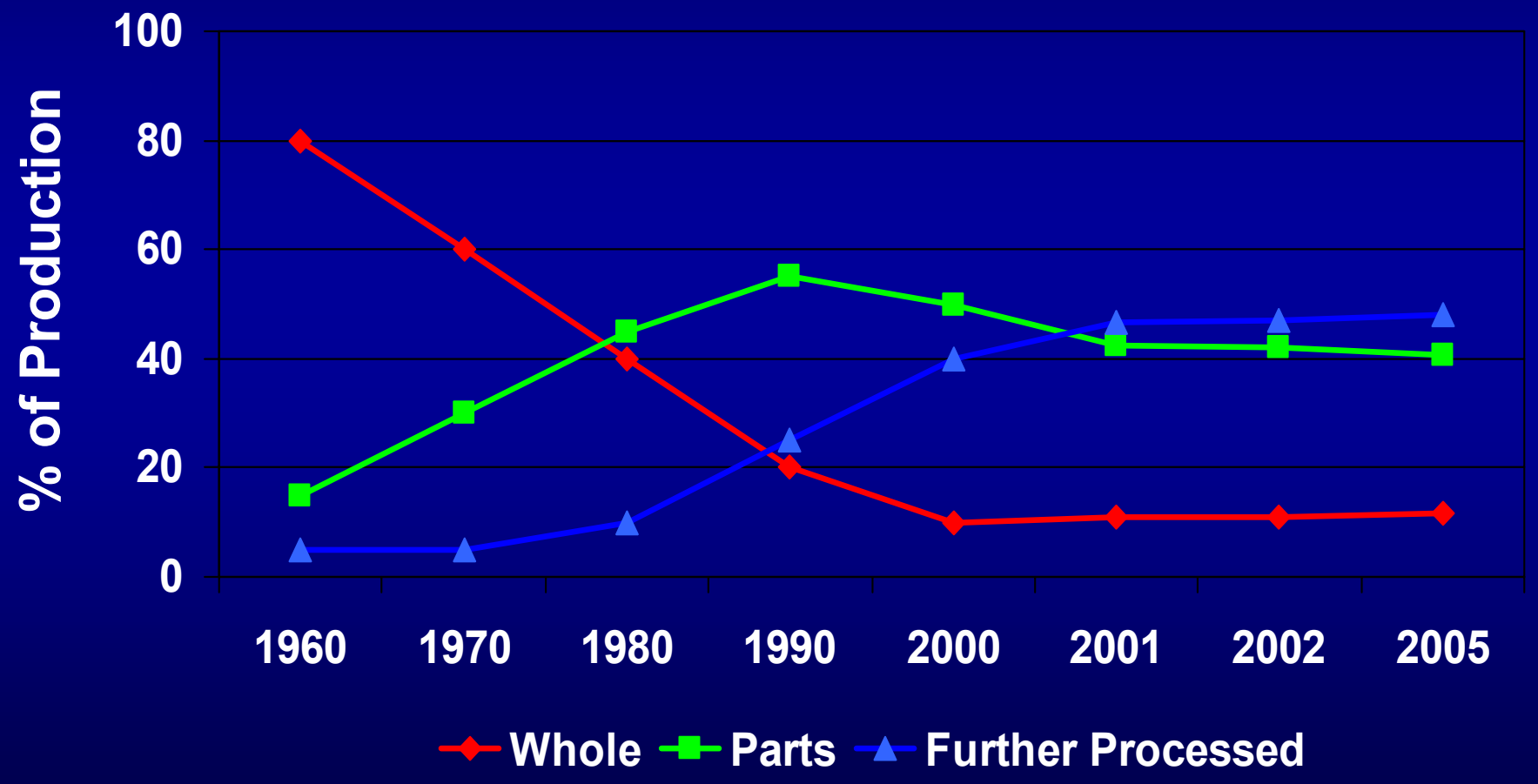
Brining and Marination

“Enhanced Poultry Products”

Shelly McKee
Auburn University

U.S. Poultry Industry: Market Segments



Consumer Trends

- Value-added for convenience
- Minimal preparation time
- Portion sizing
- High protein
- Enhanced flavor,
  - diverse palate
  - ethnic
- Organic

Consumer Trends

- The $115- to $150-billion ready-to-eat (RTE) segment is exploding
- 73% of consumers make evening meal decision around 4:30 P.M. the same day
- Majority want meal preparation to be 45 minutes or less
- Most meals chosen have 5 ingredients or less High protein

Enhanced Meat Products

- "**Enhanced meat** can be defined as fresh, whole muscle meat that has been injected with a solution of water and other ingredients that may include salt, phosphates, antioxidants, and flavorings"

Enhanced Poultry Meat Labels

- *"Contains up to 7% of a solution to enhance juiciness and tenderness of water, salt, modified food starch, sodium phosphates and natural flavors.“*
- *"Injected with up to 15% of a solution to enhance juiciness. Solution ingredients: turkey broth, salt, sugar, sodium phosphates, flavoring"*


Topps
6 Chicken Kabobs
Chicken Breast with Rib Meat,
Bell Peppers, Mushrooms, on a Wooden Skewer
98% Lean
Vacuum Sealed
For Freshness
Keep Frozen
NET WT. 28 oz. (1 LB. 12 oz.) .79kg.
INSPECTED
U.S.
P-9748
Serving Suggestion


Tyson
WHOLE CHICKEN

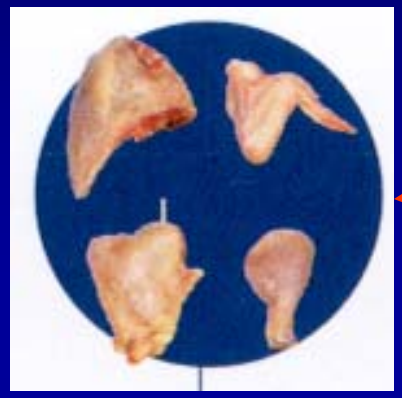
Marination vs. Brining

- *MARINATION*
  - Evolved as a method of meat preservation
  - Includes a mixture of oil and acidic liquids
    - Vinegar, lemon juice or wine and other spices
  - pH of system lower than typical brines
  - Typically includes salt and may include phosphates
  - Soak &/ or injected (~10% uptake), tumbled

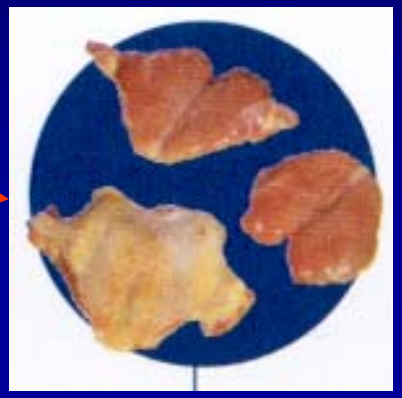
Marination vs. Brining

- BRINE
  - Soaking meat in or injecting meat with a salt water solution
  - Usually alkaline phosphates
  - Other seasonings maybe added as well
  - Maybe used as a soak solution, injected into the meat and then soaked or they maybe injected and tumbled
  - Can be used as a functional step in production of value added products

Areas of Further Processing



Cut-up



Debone

Formed: whole

Formed: comminuted

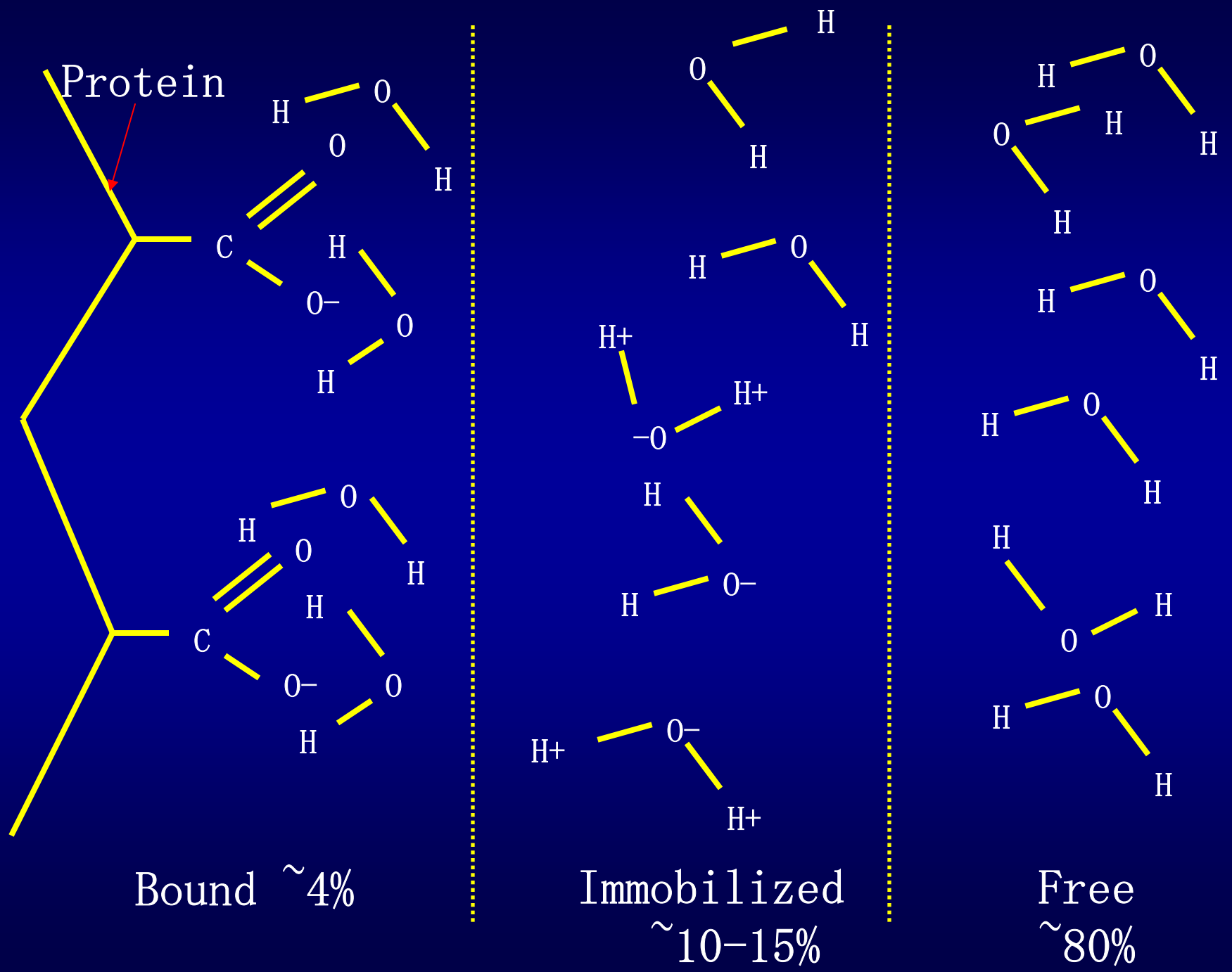
Formed: emulsion

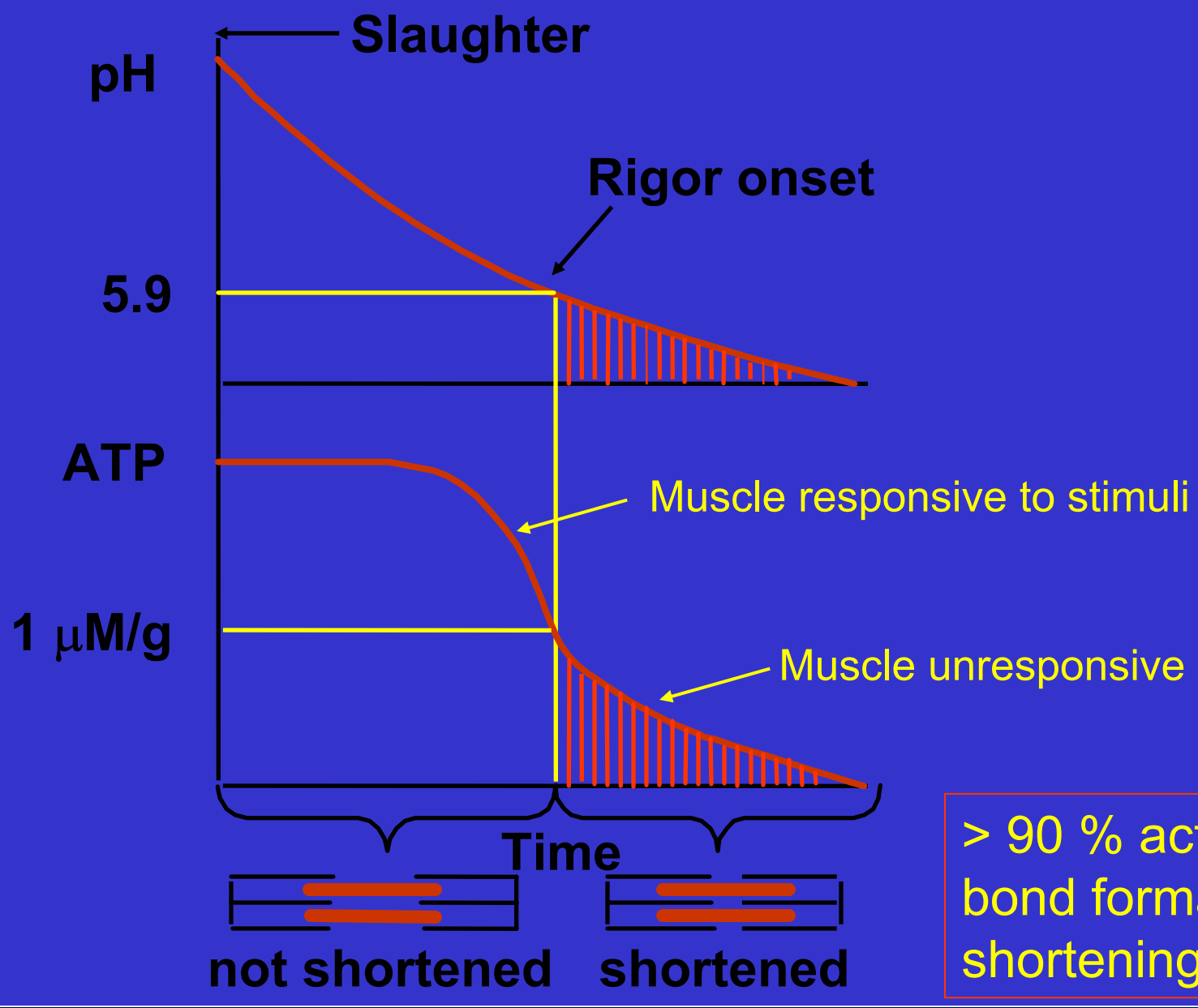
Overview…..

- Meat Chemistry
- Functional Ingredients
- Injection Marination
- Tumbling
- Other

Water: Muscle is around 70% water

- Phases
  - **Bound water**
    -Water molecules closely associated with muscle proteins
  - **Immobilized water**
    -Water attracted to bound molecules, net charge attraction
  - **Free water**
    -Easily separates, loosely bound

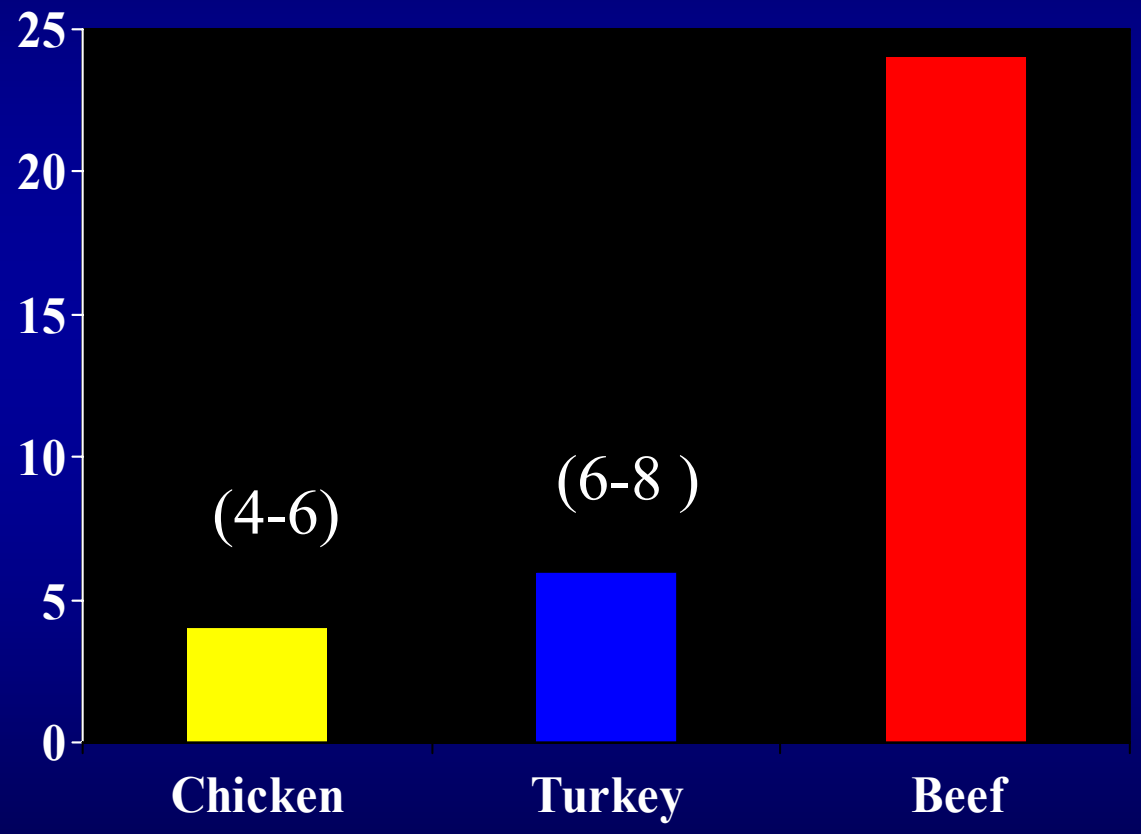

Protein
Bound ~4%
Immobilized
~10-15%
Free
~80%



> 90 % actomyosin bond formation = shortening

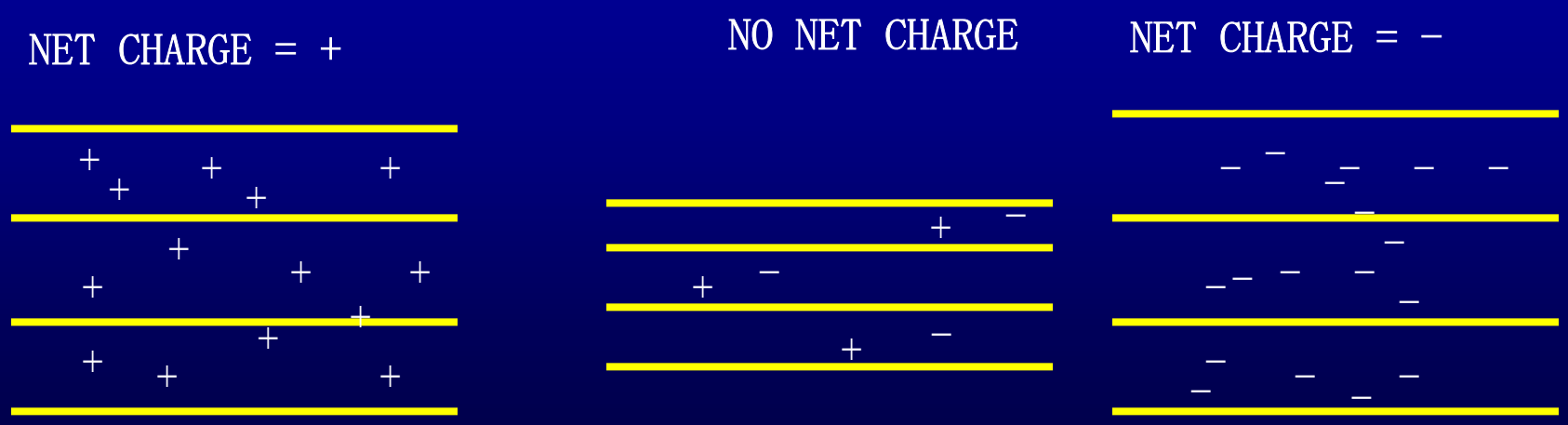
Phases of Rigor Mortis

- **Completion (Hrs)**



Water Holding Capacity

- **Decreases in muscle pH during rigor development causes:**
  - **Reduced net protein charge**
  - **Reduced interstitial space**



Water Holding Capacity

- **Steric Effect**
  - **2/3 of all reduced WHC due to steric effect**
  - **Spatial issue**
  - **Steric effect related to rigor mortis development**

Muscle Proteins

- Myofibrillar (55%)
  - Structural
  - High ionic (salt soluble)
  - Most functional in processed meats
- Sarcoplasmic (35%)
  - Cellular content
  - Low ionic
  - Little effect on processed meats
- Stromal (connective tissue)
  - Most abundant protein in body
  - Insoluble in salt or water
  - Somewhat useful in processed meats

Muscle Proteins

- Myofibrillar proteins(55%)
  - Myosin
  - Actin
  - Actomyosin (postrigor)
  - Salt soluble > 4 Molar
  - Isoelectric point ~5.3

Muscle Proteins

- Functional Properties of Muscle Proteins
  - Water holding capacity
  - Meat particle binding
  - Gelation
  - Fat encapsulation
  - Browning (Maillard) Reaction
  - Protein Skin

Components of Marination

- Water
- Salt
- Sodium Phosphate
- Modified Food Starch
- Soy Protein Concentrate/Isolate
- Seasoning
- Other: Gums, Carrageenan

Salt

- Enhance product flavor
- Increase moisture retention
- Act as a synergist with STPP to extract salt soluble proteins
- Inhibit the outgrowth of *Clostridium botulinum* via salt's synergistic role with sodium nitrite
- At high concentrations, salt applied to the surface of meat dehydrates the meat and serves as a preservative

Salt

- Level not regulated
- 2% average
  - 1.5%-3%
- Types:
  - Fine
  - Granular/Coarse
  - Ionized
  - De-ionized
  - Sea Salt- may contain high level of impurities

Phosphates

- Water Binding (Increased Yield)
- Synergist with salt to extract myofibrillar proteins
- Improve texture
- Flavor Stabilization
- Color Preservation
- Prevent lipid oxidation

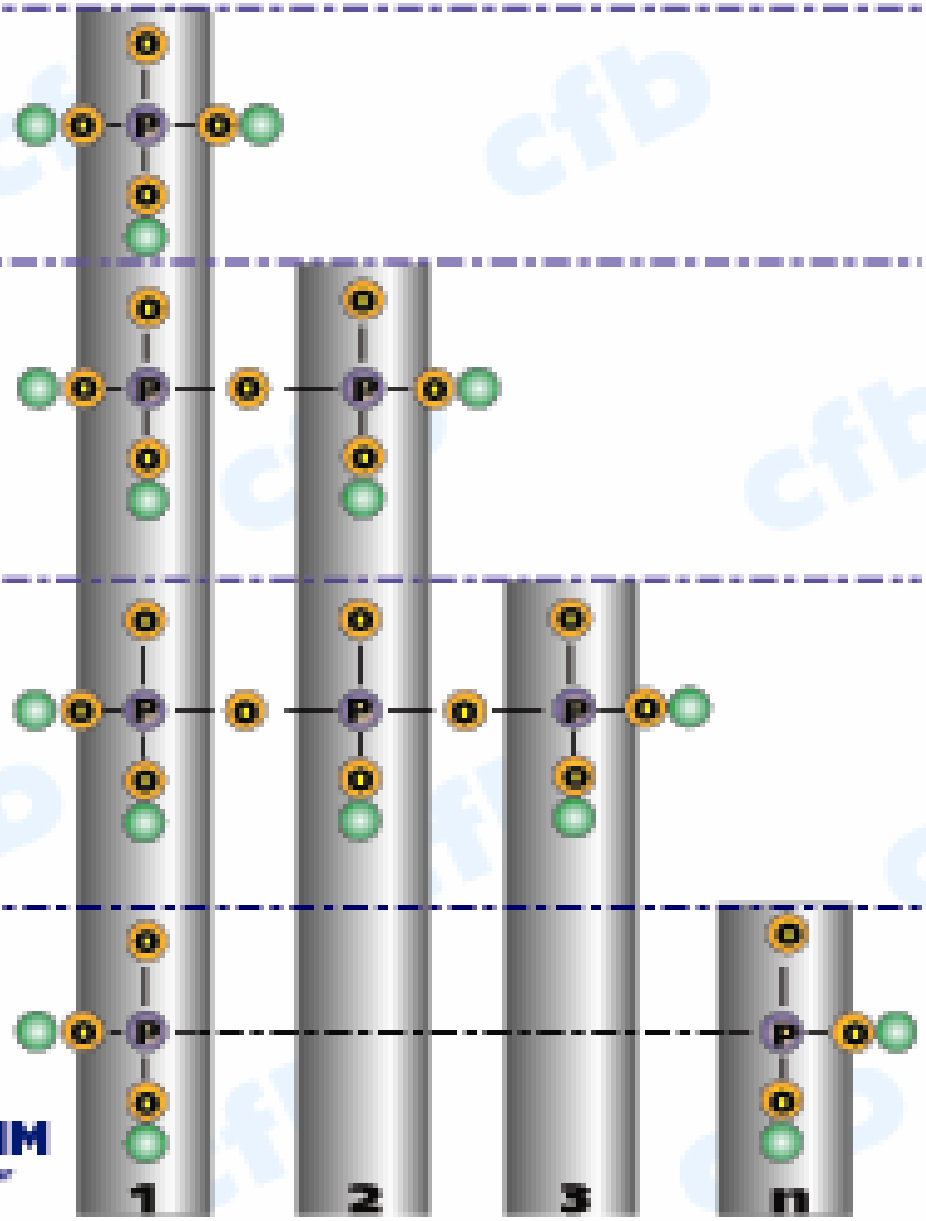
Kind of Phosphates

Monophosphates

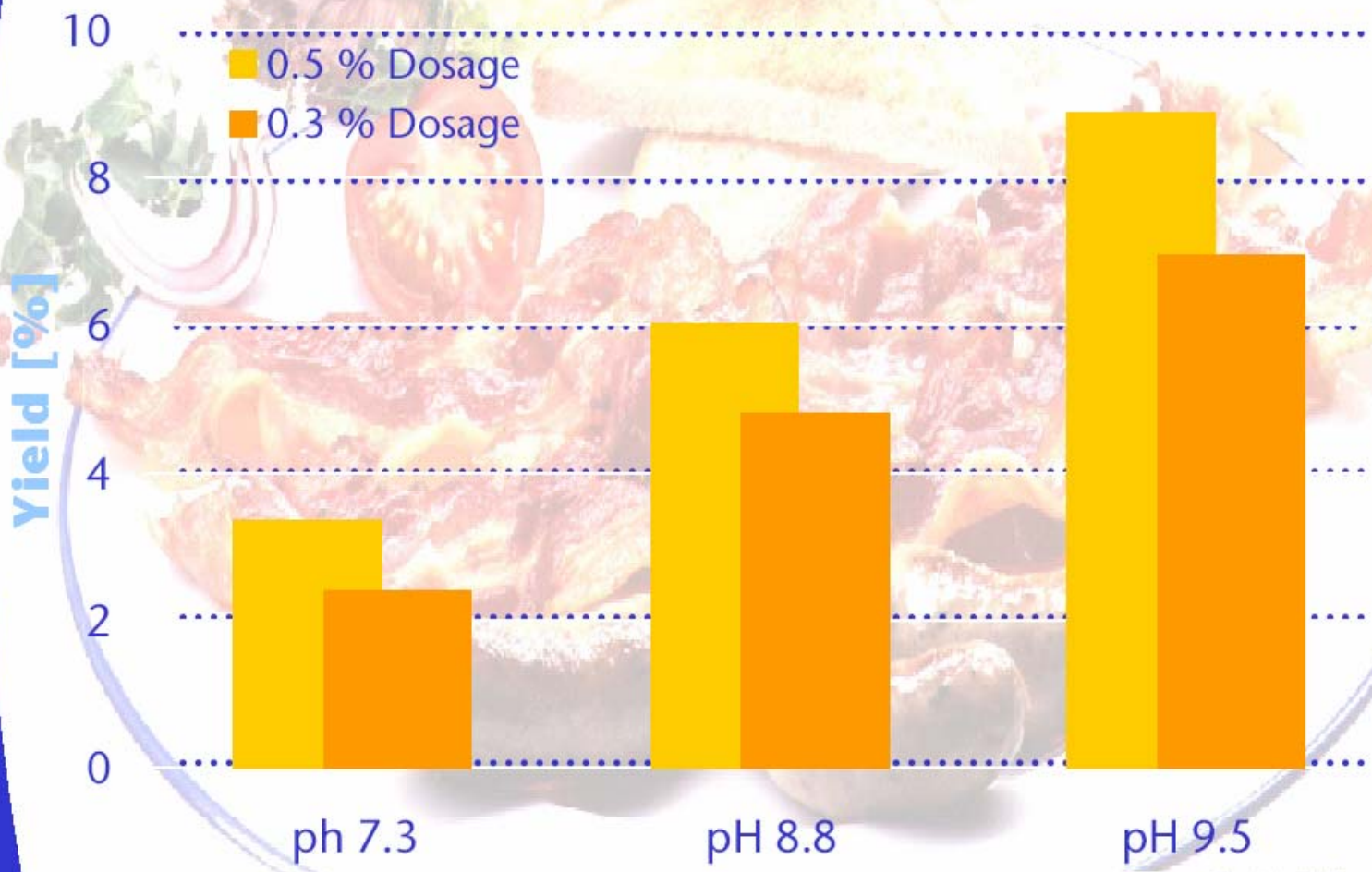
Diphosphates

Triphosphates

Polyphosphates



Increased yield
at higher pH and higher dosage



Chemische Fabrik
BUDENHEIM
Rudolf A. Oetker

Classes, Formulas, pH, Solubility, and Functions of Several Phosphates

Class: Orthophosphates

Phosphate name	Generally accepted formula	pH 1% solut.	Solubility at 25C (g/100g water)	Functions
Monosodium phosphate	NaH_2PO_4	4.6	87	emulsifier, buffer
Disodium phosphates	Na_2HPO_4	9.2	12	emulsifier, buffer
Disodium phosphate dihydrate	$Na_2HPO_4+2H_2O$	9.1	15	emulsifier, buffer
Trisodium phosphate	Na_3PO_4	11.8	14	emulsifier, buffer
Monopotassium phosphate	KH_2PO_4	4.6	25	water binding in meat
Dipotassium phosphate	K_2HPO_4	9.3	168	emulsifier, buffer
Tripotassium phosphate	K_3PO_4	11.9	107	emulsifier, buffer

Food Technology 1990

Classes, Formulas, pH, Solubility, and Functions of Several Phosphates

Class: Condensed Phosphates Pyrophosphates

Phosphate name	Generally accepted formula	pH 1% solut.	Solubility at 25C (g/100g water)	Functions
Sodium acid pyrophosphate	$Na_2H_2P_2O_7$	4.3	15	emulsifier, buffer, sequestrant, water- biding agent in meal
Tetrasodium pyrophosphate	$Na_4P_2O_7$	10.3	8	dispersant, coagulant, crystallization inhibitor in canned tuna
Tetrapotassium pyrophosphate	$K_4P_2O_7$	10.5	187	emulsifier, water binding agent in meats, suspending agent

Food Technology 1990

Classes, Formulas, pH, Solubility, and Functions of Several Phosphates

Class: Tripolyphosphates

Phosphate name	Generally accepted formula	pH 1% solut.	Solubility at 25C (g/100g water)	Functions
Sodium Tripolyphosphate	$Na_5P_3O_{10}$	9.9	15	Emulsifier, water binding agent in meats
Potassium tripolyphosphate	$K_8P_3O_{10}$	9.6	193	Emulsifier, water binding agent in meats

Food Technology 1990

Classes, Formulas, pH, Solubility, and Functions of Several Phosphates

Class: Long-chain polyphosphates

Phosphate name	Generally accepted formula	pH 1% solut.	Solubility at 25C (g/100g water)	Functions
Sodium	$(NaPO_3)_6+Na_2O$	7.7	40a	Sequestrant, emulsifier, water binding agent in meats, suspending agent
Polyphosphates, glassy, or Graham's Salt; three chain lengths; Sodium hexametaphosphate has an average chain length of 13	$(NaPO_3)_{13}+NA_2O$	6.9	40a	Sequestrant, emulsifier, water binding agent in meats, suspending agent
	$(NaPO)_{21}+Na_2O$	6.3		Sequestrant, emulsifier, water binding agent in meats, suspending agent

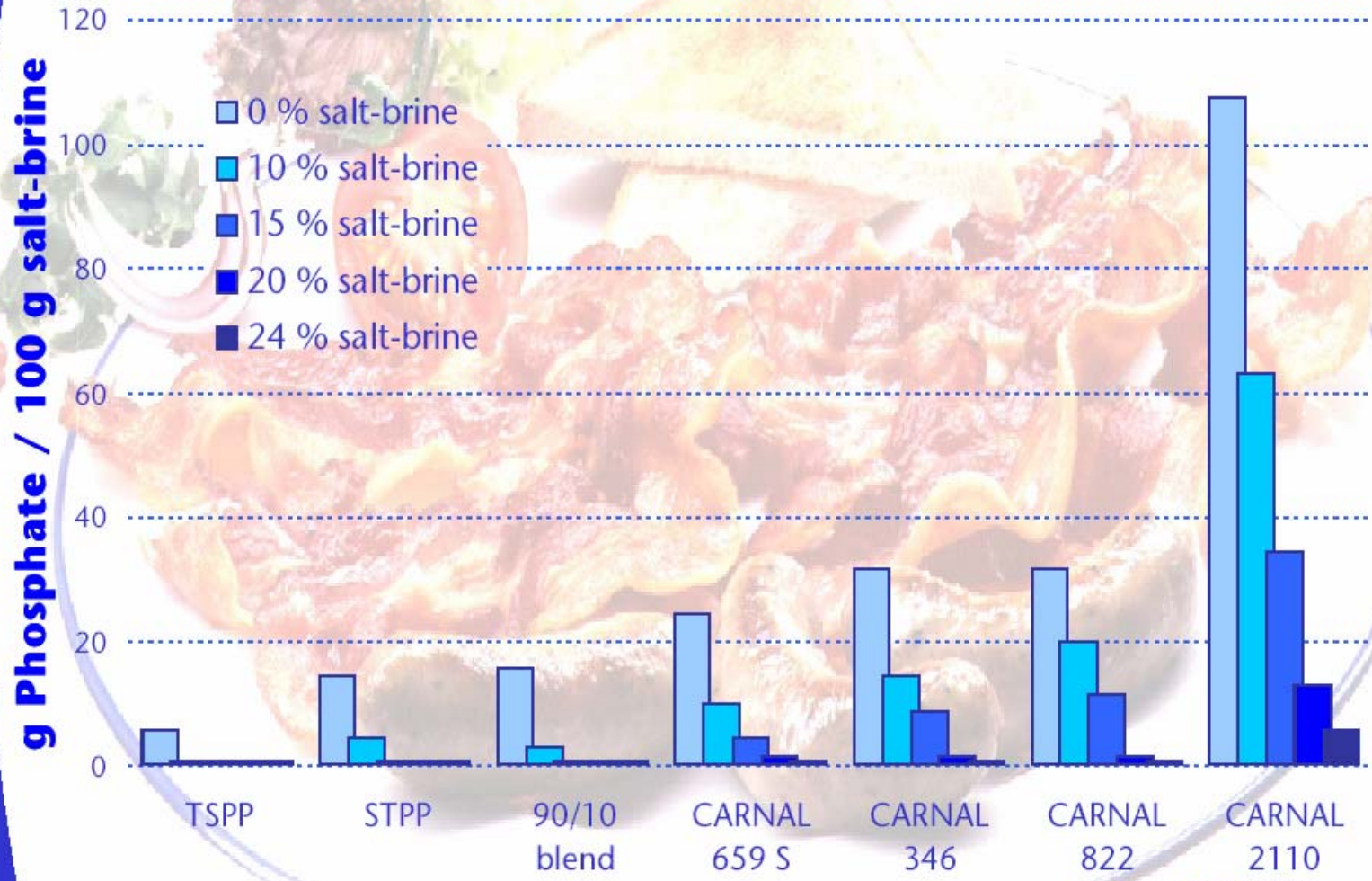
Food Technology 1990

Classes, Formulas, pH, Solubility, and Functions of Several Phosphates

Class: Metaphosphates, Tri-, Tetra-

Phosphate name	Generally accepted formula	pH 1% solut.	Solubility at 25C (g/100g water)	Functions
Sodium trimetaphosphate	$(NaPO_3)_3$	6.7	23	
Sodium tetrametaphosphate	$(NaPO_3)_4+4H_2O$	6.2	18	

Maximum solubility in salt-brines at 20 °C



Chemische Fabrik BUDENHEIM Rudolf A. Oetker

Phosphates

- Diphosphate or pyro content (smaller chains) provide buffering capacity
- Need to dissolve phosphate prior to adding salt
- No greater than 0.5% in finished product
- STPP account for 80% of phosphates used

What to look for when buying a sodium Phosphates

- Product must be free of impurities
- Are plants using hard or softened water
- pH- needs to be controlled
- Solubility, product must dissolve
- Stays in solution
- Is product effective at lower usage levels
- Increase in yields
- Retain water during freeze thaw period

What to look for when buying a sodium Phosphates

- Compounds are chemically bound molecule to molecule (standard phosphates are granular to granular such as a 90-10 blend
- Are you getting enough di-phosphate to retain moisture.
- Should be salt tolerant

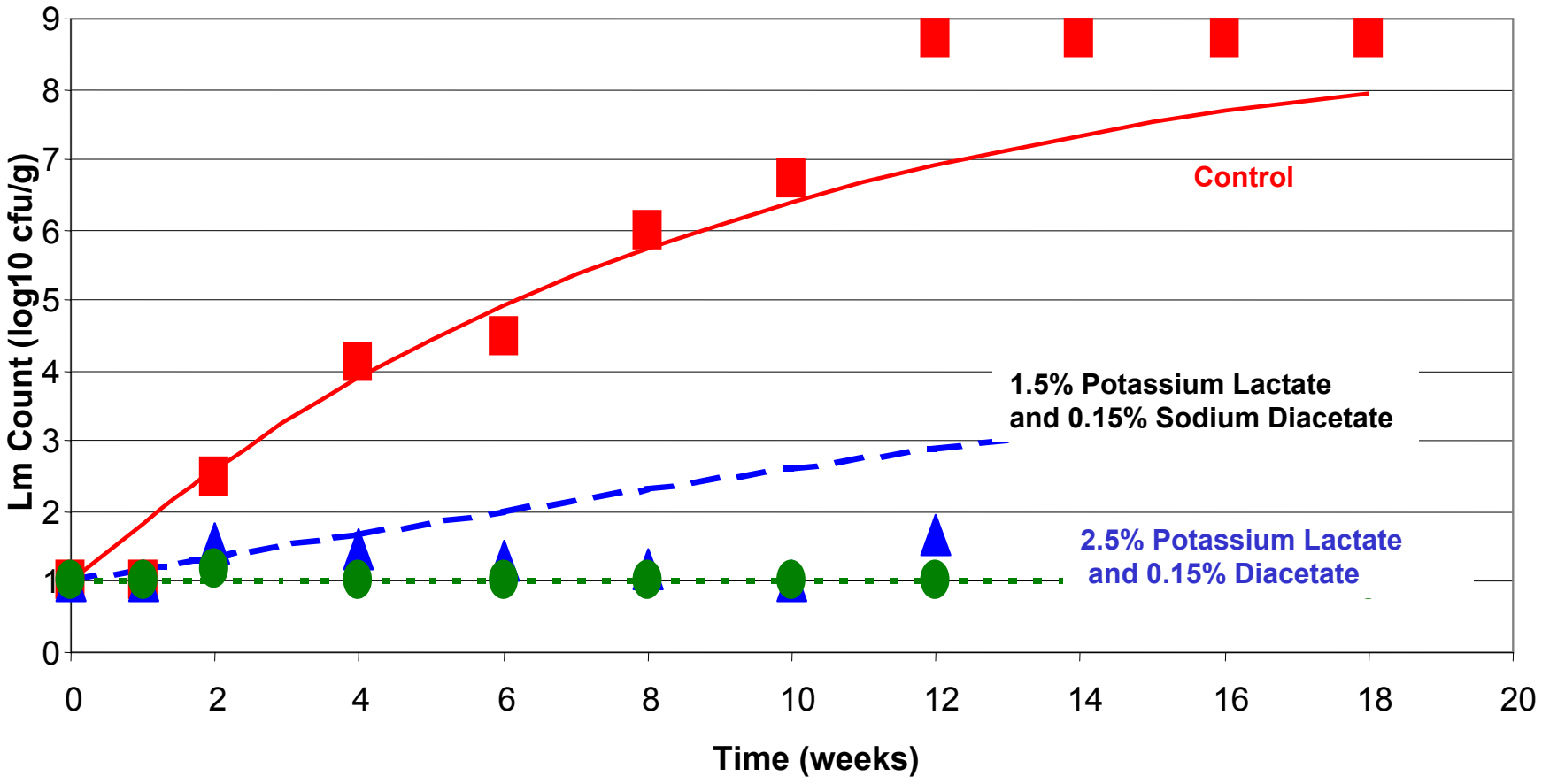
Sodium and Potassium Lactate

- Weak acid
- Disrupts membrane pH gradients
- Inhibit energy metabolism.
- Lactate alone only bacteriostatic at high concentrations
- 2.9% pure sodium lactate or 4.8% in a 80% solution allowed

Sodium Diacetate

- Dissociates into acetic acid and sodium acetate
- Lower pH due to presence of acetic acid
- Sodium diacetate alone only bacteriostatic at high levels
- 0.25% allowed in finished product

Validation Cotto Salami

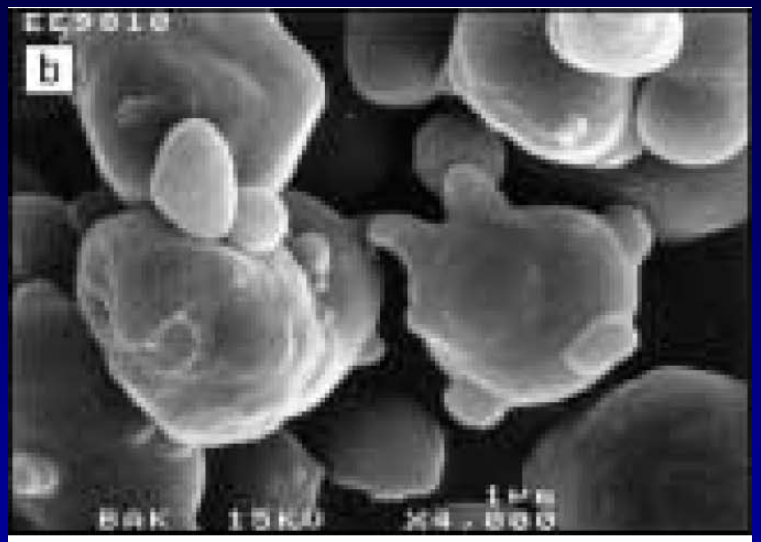


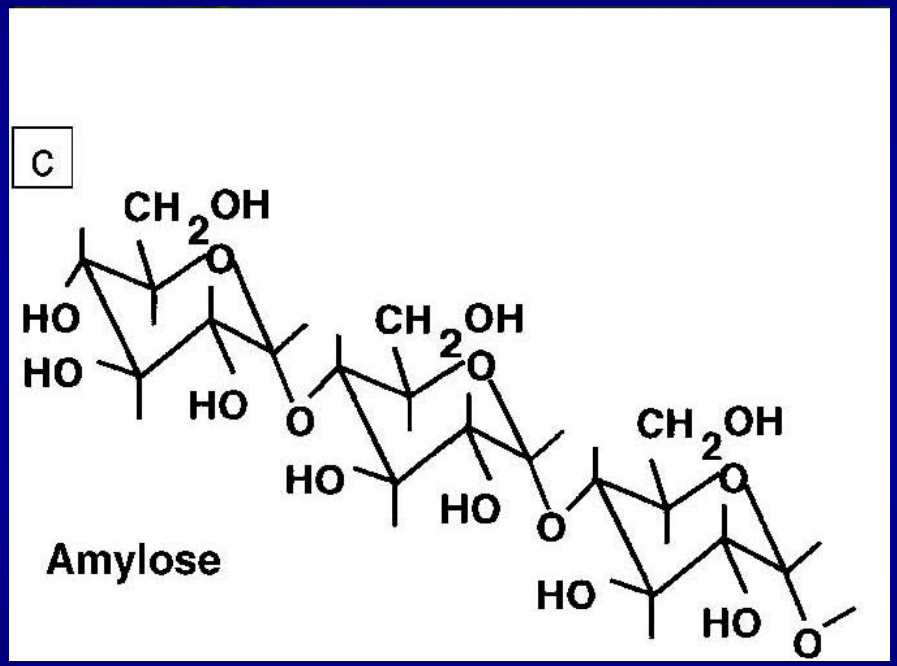
Milkowski, 2002

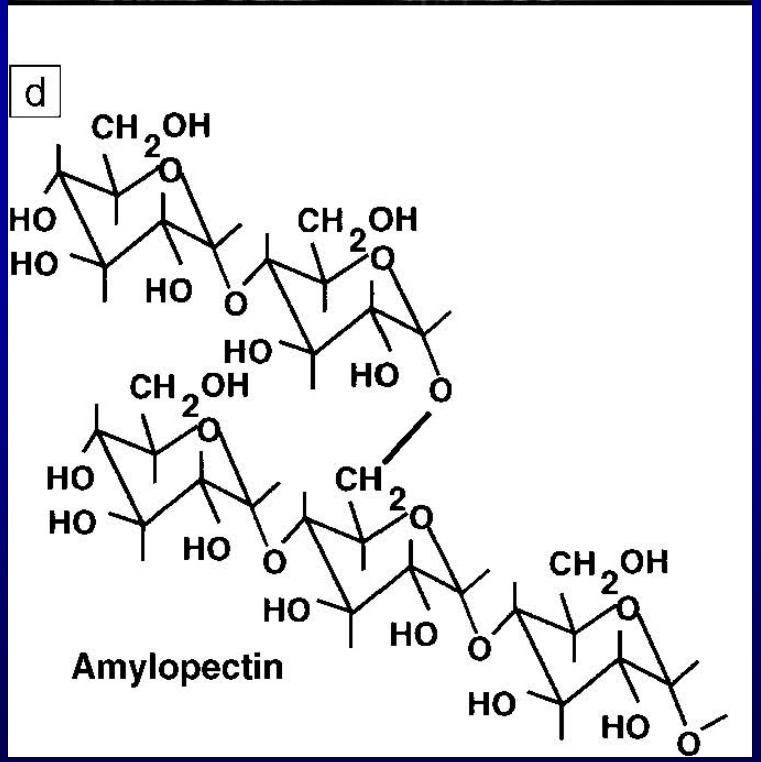
Starches

- Binds water – hydrogen bonding
- Improves texture
- Increases yield
- Increases viscosity
- Used as fat replacers
- Native and modified starches
  - Modified typically used because ease of hydration
- Average use around 2.0%, 3.0% max

Starches


b


c
CH2OH
HO
HO
HO
O
CH2OH
HO
HO
HO
O
CH2OH
HO
HO
HO
O
Amylose


d
CH2OH
HO
HO
HO
O
CH2OH
HO
HO
HO
O
CH2OH
HO
HO
HO
O
CH2
HO
HO
HO
O
CH2OH
HO
HO
HO
O
Amylopectin

Amylose Content of Various Starches

Starch Source	% Amylose
Waxy Rice	0
High Amylose Corn	70
Corn	28
Cassava	17
Waxy Sorghum	0
Wheat	26
Potato	20

Soy Proteins

- Binds water – hydrogen bonding
- Protein-protein binding
- Increases bite
- Cohesion
- Emulsification
- Extenders- flours
- Adds viscosity
- Increases yield

Soy Proteins

- Defatted Soy Flour- 50% protein
  - Used as extender for sausages and ground beef
  - Can lead to beany flavors at high levels
- Soy Concentrate-70% protein
- Soy Protein Isolate-90% protein
  - Excellent binder
  - Emulsification

Binds 1 to 6 grams water per gram protein, 3.5 % max

Main carageenan types and their properties.

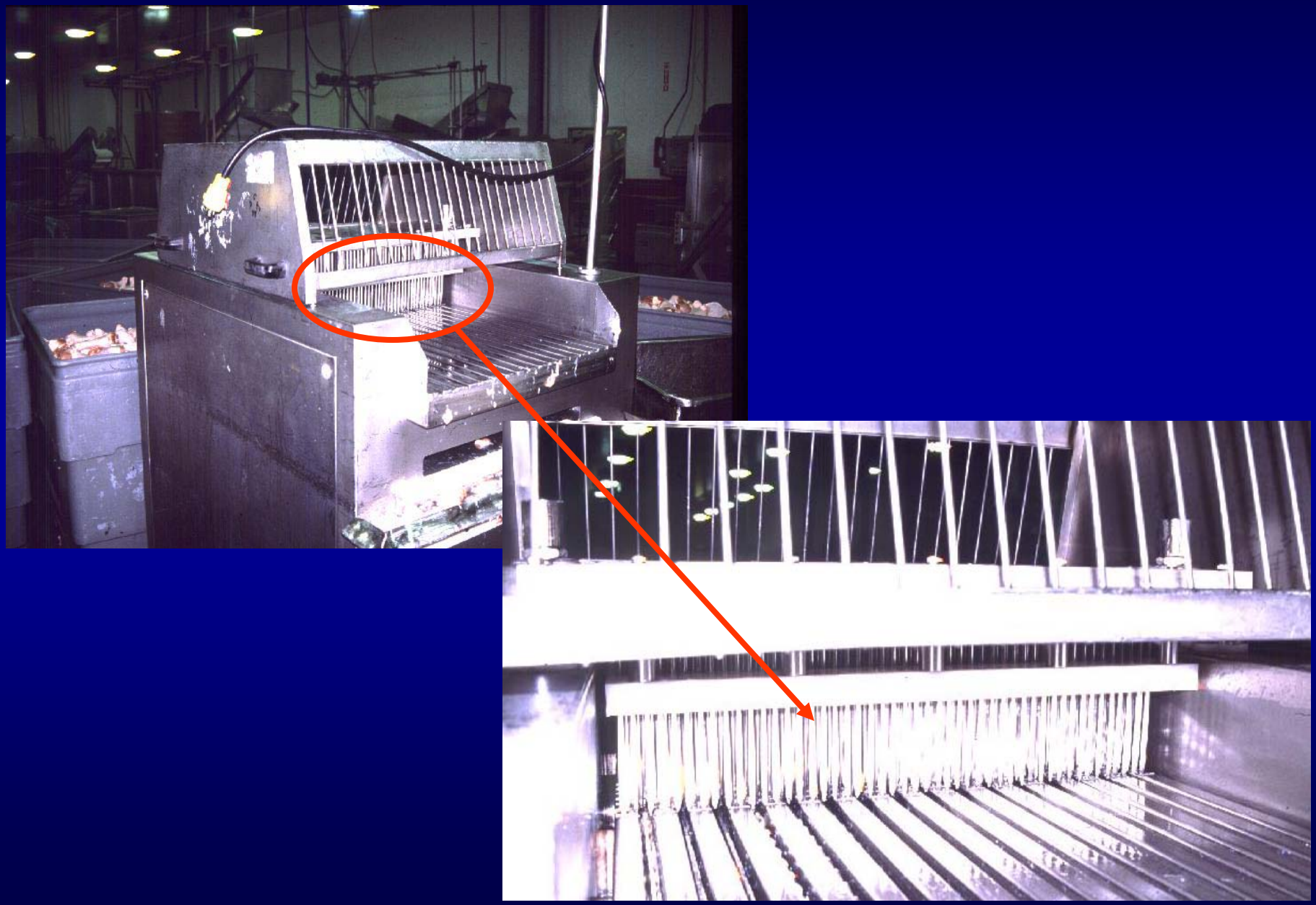
Carageenan Types	Properties
Kappa	Forms strong and brittle gels that are reversible when heated
Iota	Forms weak elastic gels that reverse when heated
Lambda	Thickening agent-does not form gels

Carageenans-Polysaccharides, Gums

- Increasing yield
- Water binding
  - Gel network
- Consistency
- Sliceability
- Spreadability
- Cohesiveness
- Decreases purge, fat content and slicing loss

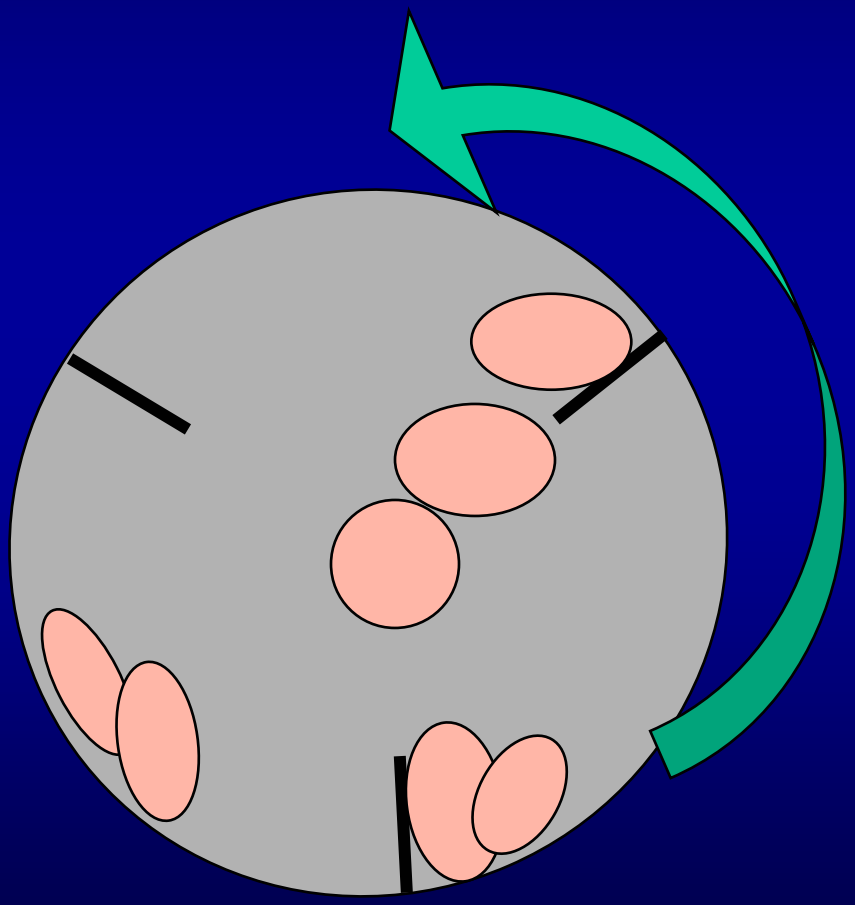
0.5-1.5% in meat applications
cured hams the level is maximum of 1.5%.

Injector - needles



Formed Products

- Tumbling - Actions

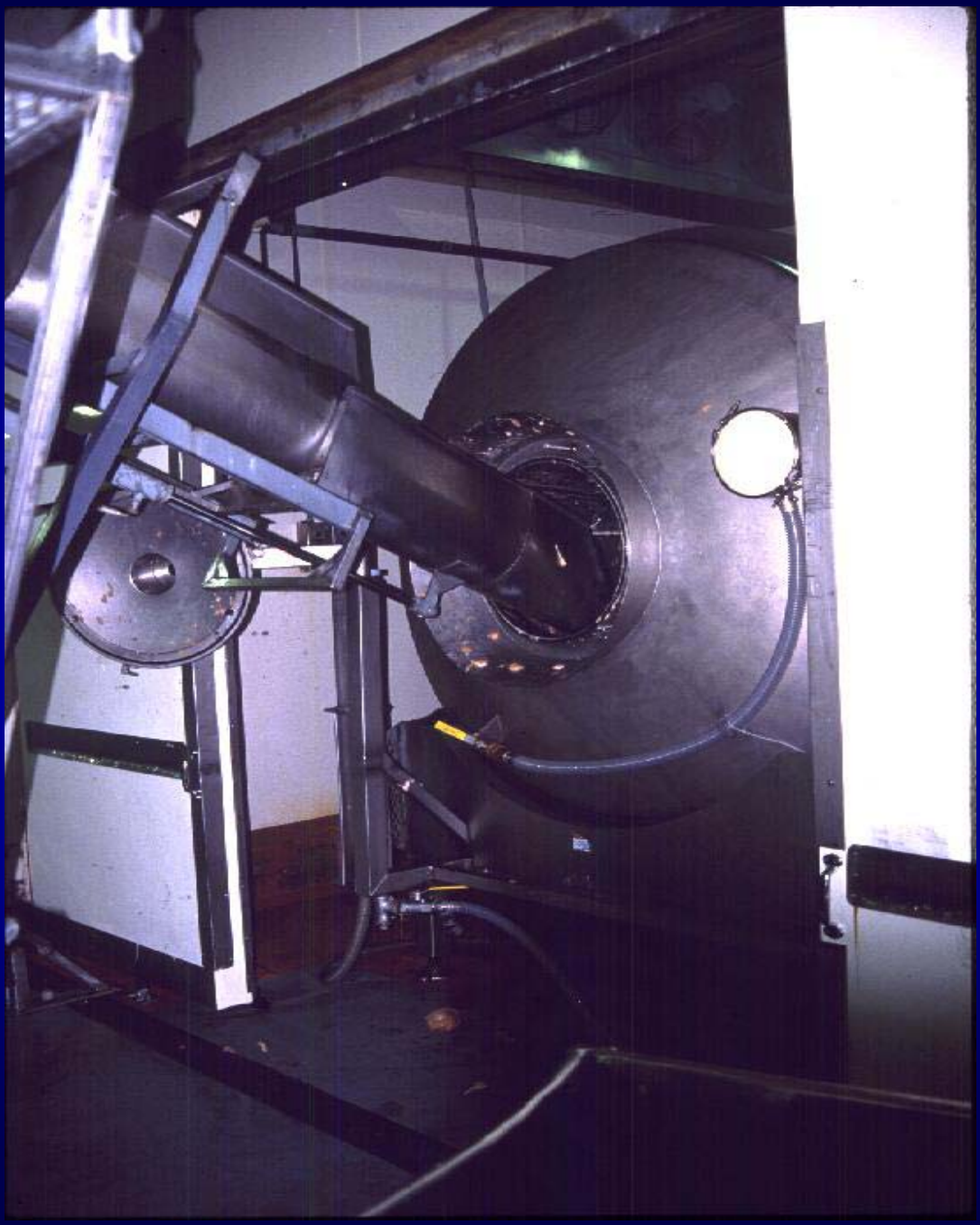


Tumbling

- Increases penetration of brine
  - agitation
  - physical impact
  - vacuum - opens meat structure,
  - meat swells and draws solution in
  - helps extract salt soluble proteins to surface
  - tumble, 4° C, 1/2 hour to overnight

- Whole muscle products, large muscle parts
- Not used with comminuted poultry products

Tumbler



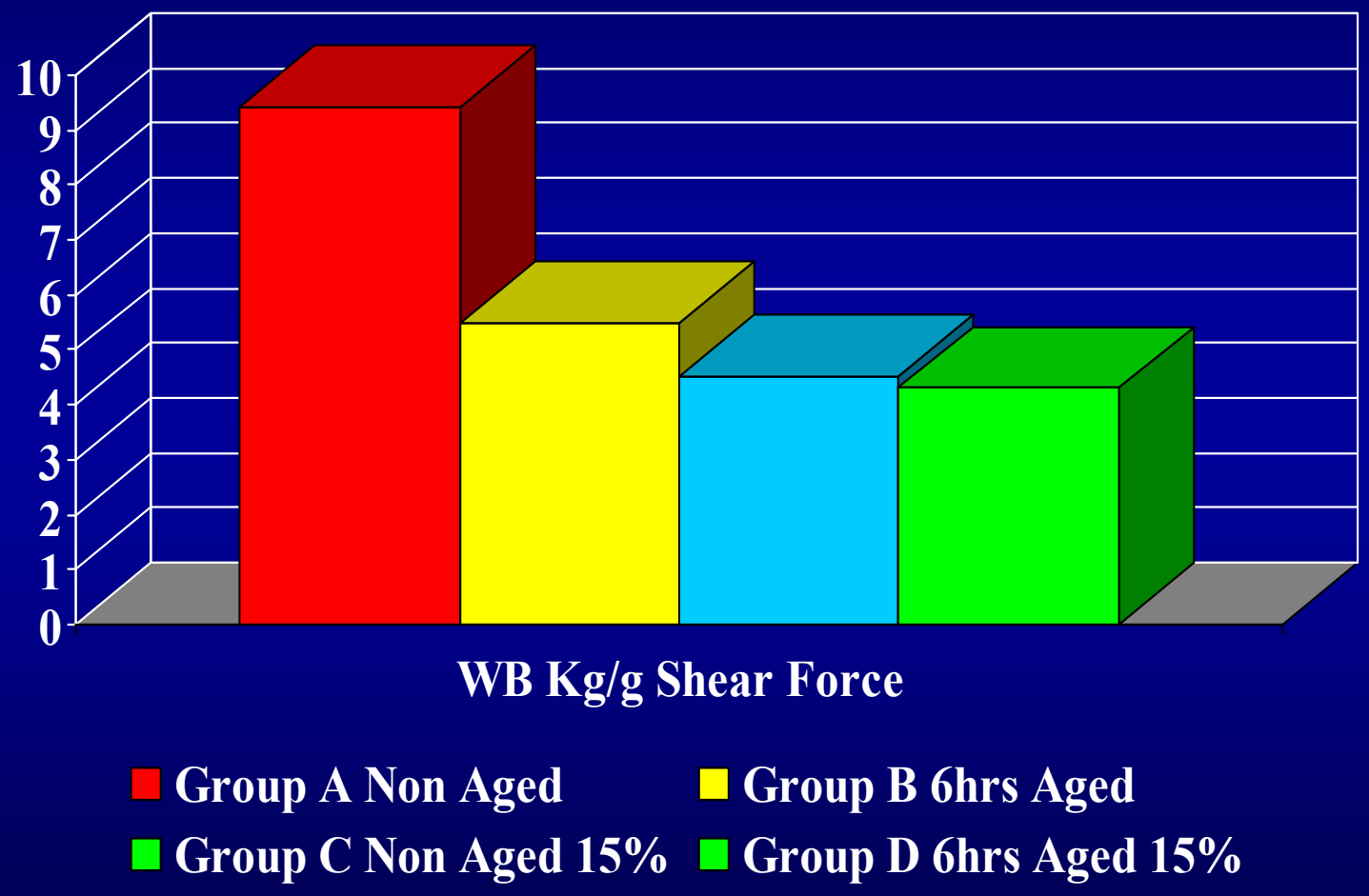
Tumbling

- Benefits
  - even out distribution of brine
  - increase protein extraction
  - accelerate curing reaction (cured products)
  - maximize and obtain uniform yield
  - reduce processing time
  - reduce cooking loss
  - improve sliceability
  - salvage protein that would be lost in brining

Marination and Cook

- Chiller temperature -7 C
- Front halves were boned out with fillet wt of 4-4.5 oz.
- Tumble for 18 minutes, rest for 5 minutes then proceed to packaging.
- Pouched and held for 4 hrs, purge was measured, recorded and then cooked at 350 F till an internal temp of 160 F.

Results


10
9
8
7
6
5
4
3
2
1
0
WB Kg/g Shear Force
Group A Non Aged
Group B 6hrs Aged
Group C Non Aged 15%
Group D 6hrs Aged 15%