-60% protein)
- Concentrates (65-80% protein)
- Isolates (>90% protein)

Disadvantages

- Limiting AA: Lysine, Methionine, and Cystine.
- Anti-nutritive: Trypsin inhibitors and hemagglutinins.
- Major Allergen
- Bitter/Beany note



Application

- Beverage powder, creamer, frozen dessert, soup, whipped topping, dressings
- Texturized meat replacement



PEA (Legume/Pulses)

Advantages

- PDCAAS Value : 0.64
- Protein content : 28%
- High in Lysine and BCAA
- Fiber, protein, thiamin, folate, Phosphorus, potassium.
- Emulsification, gelling and foaming.
- Low Allergenicity

Application

- Broad applications, e.g., pasta, bakery goods, extruded snacks
- Meat extender/texturizer

Available Formats

- Air classified flour
- Concentrate
- Hydrolyzed
- Isolates

Protein Nutrition

Allergenicity

Flavor

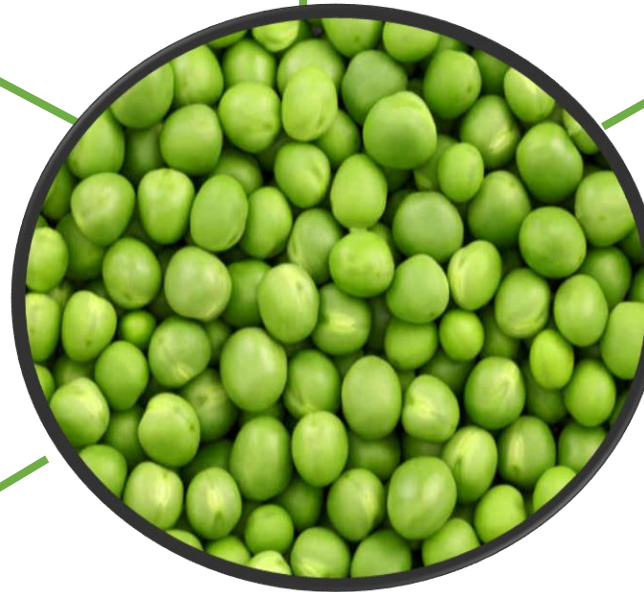
Functionality

Cost

Crop Supply

Disadvantages

- Limiting AA: Methionine and Cystine.
- Anti-nutritive: Lectins, Trypsin inhibitors and phytic acid.
- Beany flavour
- Lower solubility and functional properties



PEANUT (OILSEED)

Protein Nutrition				●		
Allergenicity	●					
Flavor					●	
Functionality					●	
Cost						
Crop Supply					●	

Available Formats

- Defatted flour

Advantages

- PDCAAS Value: 0.52
- Protein content: 28%
- Source of vitamin B & E, manganese, magnesium, phosphorus, fiber
- High gelling,
- Foaming & emulsification

Disadvantages

- Limiting amino acids: Threonine
- Aflatoxin risk
- Allergen (0.6% in the USA)



Application

- Peanut butter
- Extruded crisps
- Baked goods (including gluten-free),
- sauces, protein supplement.



MUNG BEAN (Legume/Pulse)

Protein Nutrition			●		
Allergenicity			●		
Flavor				●	
Functionality				●	
Cost		●			
Crop Supply			●		

Available Formats

- Emerging protein extract



Advantages

- PDCAAS Value : 0.55
- Protein content : 26%
- Rich in fiber, potassium, magnesium
- High solubility and gelling.
- Savoury flavour

Disadvantages

- Limiting amino acids: Methionine, and Cystine.
- Anti-nutritional factors

Application

- Plant-based meat ,Egg alternatives, Starch used for noodles, jelly, crepes



CHICKPEA (Legume/Pulse)

Protein Nutrition				●		
Allergenicity				●		
Flavor				●		
Functionality					●	
Cost		●				
Crop Supply					●	

Available Formats

- Flour
- Concentrates
- Isolates
- Texturized

Advantages

- PDCAAS Value : 0.52
- Protein content : 22%
- High fiber, folate, iron, phosphorus
- High solubility, foaming, emulsification.
- Gritty mouthfeel in flour
- Characteristic aroma

Disadvantages

- Limiting amino acids: Tryptophan, Methionine, and Cystine.
- Anti-nutritional factors
- Regional Allergen

Application

- Meat analogues, Plant based Dairy, Mayonnaise, Pasta, Bakery



OAT (Cereal)

Protein Nutrition					●
Allergenicity					●
Flavor					●
Functionality		●			
Cost					
Crop Supply			●		

Available Formats

- Oats flour
- Oats milk



Advantages

- PDCAAS Value : 0.66
- Protein content : 15%
- High glutamine, B-glucans & avenanthramides
- Gluten-free
- High stability emulsions and gelling.

Disadvantages

- Limiting amino acids: Lysine
- Low solubility

Application

- Oatmeal, dairy, Baking: bars, breads, snacks , breakfast cereals and nutritional shakes.



QUINOA (Pseudo-Cereal)

Protein Nutrition					●
Allergenicity					●
Flavor			●		
Functionality					●
Cost		●			
Crop Supply		●			

Advantages

- PDCAAS Value : 0.79
- Protein content : 16%
- High in Lysine
- High in manganese, magnesium, phosphorus & vitamins B1, B2, B6, B9.
- High foaming, emulsification

Available Formats

- Grain
- Flour

Disadvantages

- Limiting amino acid : Phenylalanine and Tyrosine
- Allergenicity : Low, possible saponin sensitivity.
- Bitter, if saponin remains

Application

- Consumed as a grain, incorporated into products as a flour.



WHEAT (Cereal)

Protein Nutrition				●		
Allergenicity	●					
Flavor				●		
Functionality						●
Cost						●
Crop Supply						●

Advantages

- PDCAAS Value : 0.43
- Protein content : 13%
- It contains wheat germ agglutinin (lectin), fiber (b-glucan & arabinoxylan), phenolics, sterols, tocopherols & vitamins.
- Elastic dough formation, gelling and binding.

Available Formats

Starch washed from dough Vital
Wheat Gluten

Disadvantages

Limiting amino acids: Lysine.
Major Allergen



Application

- Bakery: dough improver
- Textured for meat extender/ replacer
- Seitan



POTATO (Vegetable)

Protein Nutrition						●
Allergenicity						●
Flavor			●			
Functionality				●		
Cost		●				
Crop Supply						●

Available Formats

- Isolate

Advantages

- PDCAAS Value : 0.99
- Protein content : 7.4%
- High BCAA & Lysine, potassium, vitamins C & B6
- Patatin: major storage protein
- Allergenicity: Rare
- High solubility, gelling and foaming.
- Antioxidant

Application

- Meat analogs, ice cream, cream cheese, protein beverages, gluten-free foods

Disadvantages

- Metallic taste



Algae, seaweed, and aquatic plants



Spirulina

**High in protein
(e.g. 9-25%)**



Duck weed

**Omega-3 fatty acid
content**



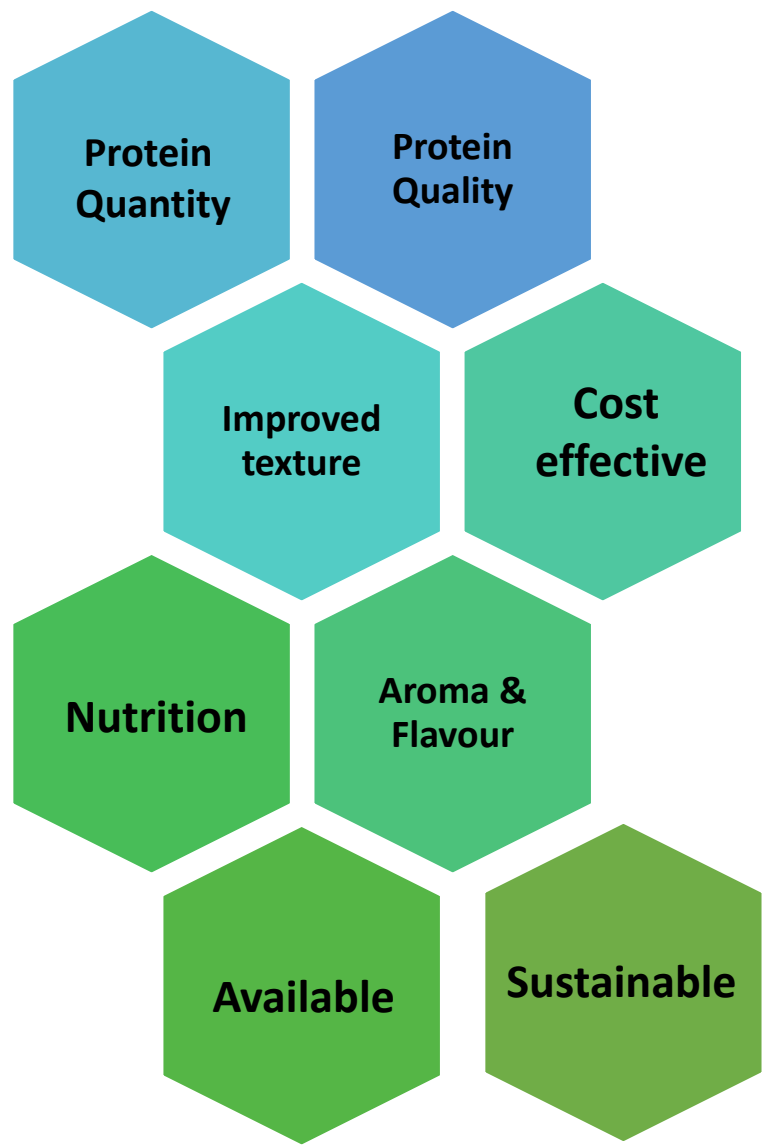
Dulse seaweed

Nutrient dense

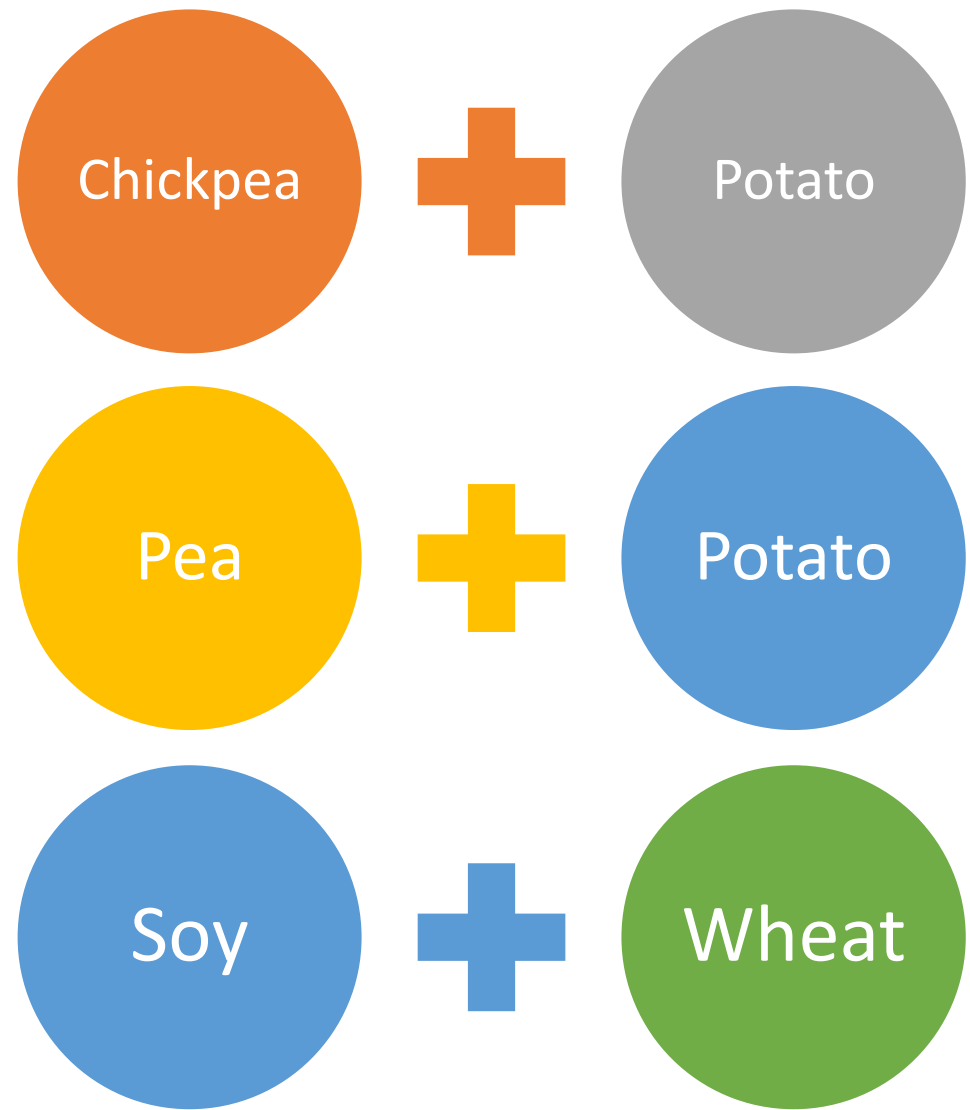
How to use the plant proteins



Combining two or more different plant proteins can help achieve a



Synergistic combinations





The right plant-based foods can be excellent sources of protein and other nutrients



Thank you