

Protein Structure

Proteins exist in the lowest kinetically attainable state of free energy

Protein Structure

One of the main ways that proteins lower their free energy involves removal of hydrophobic groups from contact with the aqueous environment

Protein Structure

The structures attained by proteins are not rigid, but are dynamic. The protein can alter its structure as environmental conditions change.

Crosslinks

Proteins that contain crosslinks are less likely to unfold and are more stable towards forces that cause denaturation.

Environment

Protein structure is highly dependent upon the environment. Proteins will assume different conformations as environmental conditions change.

Interactions

For a protein to exhibit functionality it must interact with other food components including water, minerals and other proteins.

Functions of Proteins in Foods	
Foam Formation	Binding
Fiber Spinning	Viscosity
Emulsification	Gelation
Dough Formation	Flavor
Extrusion	Solubility

Flavor
<p>Proteins contribute little to flavor. Contributions may be through:</p> <ul style="list-style-type: none"> Bound molecules Adsorption Break down products Chemical reactions

Binding
<p>An operational term referring to the ability of a protein to hold ingredients together in solid, semi-solid or fluid states.</p> <p>May be involved in retention of flavors, water, lipids or other components as well as adhesion, film formation, fiber formation and viscosity.</p>

Types of Water Associated With Proteins
<ul style="list-style-type: none"> Structural Monolayer Unfreezable Hydrophobic hydration Capillary

Factors Affecting Viscosity
<ul style="list-style-type: none"> pH Temperature Concentration Ionic Strength Water Activity

Gelation
<p>Definition by Ziegler and Foegeding:</p> <p>A gel is a continuous network of macroscopic dimensions immersed in a liquid medium exhibiting no steady-state flow.</p>

Types of Gels	
Clear	Cloudy
Elastic	Inelastic
Stranded	Particulate
Firm	Soft

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Bound Water

A small portion of the water is tightly bound to proteins

The majority of water in a gel is capillary water

A three dimensional network must be formed to entrain water

Gel Formation

Formation of protein stabilized gels requires a balance of attractive and repulsive forces

Gel Formation - Factors

Protein hydrophobicity

Protein concentration

pH

Salt concentration

Calcium concentration

Free sulfhydryl concentration

pH

pH affects the strength and nature of the gel

At lower pH values more coagulated gels are formed

The effect of sulfhydryl reagents is greater at higher pH values

Calcium Concentration

Calcium forms crosslinks between proteins and adds structure to the gel

Approximately 20 mM Ca is optimal for WPC gelation

At higher levels, calcium may promote protein aggregation

In WPC, increased calcium decreases gel strength

Sulfhydryl Groups

Sulfhydryl groups can form effective crosslinks in protein gels

Excessive sulfhydryl groups can inhibit gel formation

The effect of sulfhydryl groups are most noted above pH 7.5

In WPC, increases in sulfhydryl groups increase gel strength

Protein Hydrophobicity

Hydrophobic groups can form crosslinks in protein gels

Excessive hydrophobicity can cause aggregation prior to proper crosslink formation

In normal WPC, increased hydrophobicity increases gel strength

Factors that affect the strength of WPC gels

Below pH 7.5

Calcium - negative

Hydrophobicity - positive

Sulfhydryls - no affect

Above pH 7.5

Calcium - little affect

Hydrophobicity - little affect

Sulfhydryls - positive

Objective

Devise a method to decrease the gelation temperature of whey protein concentrates

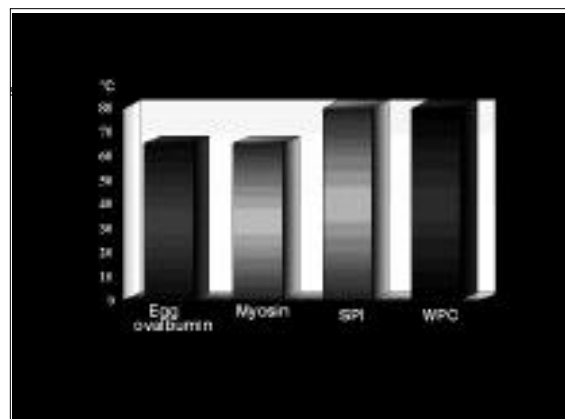
Improve Functionality:

Gel Strength

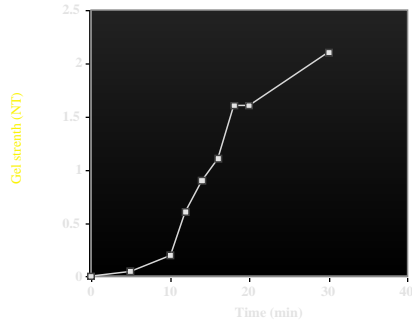
Emulsion Stability

Foaming Stability

Meat Products



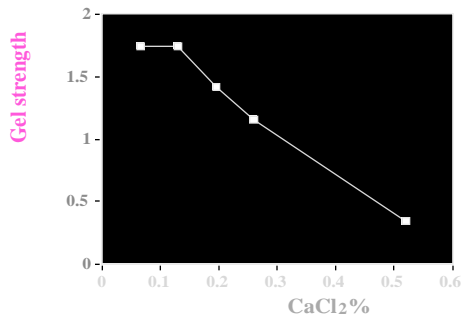
Effect of preheating at 70°C on gel strength at 60°C



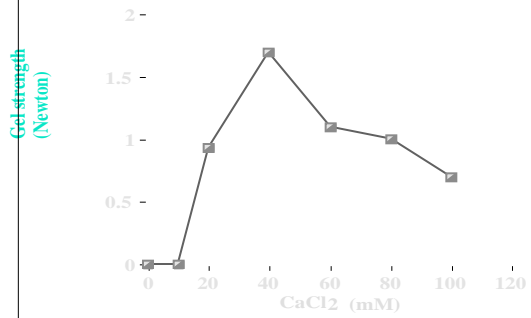
Effect of preheating on gel strength

Temperature	Time (min)	After Preheating	Gel strength (N)
60	20	No gel	No gel
65	20	No gel	0.07
70	20	No gel	1.6
75	20	Form gel	----
75	5	No gel	0.54

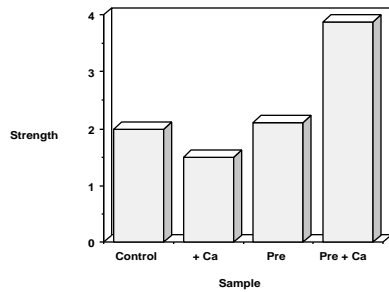
Effect of added Ca on gel strength



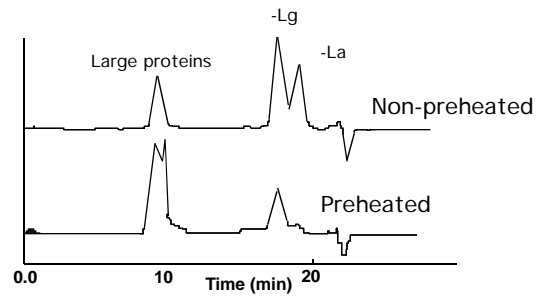
Effect of added Ca after preheating on gel strength



Effect of preheating and Ca addition on gel strength

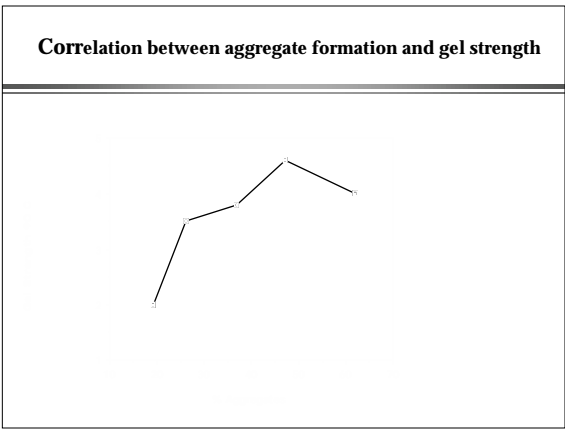
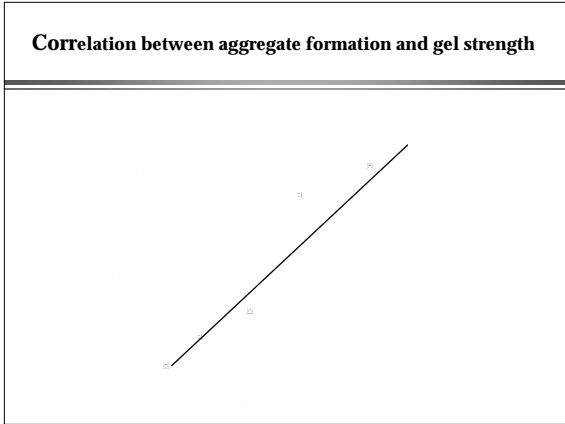


HPLC of preheated and control WPC



Effect of preheating on EVI

Preheating CaCl ₂ (mM) Temperature	EVI (%)	
No preheat	0	11
No preheat	40	10
70	0	11
70	5	11
70	10	18
70	20	Form gel
70	40	Form gel
66	40	17



Low Fat Sausage

Attribute	Control	Whey	Preheated
Acceptability	6.2	6.1	6.9
Foavor	5.6	5.6	6.4*
Appearance	6.9	6.3	7.3
Texture	5.1	4.8	5.8*