Value Added Soy Processing

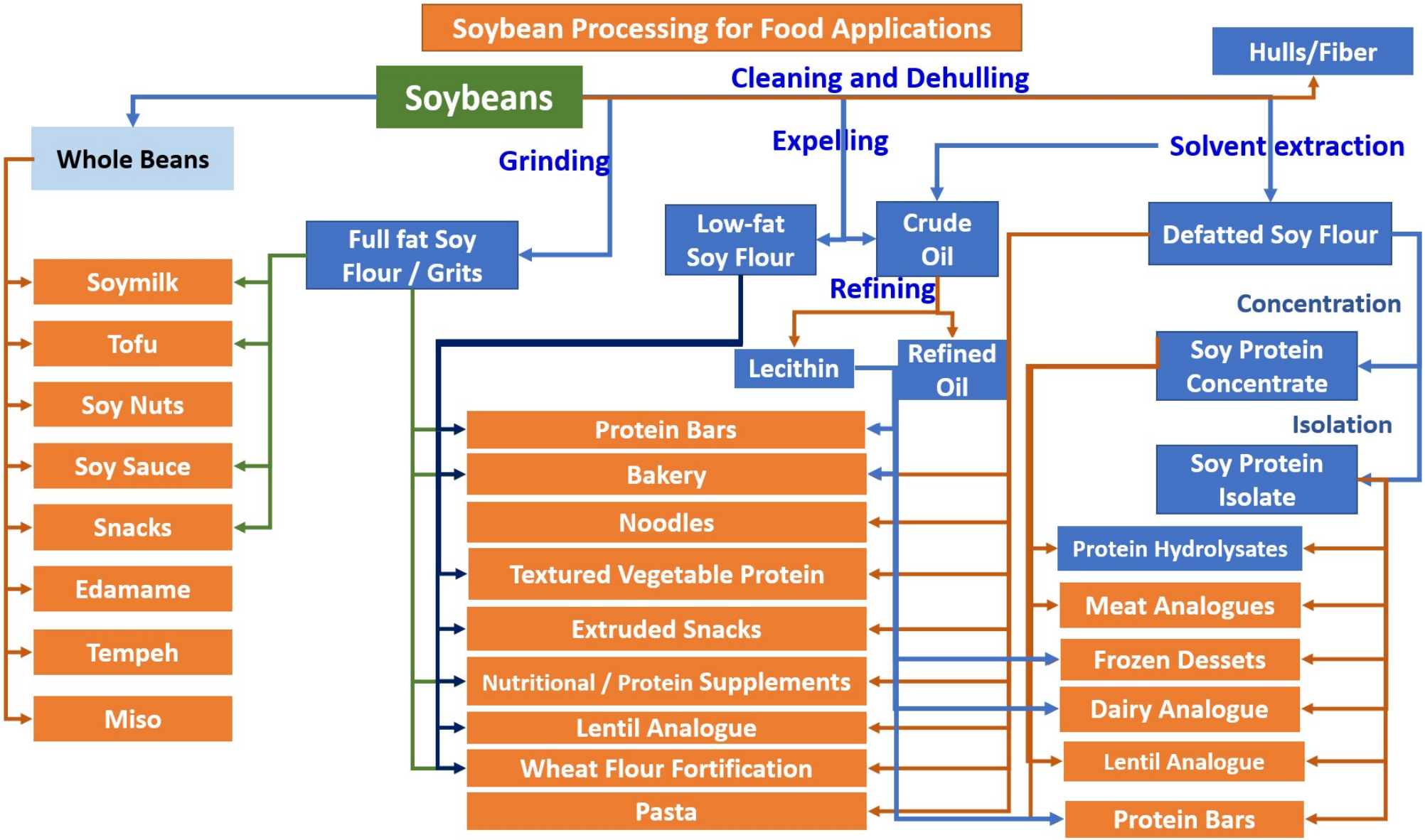
Suresh Itapu, Ph.D.

Chairman, Soy Food Promotion and Welfare Association

Tel: +91 98105 87046

Outline

- Soybean Processing for Food Applications
- Upgradation


Soybean Processing for Food Applications
Soybeans
Cleaning and Dehulling
Hulls/Fiber
Whole Beans
Grinding
Expelling
Solvent extraction
Full fat Soy Flour / Grits
Low-fat Soy Flour
Crude Oil
Defatted Soy Flour
Soymilk
Tofu
Soy Nuts
Soy Sauce
Snacks
Edamame
Tempeh
Miso
Refining
Concentration
Lecithin
Refined Oil
Soy Protein Concentrate
Isolation
Soy Protein Isolate
Protein Bars
Bakery
Noodles
Textured Vegetable Protein
Extruded Snacks
Nutritional / Protein Supplements
Lentil Analogue
Wheat Flour Fortification
Pasta
Protein Hydrolysates
Meat Analogues
Frozen Dessets
Dairy Analogue
Lentil Analogue
Protein Bars

Benefits of Soy Derivatives in Food Industry

- Bakery
  - Improve product quality
  - Reduce costs
  - Reduce wastage
- Beverages
  - Stability
- Process meats
  - Improves texture
  - Reduce wastage
  - Economical
- Dairy analogues
  - Economical
- Frozen desserts
  - Increases overrun
  - Economical
- Snack foods
- Dressings and Spreads
  - Economical
- Protein supplements
  - Stability
  - Economical
  - Disease specific
- Sports nutrition
  - Economical

Can be added to all categories of foods

Soybean Processing for White flakes

- Growing demand for soy protein food ingredients.
- Significance of defatted white flakes in the soy protein scheme
- The key factors in producing high-quality defatted white flakes are:
  - Soybean preparation
  - Desolventizing technology

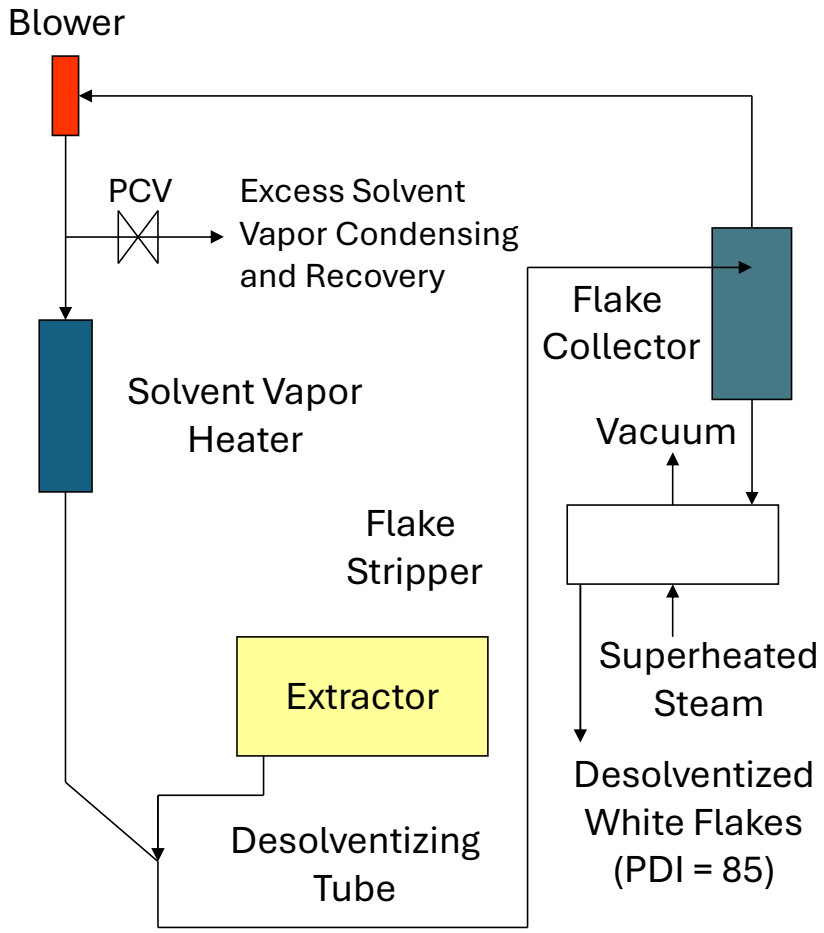
What should be done to Produce White Flakes?

- Upgrade the process
- Proper storage of raw materials
- Pre processing
  - Tempering (10-11% moisture)
  - Dehulling
  - Cracking (1/6 to 1/8 chips)
  - Conditioning (70 to 75^{o}C) to increase elasticity in the flakes and reduce breakage
  - Proper desolventizing (Flash/Down Draft)
  - Cooling (within 5 °C of ambient) to prevent biological and oxidative degradation
  - Proper storage

Desolventizing to Produce High PDI White Flakes

- Objectives
  - Preserve the enzymes
  - Maximize functionality (high PDI)
- Means of Achievement
  - Low temperature
  - Low moisture exposure
- Processing schemes
  - Flash desolventizing by DeSmet, Krupp, & others
  - Down draft desolventizing by Crown Ironworks

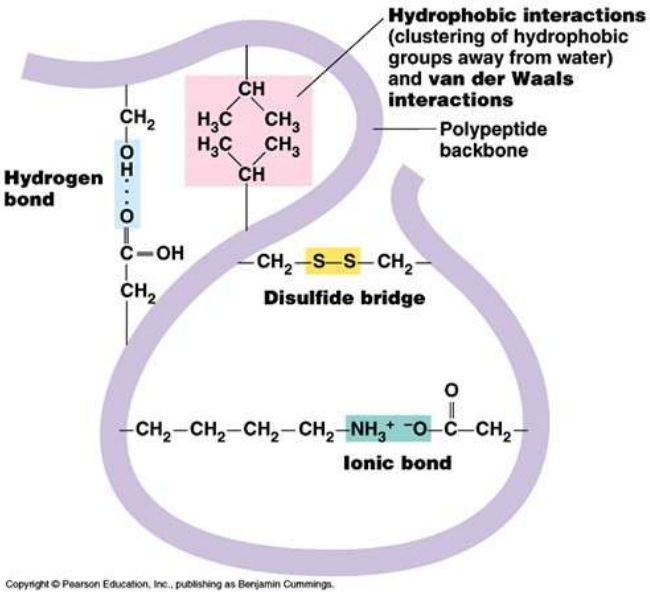
Flash Desolventizing



- Wet flakes:
  - 30% retained solvent
  - PDI = 90
- Solvent vapor temperature = 116 to 138 ºC
- Flake residence time in desolventizer tube = 5 sec.
- Collector outlet flakes:
  - Solvent = 0.5 ± 0.1%
  - Moisture = 3 to 5%
- Stripper outlet flakes:
  - Moisture = 6 to 8%
  - PDI = 85

Applications for White flakes (high PDI)

- Before the revelation of the health benefits soy protein products are used primarily for their functional characteristics.
- Soy protein has both lipophilic and hydrophilic groups in the same polymer chain facilitates association of the protein with both fat and water.
- Initially there were many challenges in replacing the functionality of these traditional ingredients with soy proteins
- Advances in the breeding and processing resulted in much better and comparable functionality
- Explored for the replacement of expensive ingredients such as egg and milk for the food processing industry



Functional Properties of Soy Protein Products in Food

Functional property	Mode of action	Food system used	Product*
Solubility	Protein salvation, pH dependent	Beverages	F,C,I,H
Water & binding absorption	Hydrogen-bonding of water, entrapment water	Meats, sausages, breads, cakes	F,C
Viscosity	Thickening, water binding	Soups, gravies	F,C,I
Cohesion/- adhesion	Protein acts as an adhesive	Meats, sausages, bakery and pasta products	F.C.I
Emulsification	Formation and stabilization of fat emulsions	Sausages, bologna, soups, cakes	F,C.I
Fat absorption	Binding of free fat	Meats, sausages, doughnuts	F,C,I
Foaming	Forms film to entrap gas	Whipped toppings, chiffon desserts, angel cakes	I,H
Color control	Bleaching (lipoxygenase)	Breads	F

***: F,C,I, and H denote soy flour, concentrate, isolate, and hydrolyzate respectively**

Functions of Soy Protein in Meat-based Product

- Improves uniform emulsion formation and stabilisation.
- Reduces cooking shrinkage and drop by entrapping-binding fats and water.
- Prevents fat separation.
- Enhances binding of meat particles without stickiness.
- Improves moisture holding and mouthfeel.
- Gelation improves firmness, pliability and texture.
- Facilitates cleaner, smoother slicing.
- May impart antioxidant effects.
- Improves nutritional value.

Soy Protein in Plant-based Products

- Plant-based segment is one of the fastest growing segments
- Soy protein is one of the most widely available plant protein with highest protein density
  - Defatted soy flour, SPC, ISP, Low fat soy flour, peptides,…
- Soy protein products can be efficiently used to produce
  - Meat analogs, dairy analogs, egg alternates
- Excellent functionality and extrudability
- Huge amount scientific literature
  - Has been used for decades

Relationship between physical properties of proteins and beverage attributes

Physical property	Beverage functional attribute
Solubility	Appearance, mouthfeel, sediment, suspension stability
Emulsification	Suspension stability, mouthfeel, appearance, colour
Viscosity	Mouthfeel, stability, flavour
Flavour binding	Flavour
Particle size	Mouthfeel, colour and appearance
Heat stability	Colour, suspension

Source: Riaz, M. N. (2006). Soy Applications in Foods. London: CRC Taylor and Francis pp. 39-226.

Selected Functional Characteristics of Soy Protein in Baking Systems

Functional property	Mode of action	Baking system	Protein form
Emulsification			
Formation	Formation and stabilization of fat emulsions	Breads, cakes	Flour, SPC, ISP
Fat Adsorption			
Prevention	Binding of free fat	Doughnuts, pancakes	Flour, SPC
Water Absorption and Binding			
Uptake	Hydrogen bonding of water, entrapment of water, no drip	Breads, cakes	Flour, SPC
Retention			
Dough formation	-	Breads, cakes	Flour, SPC, ISP
Cohesion-adhesion	Protein acts as adhesive material	Breads, cakes	Flour, SPC, ISP
Elasticity	Disulphide links in deformable gels	Breads, cakes	Flour, SPC, ISP
Flavour-binding	Adsorption, entrapment, release	Breads, cakes	SPC, ISP, hydrolysates
Foaming	Forms stable films to trap gas	Whipped toppings, chiffon desserts, angel cakes	ISP, soy whey, hydrolysates
Colour control			
Bleaching	Bleaching of lipoxygenase	Breads	FFS
Browning	Maillard, caramelization	Breads, pancakes, waffles	All protein derivatives

The Beneficial Role of Soy in Bakery Products

- Increase Productivity (yield):
  - Addition of 1% soy flour (PDI 70) = Additional 1.4% dough
  - Addition of 3% soy flour (PDI 70) = Additional 4.2% dough
- Improvement in dough handling Properties
- Reduction in Baking time and Temperature
- Improvement in crumb and crust color
- Improvement in crumb softness
- Improvement in rolling and folding properties, and tearing quality (flat breads); and higher bread volume.
- Prolong shelf life
- Enzyme treated soy protein will replace gluten in bread

Replacement of Expensive ingredients

- Whole Egg
  - Eggs can be fully or partially replaced using lecithinated defatted soy flour
  - Studies at AIB demonstrated about 25% reduction in raw material cost
- Skim Milk Powder (SMP)
  - Defatted soy flour (60%) and sweet dry whey (40%) can replace SMP
- Egg White
  - Enzyme treated soy isolate can replace egg white
  - Can whip to as much as twice the volume of egg whites but will not set when heated.
  - 75% replacement of egg albumen can yield similar product
- Oil
  - Reduction of oil absorption in fried products

How Does Soy Protein Fare With Other Sources?

How Does Soy Protein Fare With Other Sources?					
	Soy	Milk	Egg	Meat	Pea
Protein Density	✓			✓	
Protein Quality	✓	✓	✓	✓	
Supported by Health Claim	✓				
Bioactive Components	✓	✓			✓
Proven Health benefits	✓	✓			
Clean Label					✓
Safety	✓	✓	✓	✓	✓
Functional Properties	✓	✓	✓		
Economics	✓		✓		
Availability	✓	✓	✓	✓	
Score	9/10	6/10	5/10	4/10	3/10

Characteristics of Soy Protein

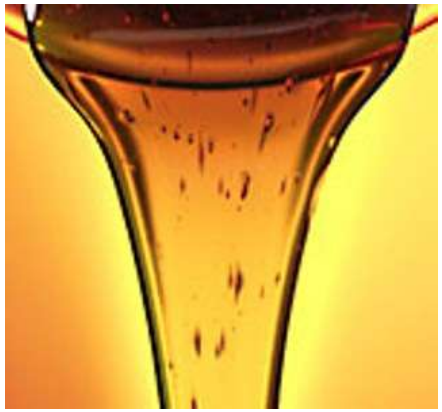
- Most Economical
  - Soy protein is one of the cheapest sources of protein
  - Cost effective
  - Stable
  - Most stable pricing
  - High Protein density
- Functional Properties
  - Full or partial replacement of expensive functional ingredients
  - Nutritional Quality
- Safety
- Availability

Why Soy Protein?

- Soy protein is an abundantly available plant protein with a great versatility.
- Soy protein has both health benefits and functional benefits in food systems
  - Based on these two factors soy and soy ingredients have immense potential in the food processing industry.
- Soy is a highly versatile that can be processed as food ingredients.
- Functionally active soy ingredients provide benefits in the food processing systems such as,
  - producing vegan/vegetarian products (dairy & meat analogs)
  - replacing expensive ingredients
  - improving process efficiencies, etc.
- Epidemiological data available across the world shows that soy is one of the safest and highly economical protein sources.
- Based on various characteristics of soy protein, it can be considered as the ideal protein for food systems.

Lecithin

- Lecithins are organic compounds, rich in phosphorus, formed by natural phospholipids and other polar lipids.
- Has number of functional benefits in food systems and have proven health benefits
- Lecithin Action in Food Systems
  - Emulsification, Wetting & Instantizing, Viscosity modification, Release Agent, Separating Agent, Extrusion Aid, Anti-Dusting Agent, Shelf- Life Aid, Nutritional Supplement
- Applications of Lecithin in Food industry
  - Baked Goods
  - Dairy Products
  - Chocolate
  - Cocoa Powder
  - Chewing Gum
  - Caramels & Toffees
  - Hard Candies
  - High Protein Beverages
  - Powdered Chocolate Beverages
  - Gravies, Instant Foods, Prepared Foods



Soy Fiber

- There are two types of soy fiber available for food application
  - Soy fiber from soy hulls
  - Soy fiber from soy cotyledons
- Soy fiber from hulls is called soy bran
  - Used in breads, cereal and snacks
- Soy fiber from soy cotyledons
  - Very similar to okara
  - After appropriate purification, this material is dried and sold as soy fiber.
  - Mainly used in beverages, puddings, retorted soups etc
  - Also used in breads, muffins, crackers, cookies or breakfast bars

Summary

- Soy offers versatile derivatives for processed food industry
- Edible soy processing and production of white flakes offer enormous benefits
- Soy derivatives provide various functions in the food systems and thus are valuable ingredients for food industry.
- A wide range of soy derivatives are available for different applications.
- A systematic approach to formulation is worthwhile.
- Soy protein is the most ideal protein for the food processing industry
- Soy processors may upgrade their facilities to produce value added soy ingredients to meet the industry requirements