

USE OF SOY PROTEIN IN BEVERAGES

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OUTLINE

- Beverages containing soy protein
- Markets
- Nutrition
- Soy Proteins
- Hydration
- Physical / functional properties
- Applications
 - Spray dried

OUTLINE

(CONTINUED)

- Soy milk
 - Whole beans
 - Isolated soy protein
 - Spray dried
- Nutritional beverage
- Fruit juice plus soy protein
- Milk plus soy protein
- Yogurt
 - Soy yogurt
 - Dairy yogurt in combination with soy proteins

TYPES OF READY TO DRINK SOY PROTEIN CONTAINING BEVERAGES

- Soy Milk (Milk alternatives)
- Milk-plus soy protein
- Nutritional beverages
- Meal replacers / weight loss beverages
- Weight gain / sports nutrition
- Fortified juices <1.5% protein
- Fruit smoothies >1.5% protein
- Yogurt

POTENTIAL MARKETS FOR SOY IN BEVERAGES

SELECTED BEVERAGES – POTENTIAL MARKET				
YEAR	POTENTIAL SELECTED BEVERAGES (TONS)	PERCENT OF POTENTIAL MARKET	ESTIMATED VOLUME (TONS) CONTAINING SOY	PERCENT CHANGE PA
2001	48,738	1.2	600	140.0
2002	46,567	3.3	1557	159.4
2003	47,031	4.8	2245	44.2
2004	49,260	6.1	2988	33.1
2005	51073	8.1	4131	38.3

ESTIMATED MARKET FOR SOY IN BEVERAGES

SELECTED BEVERAGE ESTIMATED MARKET

YEAR	ESTIMATED VOLUME CONTAINING SOY (TONS)	AVERAGE INCLUSION RATE	ESTIMATED SOY VOLUME TONS	PERCENT CHANGE PA
2001	600	10.0	60	140.0
2002	1557	11.0	171	185.8
2003	2245	10.7	241	40.6
2004	2988	10.9	326	35.2
2005	4131	12.3	610	56.5

EXPLOSION OF SOY CONSUMPTION IN EUROPE

RETAIL SALES (EURO MM)			
SOY BASED: BEVERAGES, DESSERTS, YOHURTS			
MARKET	TOTAL MARKET 2002	TOTAL MARKET 2003	GROWTH RATE PERCENT
UK	69.8	86.6	24
France	44.3	50.9	15
Germany	26.9	37.7	40
Spain	40.7	118.8	192
Italy	40.4	44.4	10
TOTALS	222.1	338.4	52

ESTIMATED SOY CONSUMPTION HEALTH SUPPLEMENTS

HEALTH SUPPLEMENTS – ESTIMATED MARKET

YEAR	ESTIMATED VOLUME CONTAINING SOY TONS	AVERAGE INCLUSION RATE	ESTIMATED SOY VOLUME TONS	PERCENT CHANGE PA
2001	19,043	22.5	4,279	6.9
2002	20,226	22.6	4,262	6.6
2003	21,642	22.5	4,872	6.8
2004	23,000	22.6	5,196	6.6
2005	24,566	22.6	5,547	6.8

PROTEIN QUALITY MEASUREMENT FOR HUMANS

- Protein Digestibility-Corrected Amino Acid Score (**PDCAAS**) is regarded as the best method for determining protein quality for humans
- Recommended for regulatory purposes by recognized international organizations –Food and Agricultural Organization / World Health Organization (FAO / WHO)
- PDCAAS based on human amino acid requirements

PROTEIN QUALITY MEASUREMENT FOR HUMANS

- Factors used in calculating PDCAAS include –
 - Essential amino acid content of the protein
 - Digestibility of the protein
 - Amino acid requirements of 2-to 5-year old child
- Highest possible score is 1.0

1. Henley EC, Kuster JM. *Food Technology* 1994: 48:74-72

2. *Protein Quality Evaluation, Report of the Joint FAO/WHO*

Expert Consultation Rome: FAO Food and Nutrition Paper No. 51, 1991

PROTEIN DIGESTIBLE CORRECTED AMINO ACID SCORE (PDCAAS) OF SELECTED PROTEINS

PROTEIN	PDCAAS
Soy proteins	0.95 - 1.0
Milk protein - casein	1.0
Egg white	1.0
Skim milk powder	1.0
Milk whey protein	1.0
Beef protein	0.92
Pea protein	0.69
Wheat protein - gluten	0.25

CATEGORIES OF SOY PROTEIN SOURCES FOR BEVERAGES

- Soy flour
- Whole bean extract
- Soy protein concentrate
- Isolated soy protein
- Isolated soy protein with calcium phosphate
- Isolated soy protein plus calcium phosphate, carbohydrate and vegetable oil
- Soy proteins fractionated during manufacturing
- Why all of these products?

WHY ALL OF THESE PRODUCTS?

- Protein content
 - Formula constraints
 - Lower protein does not allow formula space because of other components
 - Can result undesirable sensory result
- Physical / functional properties
- Sensory properties
- Prices differences

COMPOSITION OF COMMERCIAL PRODUCTS DERIVED FROM SOYBEANS

Component	Whole Bean Extract (%)	Defatted Soy Flour (%)	Soy Concentrate (%)	Soy Protein Isolate (%)
Protein (N x 6.25)	42	56-59	65-72	90-92
Fat	23	0.5-1.1	0.5-1.0	0.5-1.0
Carbohydrate	22	32-34	20-22	3-4
Ash	5.2	5.4-6.5	4.0-6.5	4.0-5.0
Fiber	15	19-20	16-26	<0.2

FACTORS THAT AFFECT FUNCTIONAL PROPERTIES

- Amino Acid Sequence
- Structure
- Processing (Hydration)
- Other Ingredients

FUNCTIONAL PROPERTIES

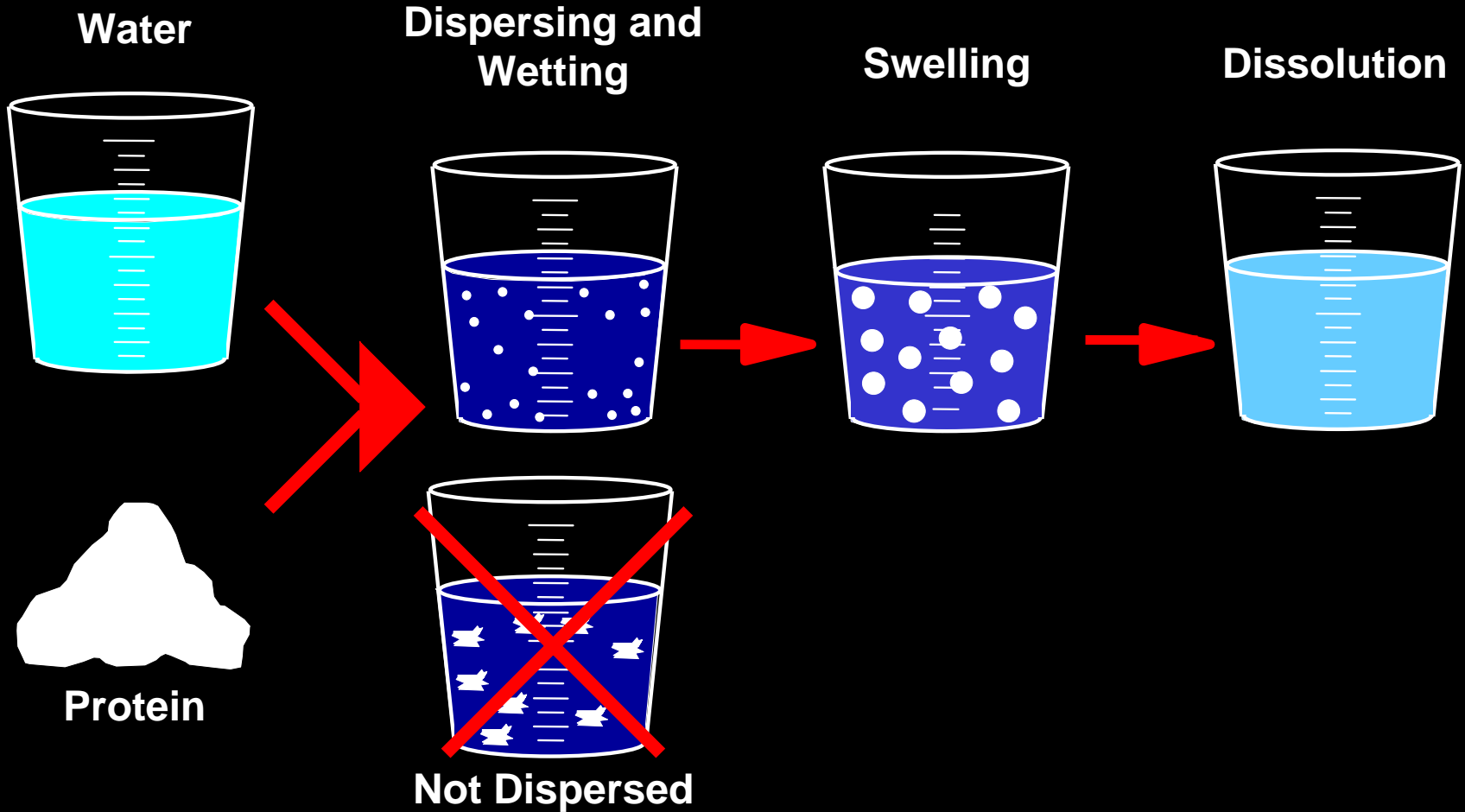
HYDRATION

FACTORS AFFECTING HYDRATION AND FUNCTIONALITY

- Time
- Temperature
- Shear or Energy
- pH
- Ionic Environment

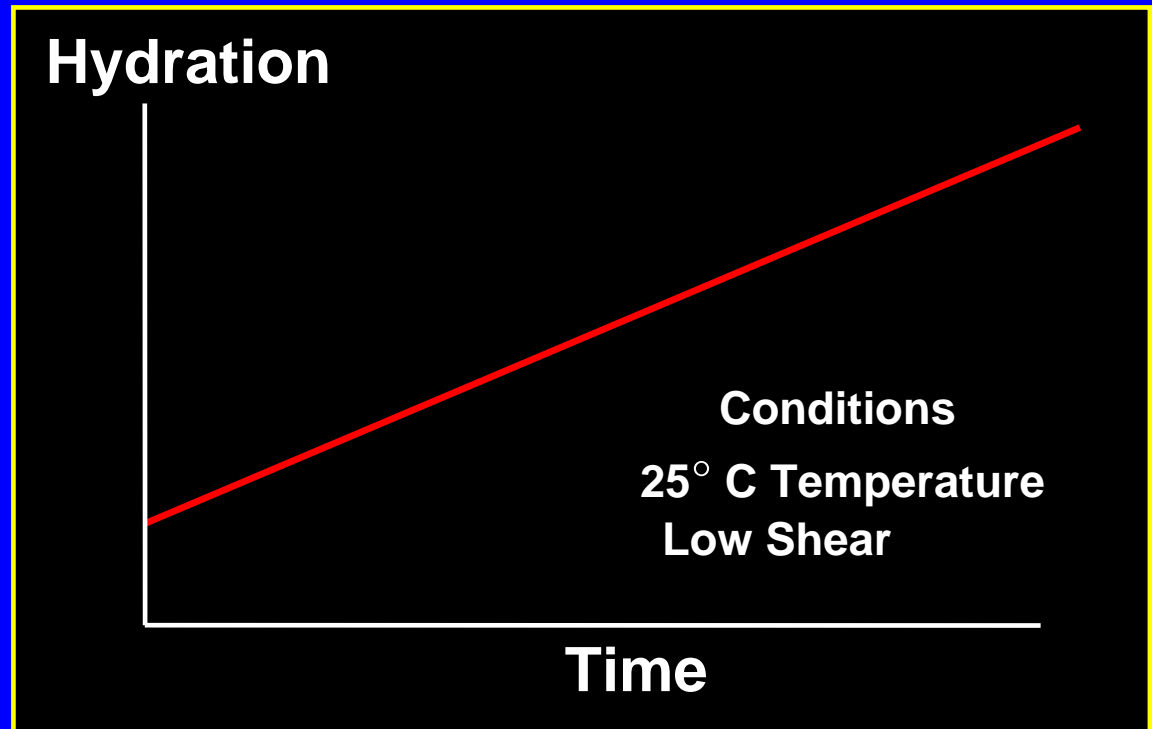
PHYSIOCHEMICAL PROPERTIES

HYDRATION



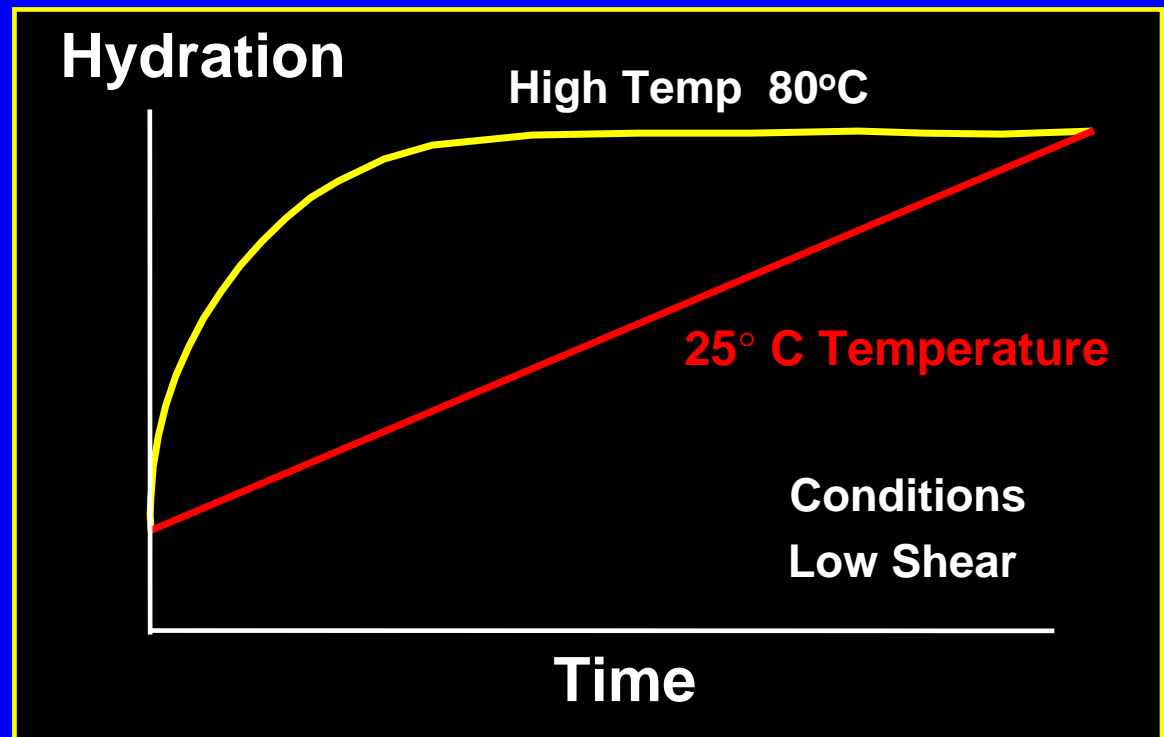
FACTORS AFFECTING HYDRATION

- Time



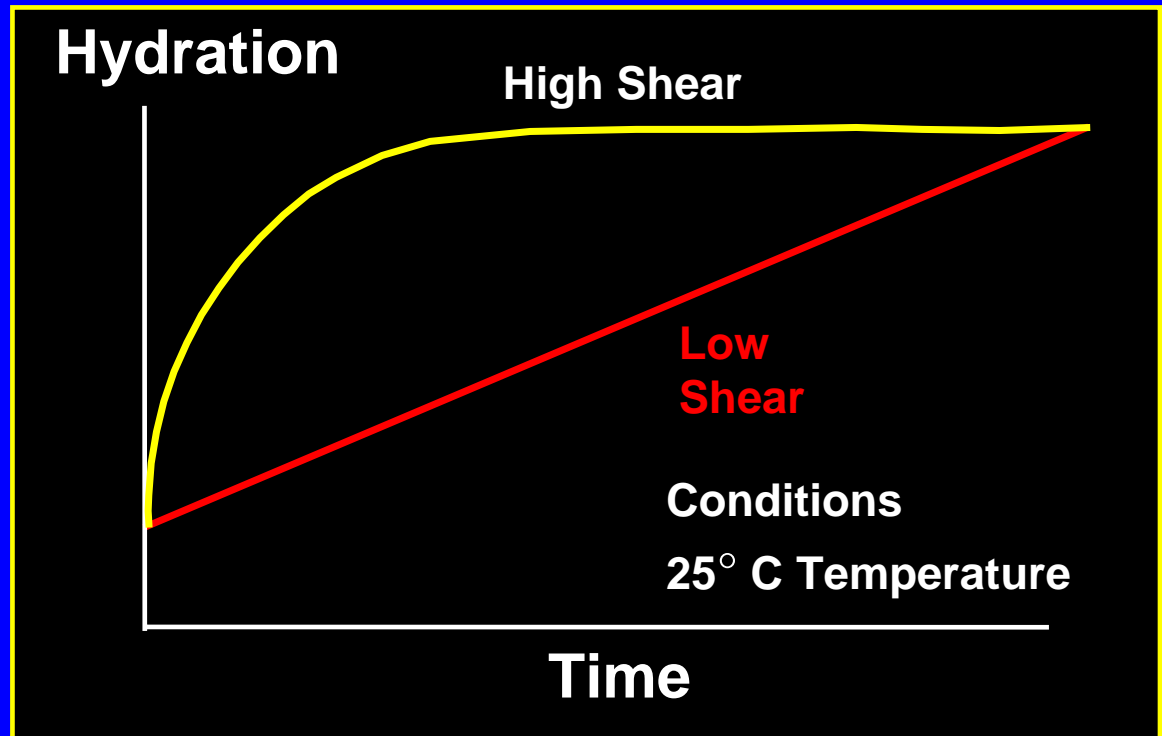
FACTORS AFFECTING HYDRATION

- Time
- Temperature

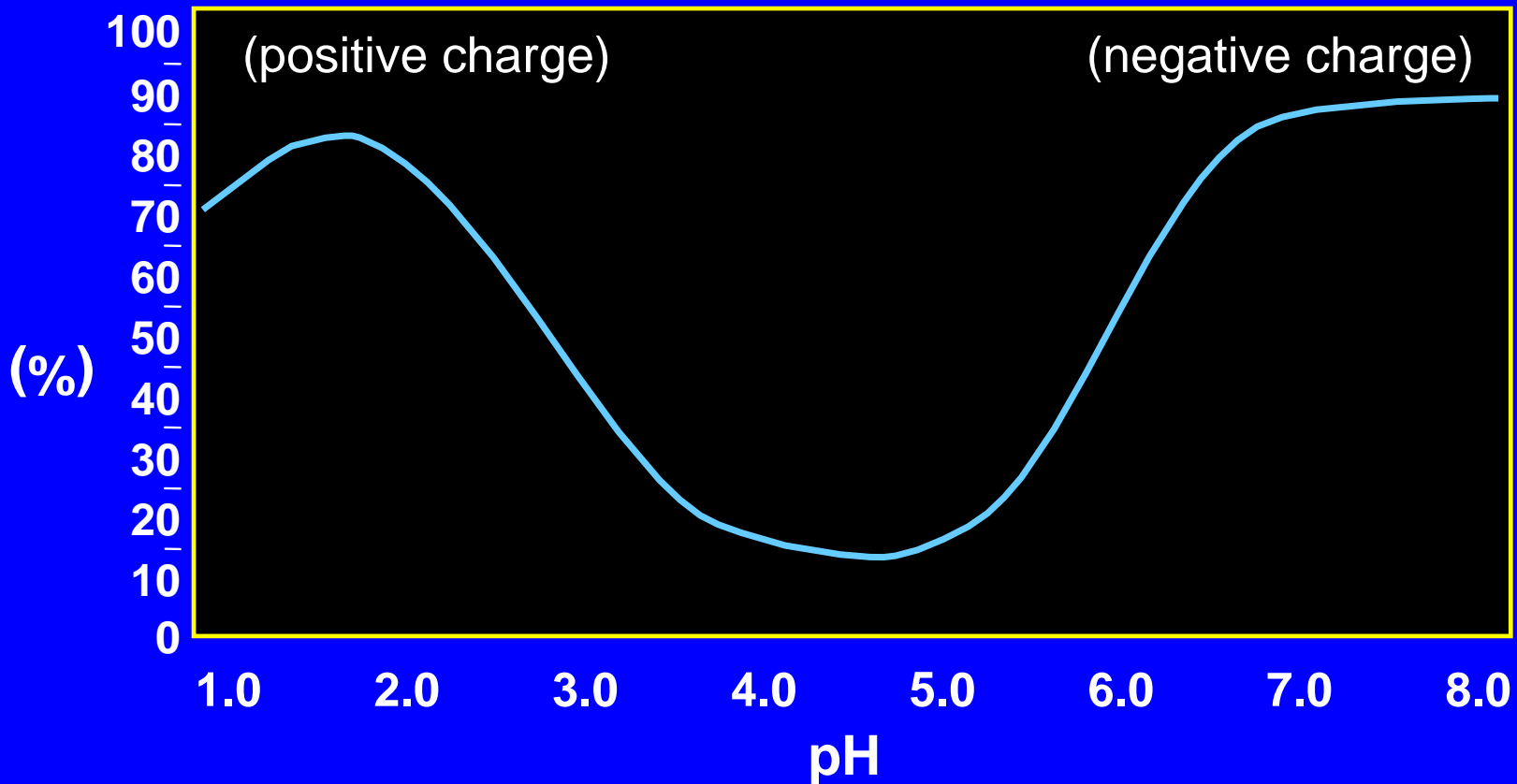


FACTORS AFFECTING HYDRATION

- Time
- Temperature
- Shear or Energy

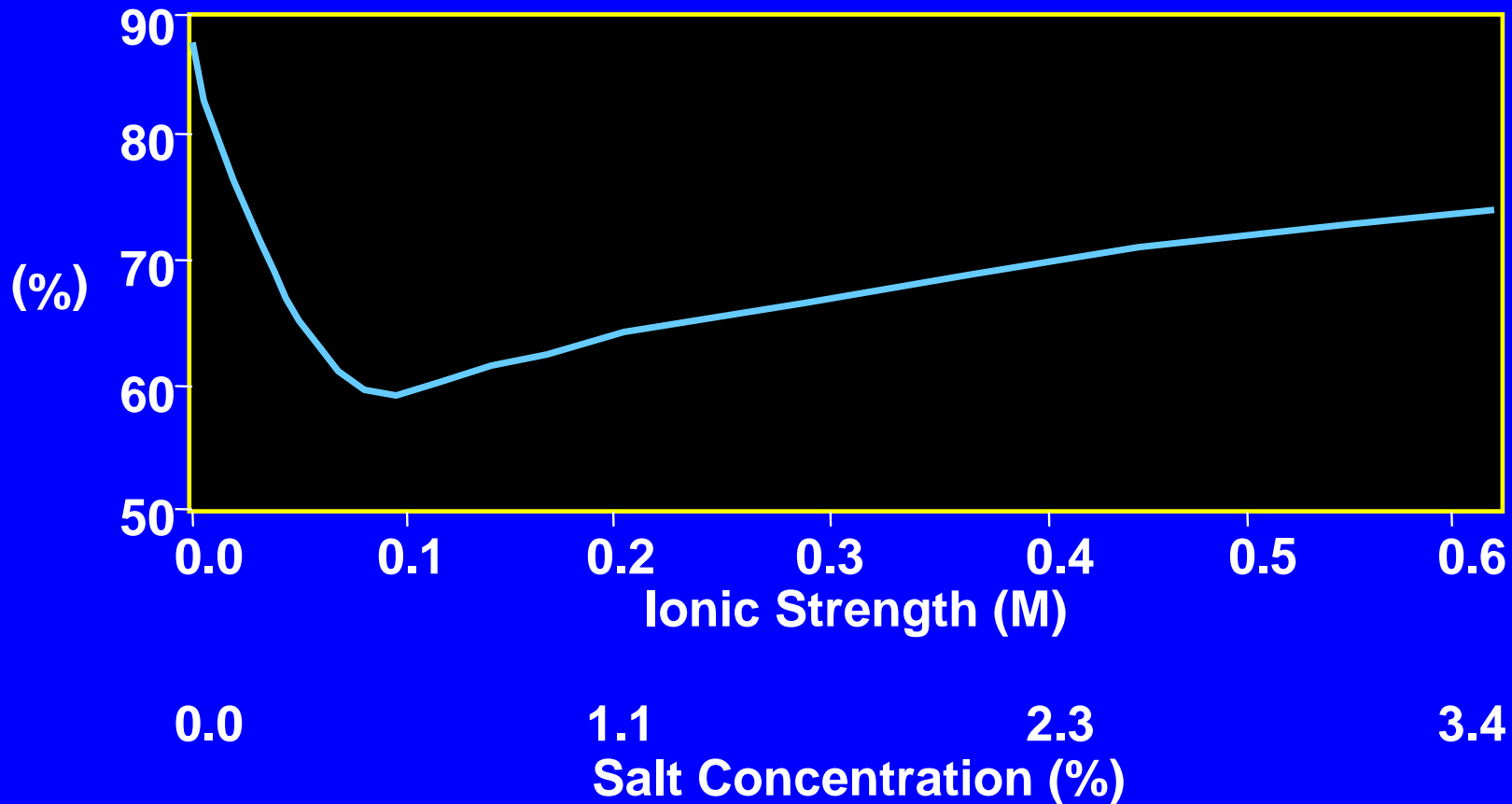


SOLUBILITY* OF ISOLATED SOY PROTEIN AS A FUNCTION OF pH



* Nitrogen Solubility Index.

SOLUBILITY* OF ISOLATED SOY PROTEIN AS A FUNCTION OF IONIC STRENGTH



* Nitrogen Solubility Index.

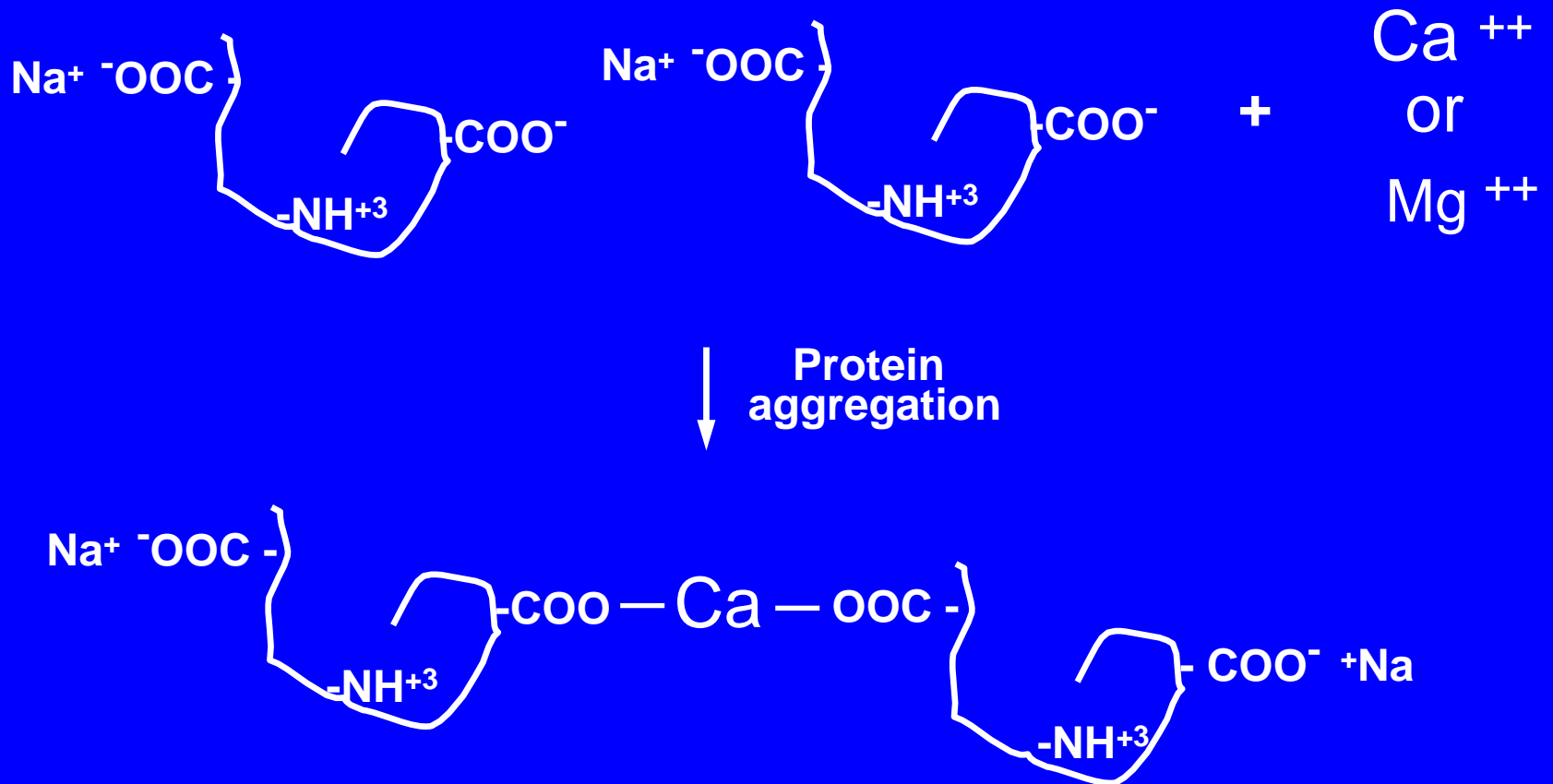
PROTEIN-MINERAL INTERACTION

- Ion Type

Divalent > Monovalent

$\text{Ca}^{++} > \text{Mg}^{++} > \text{Na}^{+} > \text{K}^{+}$

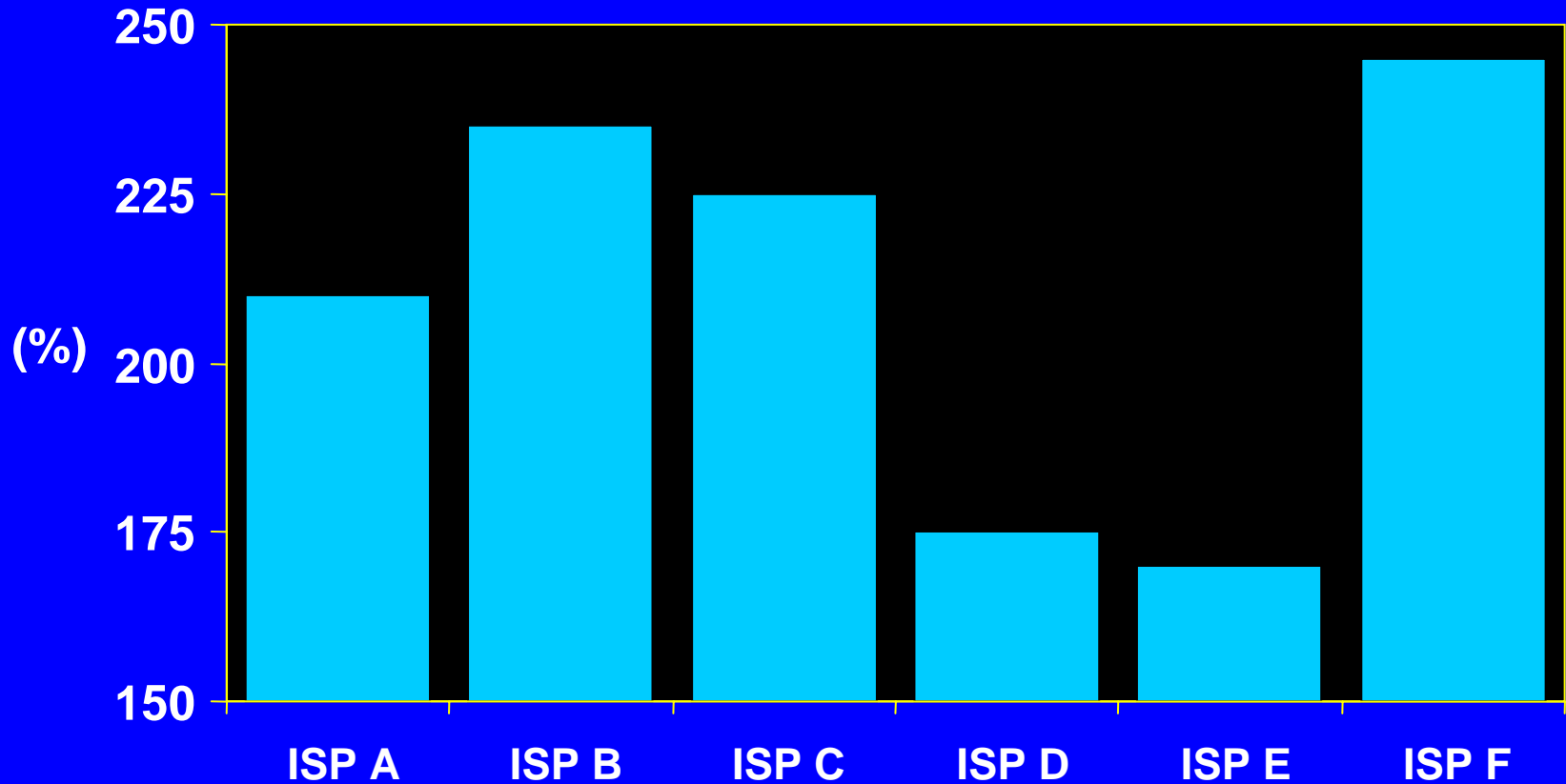
DIVALENT IONS PROMOTE PROTEIN AGGREGATION



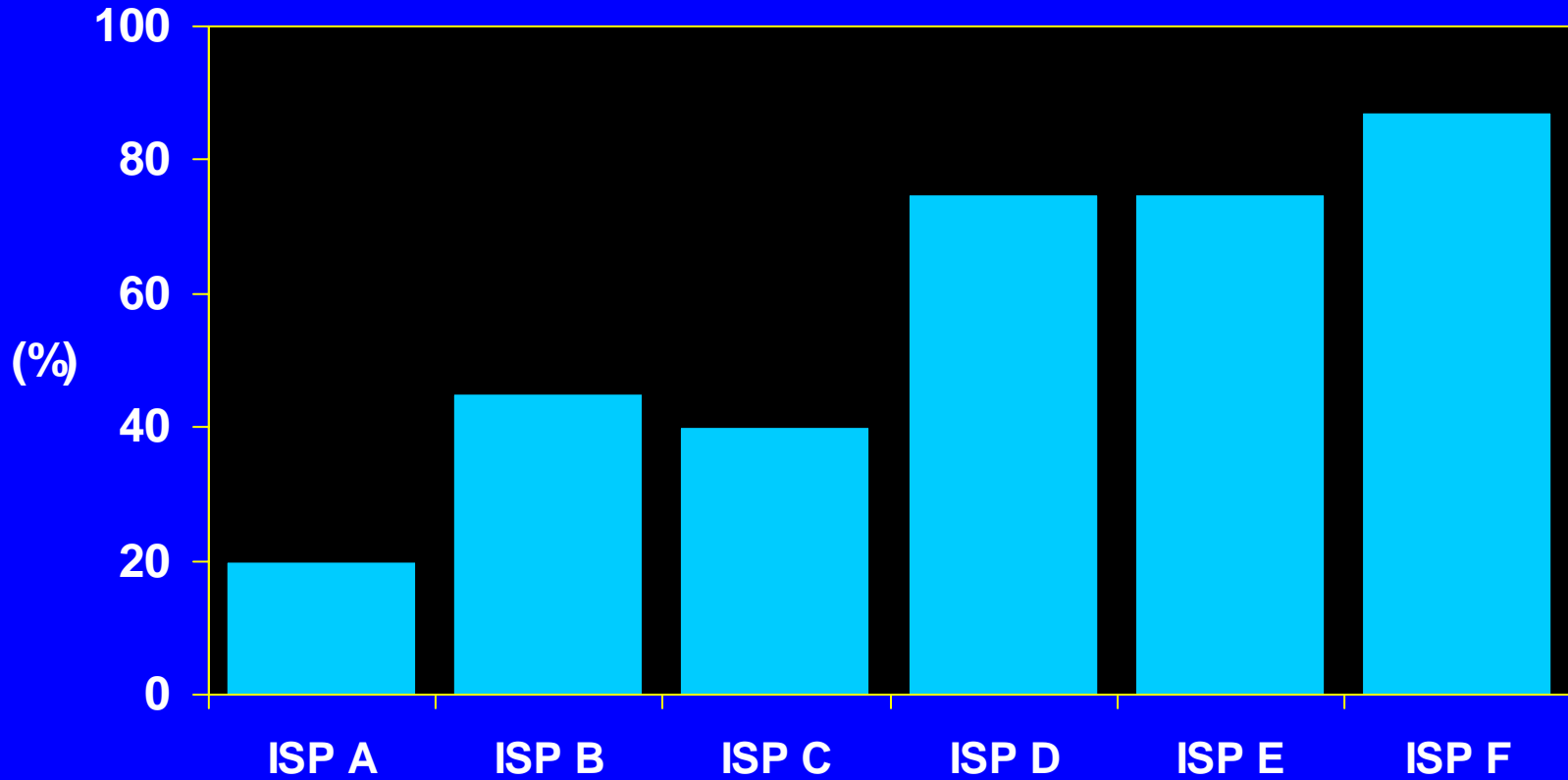
Functional Properties

- Water Absorption
- Solubility
- Viscosity
- Gelation

WATER ABSORPTION



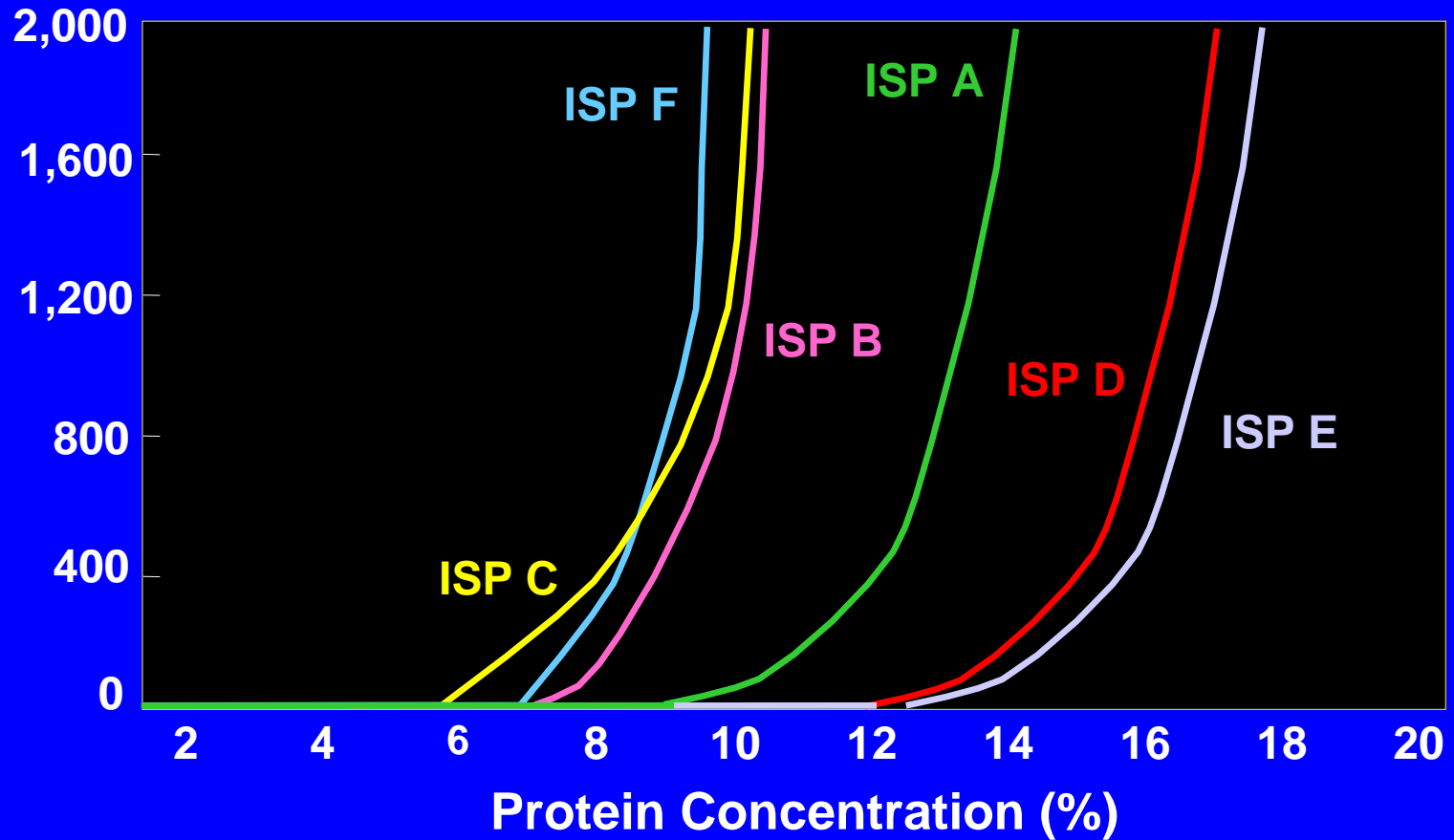
SOLUBILITY*



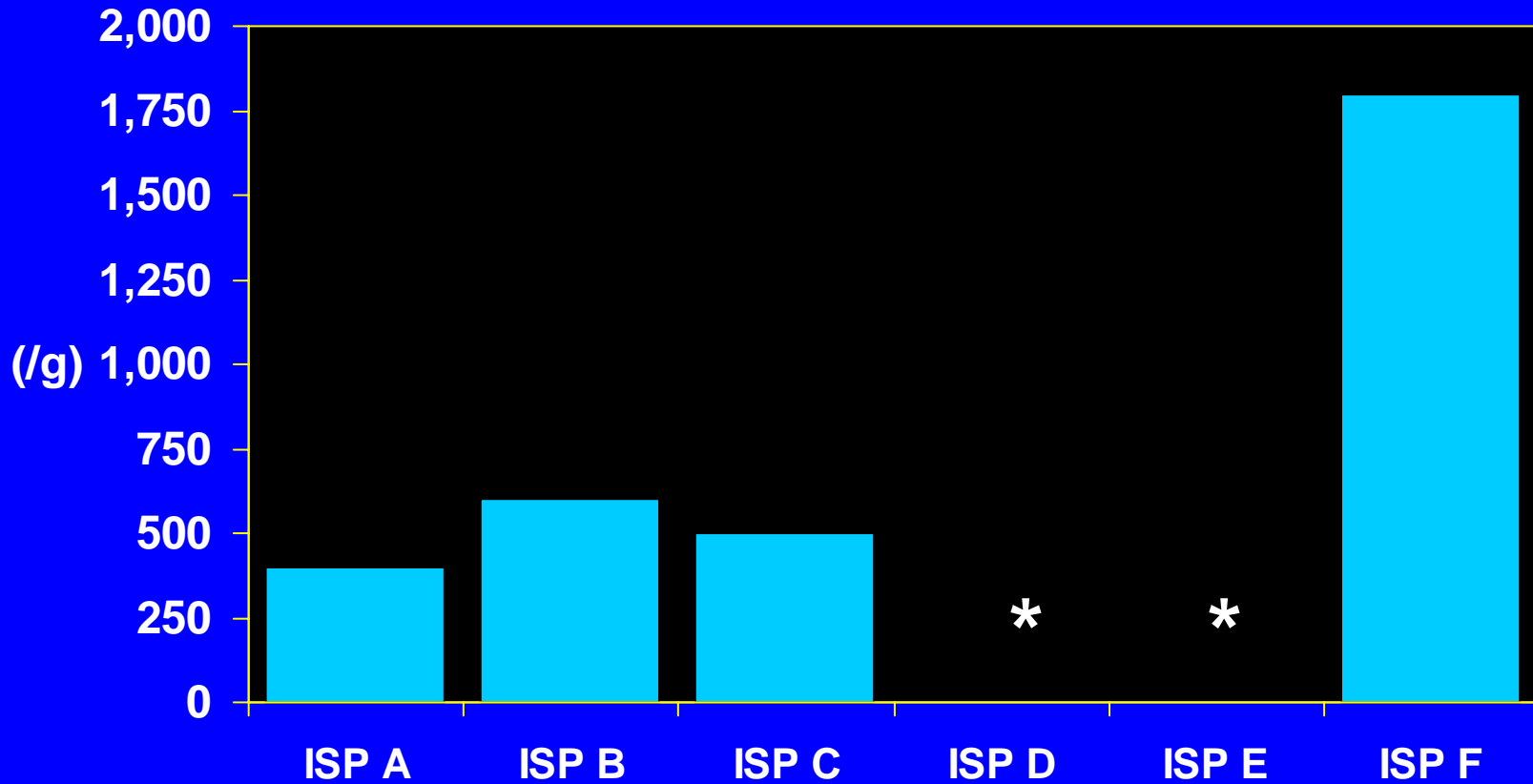
* Nitrogen Solubility Index.

VISCOSITY

Viscosity CPS, 25°C
Shear Rate: 10 Sec.



GELATION



* Does not gel

BEVERAGE APPLICATION USING SOY PROTEIN

PHYSICAL PROPERTIES OF PROTEINS AND BEVERAGES ATTRIBUTIES

PHYSICAL PROPERTY	BEVERAGE FUNCTIONAL ATTRIBUTE
Solubility	Appearance, mouthfeel, sediment, suspension stability
Emulsification	Suspension stability, mouthfeel, appearance , color
Viscosity	Mouthfeel, stability, flavor
Flavor binding	Flavor
Particle size	Mouthfeel, color and appearance
Heat stability	Color, suspension

SOY MILK EXTRACT FROM WHOLE SOYBEANS

- Traditional process from whole beans
- Soak beans usually overnight, room temp
- Grind soybeans finely and heat (cook) soybeans
- The soy extract is separated from the fiber fraction (okara). Need to find a use for the okara
- Resulting soy extract is used for soy milk and other dairy type products
- Soy extract can be flavored, pasteurized, UHT processed and / or spray dried.

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Fiber	15	19-20	16-26	<0.2

FORMULATION FOR SOYMILK WITH ISOLATE SOY PROTEIN

INGREDIENTS	SOYMILK (%)
Water	87.413
Buffering blend	0.30
Stabilizer blend	0.40
Isolated soy protein with stabilized calcium	4.18
Vegetable oil	1.05
Maltodextrin, 15 DE	4.0
Sucrose	2.5
Sodium chloride	0.03
Vitamin / trace mineral premix	0.011
Vanilla Flavor	0.086
Total	100.0

COMPOSITION OF SOYMILK WITH ISOLATE SOY PROTEIN

NUTRIENT	APPROXIMATE PER 237 ML SERVING	PERCENT OF DAILY VALUE (%)
Energy	122.5 calorie	--
Protein	7.8 gm	15.6
Fat	3.3 gm	--
Ash	1.18 gm	--
Carbohydrate	15.4 gm	--
Calcium	300 mg	30
Phosphorus	277 mg	27

FORMULATION FOR NUTRITIONAL BEVERAGE

INGREDIENTS	NUTRITIONAL BEVERAGE (%)
Water	89.549
Buffer blend	0.30
Stabilizer blend	0.40
Isolated soy protein with stabilized calcium	3.810
Vegetable oil	1.05
Sucrose	4.80
Sodium chloride	0.03
Vitamin / trace mineral premix	0.011
Vanilla Flavor	0.05
Total	100.0

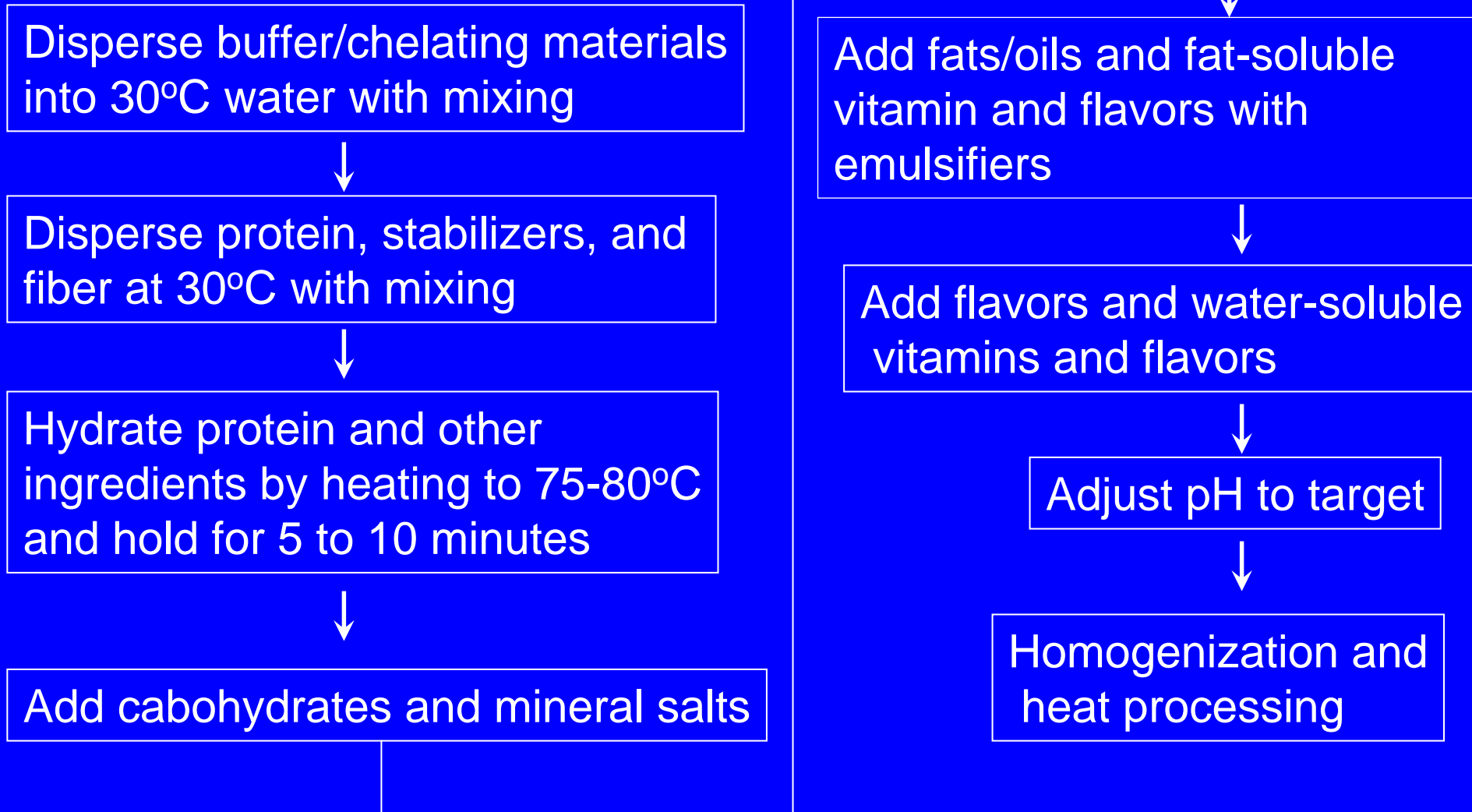
FLAVOR COMPLIMENTRY TO SOY PROTEINS

- Brown flavors
- Hazel nut
- Cholcolate
- English toffe
- Coffee latte
- Caramel
- Rum
- Raison
- Malt
- Cream
- Almond
- Passion fruit
- Peach
- Apple
- Cereal
- Coconut banana
- Honeydew melon
- I am sure there are others

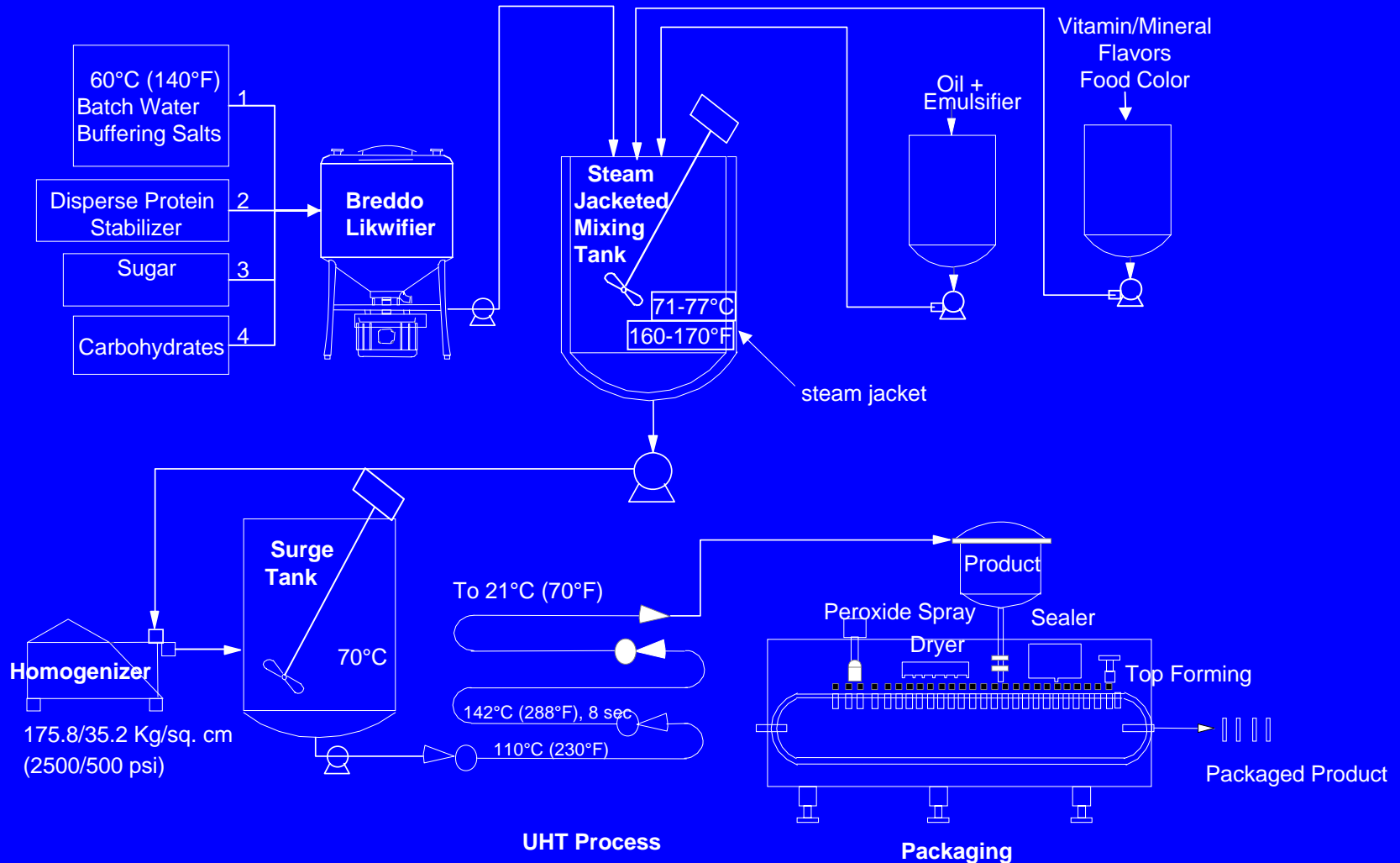
FORMULATION FOR MILK-PLUS BEVERAGE

INGREDIENTS	MILK-PLUS SOY (%)
Water	17.54
Isolated soy protein	0.56
Whole milk (12.8% solids)	80.0
Vegetable oil	0.63
Emulsifier blend	0.02
Dairy whey	1.2
Tricalcium phosphate	0.05
Total	100.0

PROCESS FOR READY TO DRINK (NEUTRAL pH) BEVERAGE



UHT PROCESSING AND ASEPTIC PACKAGING OF READY-TO-DRINK MILK ALTERNATIVE BEVERAGE



FORMULATION FOR ACIDIC BEVERAGE CONTAINING SOY PROTEIN

INGREDIENTS	FORTIFIED JUICE (%)
Water	67.78
Genu pectin	0.5
Isolated soy protein and stabilized calcium	3.57
Juice (12-15 brix ^o)	20.0
Sucrose	8.0
Sodium citrate	0.15
Flavor system	+
Color system	+
Total	100.0

PROCESS FOR READY TO DRINK (ACID pH) BEVERAGE

Disperse protein into 30–40°C water with mixing



Blend pectin with sugar and Disperse into protein slurry



Hydrate protein / pectin slurry by heating to 80°C and holding for 15 minutes. Homogenize 150 Bar



Add sugar, juice concentrate, color and flavor. Adjust pH to 3.7-3.9 with appropriate acids

Hold pH slurry for five minutes with moderate mixing

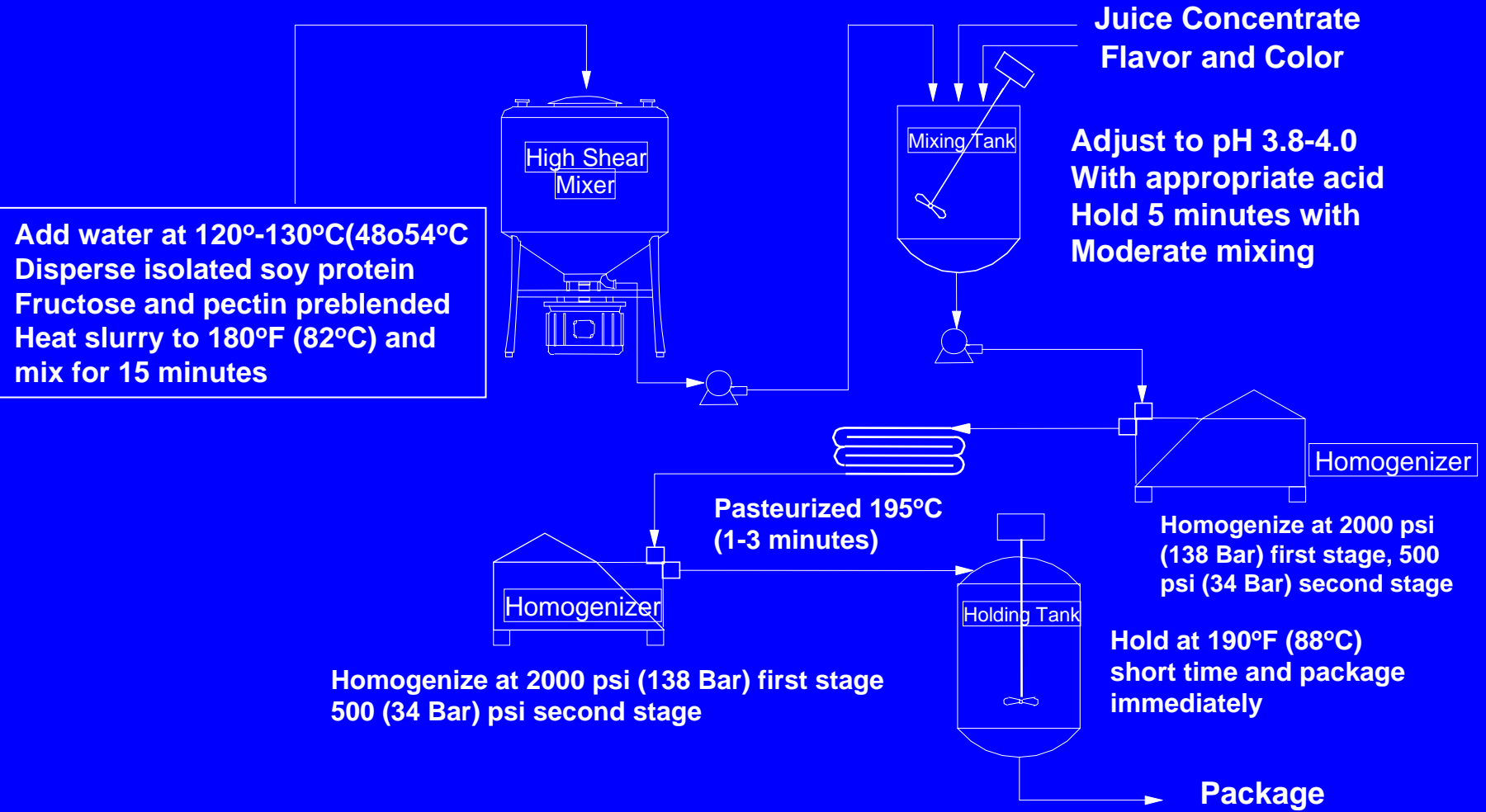


Homogenize at 150 Bar



Heat process at about 195°F for 2 minutes, package, and maintain temperature in package for about 3 minutes before cooling

PROCESS FOR MAKING AN ACID BEVERAGE CONTAINING SOY PROTEIN



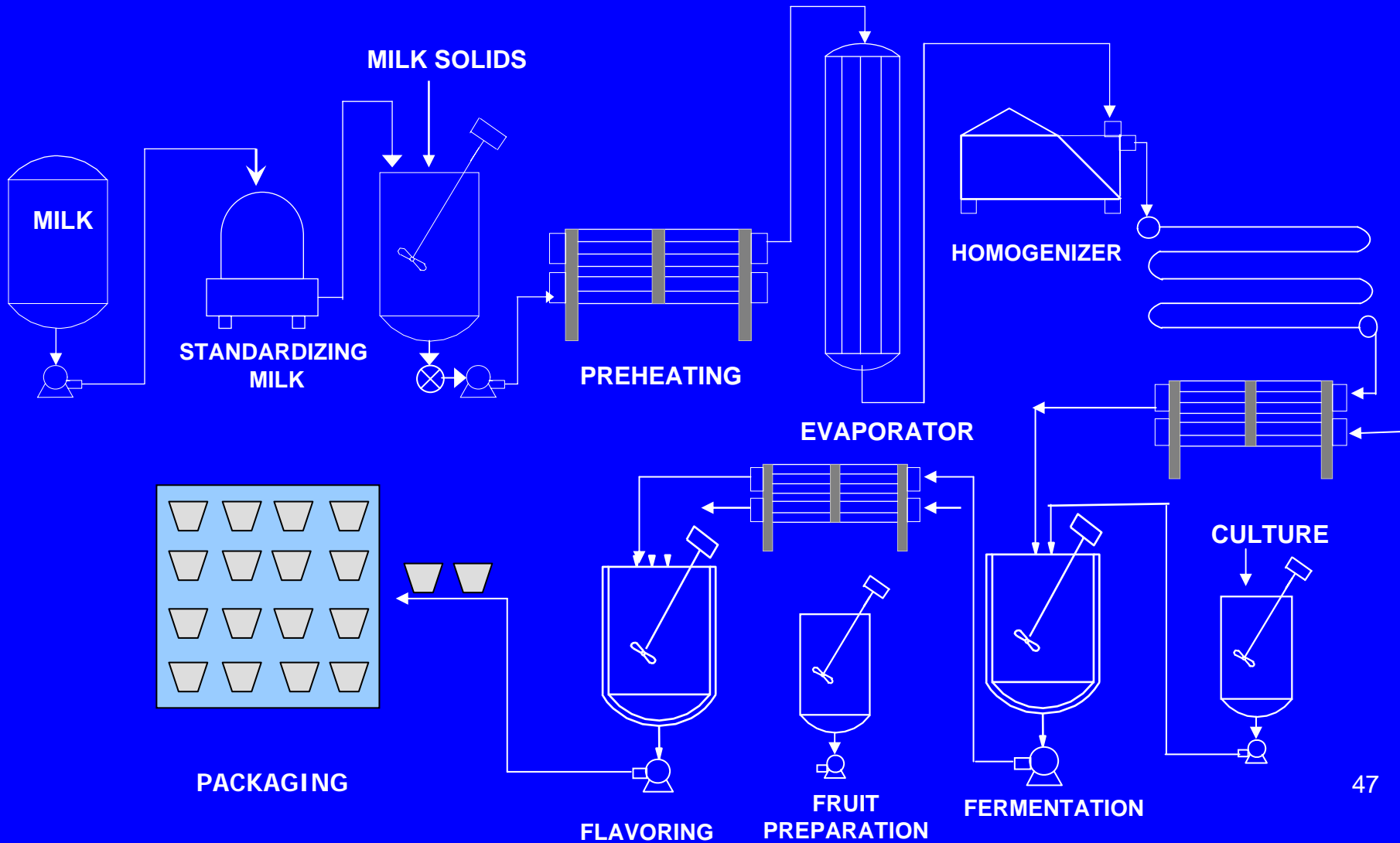
SPOONABLE AND DRINKABLE YOGURT BASED ON SOY PROTEIN

INGREDIENTS	SPOONABLE SOY YOGURT (%)	DRINKING SOY YOGURT (%)
Water	81.75	81.75
Isolate soy protein (one type)	4.6	0.0
Isolate soy protein (another type)	0.0	4.6
Mono/disaccharide blend	6.5	6.5
Maltodextrin	6.0	6.0
Vegetable oil	1.5	1.5
Pectin	0.15	0.15

MEMBRANE PROCESSED SOY PROTEIN REPLACING SKIMMILK TYPICALLY USED IN YOGURT

INGREDIENTS	DAIRY YOGURT (%)	DAIRY / SOY YOGURT (%)
Water	0	0
Milk (10% solids, 1% fat)	93.9	95.7
Skim milk powder	3.0	0
Membrane processed soy protein (80% protein)	0	1.25
Sugar	3.0	3.0
Pectin	0.1	0.1

SCHEMATIC OF YOGURT PROCESS



Danone Takes Milk and Soy Spoonable Yoghurt Mainstream in Spain



Plain and 2 Fruit flavours launched May, 2003

The Milk and Soya Success Continues with Line Extensions



Danone Bio Soja Drinkable Yogurt
Launched May, 2004

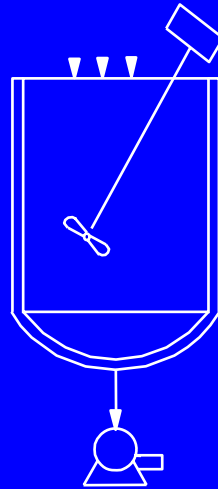
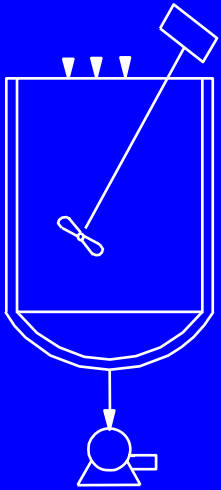
BEVERAGE PRODUCTS CONTAINING

- Soy protein manufacturers have researched and developed many different prototype beverages
- They can probably help reduce time to develop soy beverages if specific questions can be answered
- Have identified nutritional profile
- Describe physical properties required
- Are there limitations on ingredients than can be used
- What type of processing is available

BEVERAGE PRODUCTS CONTAINING

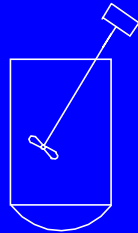
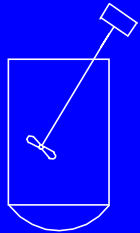
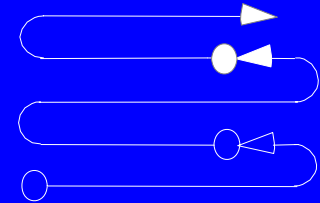
- Are there any labeling or regulatory requirements
- Health benefits have resulted in much written about soy protein and human health, thus consumers are more knowledgeable about soy protein and health
- Soy protein can provide the fat emulsification properties suspension stability
- In addition, soy protein is an economical high-quality protein

THANK YOU



160-170°F

71-77°C





EXPLOSION OF SOY CONSUMPTION IN BEVERAGES DESSERTS AND YOGURTS (UNITED STATES)