

WHEY PRODUCTS IN COLD PACK AND PASTEURIZED PROCESSED CHEESE FOODS AND CHEESE SPREADS

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Whey-based ingredients in processed cheese:

- Improve sheeting, slicing, shredding and spreading
- Enhance melting characteristics
- Yield superior flavor and body
- Provide high quality proteins and calcium
- Are cost-effective and reduce ingredient costs

Whey and whey products have been used successfully in cold pack "club" cheese foods and spreads and pasteurized processed cheese foods/spreads for years. Sweet whey, whey protein concentrates 34-80% protein (WPC), reduced-lactose whey, modified whey, demineralized whey and whey protein isolates (>90% protein, WPI) are among the most commonly used whey products.

Cost effectiveness is a key driver in using whey products in processed cheeses, since qualitative attributes such as flavor enhancement and functionality justify using optimal amounts of whey products in virtually every formula type. New whey processes and whey process control result in whey ingredients with improved flavor, functionality, and economic impact. The use of whey product(s) typically results in superior flavor, body, and texture; improved sheeting, slicing, shredding, spreading, and melt performance. Another advantage of whey products is the potential of improving nutritional attributes in a cost-effective fashion.

PROCESSED CHEESE PRODUCTS — CLASSIFICATIONS AND TYPE

There are two basic types of processed cheese products: cold pack and pasteurized processed products. The term "processed" is commonly associated with pasteurized (i.e., hot processed) cheese products, but it can also include cold packed or "club" cheeses. Regulations and definitions



vary from country to country. Please consult country-specific food codes for further information.

There are several types of classifications of processed cheeses and cheese foods that reflect commercial uses and practices. Fundamental differences between these classifications are based on:

- Compositional differences
- Amount and type of cheese(s) that can be used
- Ingredients allowed
- Finished milk fat and moisture targets and allowances
- Flavor & color (i.e., cheese type) profile desired
- Nutrient content claims to be made, where allowed and applicable
- How the finished cheese is to be used (individual slices, block or loaves for shredding, spreads, sauces, fillings or pastes as industrial food ingredients).

PROCESSED CHEESE PRODUCTS — CLASSIFICATIONS

HOW THE FINISHED CHEESE PRODUCT IS TO BE USED

Any given product to be manufactured needs to be assessed as to its ultimate use. This impacts formula composition and, thus, functionality and performance. Once formulation composition and functionality needs are determined, the exact amount and type of whey that can be used can be identified. For example, a formula for individual processed cheese food slices may be more adaptable to using whey protein concentrate depending on functionality requirements and formula composition.

Normally, for pasteurized processed cheese food to be formed into individual slices, formulas must be such that "sheets" of pasteurized product can easily be formed into sheets, removed from chilling rolls, cut appropriately, and remain as individual slices when packaged. The packaging of individual slices has allowed use of more whey products as issues related to slices sticking together are managed by the packaging. Melt characteristics can be variable as cheese food slices may be used in hot applications (e.g., grilled cheese sandwiches.)

To create pasteurized processed cheese food shreds, a firm loaf or block of cheese food product is necessary. The block must be firm and stiff to withstand the shredding process, and finished shreds need to remain firm and free-flowing during packaging and distribution. Additionally, all the melt and other textural parameters of finished cheese are necessary as shreds are almost always used in heated or hot applications.

Industrial sauces are almost always pasteurized sauce mixes or pre-mixes. Formulas must withstand the rigors of cooking and/or aseptic filling (emulsion stability, viscosity, etc.) and still retain functionality for the required purpose.

INGREDIENTS ALLOWED

Local and international standards may limit the amount and type of ingredients that can be used in each type of cold or pasteurized processed cheese, cheese food, or cheese spread. Please consult local regulations for further guidance. Whey products of all types are allowed as optional dairy ingredients in International Codex regulations.

REGULATORY CONSIDERATIONS/ NUTRITIONAL CONTENT

It is important to note that regulations concerning whey and whey products in processed cheese products vary from country-to-country. Whey products generally allowed for use in processed cheeses are: sweet whey, reduced lactose whey, demineralized whey, acid whey, whey protein concentrates and whey protein isolates.

Classifications based on nutritional content and claims are also country-specific. Please check local product legislation.

NUTRIENT CONTENT CLAIMS

Whey ingredients can allow for the partial or total replacement of cheese and milk fat, thus making quality low fat and non-fat cold or hot processed products a commercial reality.

FLAVOR AND COLOR

Cold pack and pasteurized process cheese products can also be classified by the characterizing cheese flavor (American, Cheddar, Swiss, Parmesan, Romano, Mozzarella, etc.) and by the addition of allowed flavoring adjuncts. Whey ingredients can both enhance and mute certain flavors. Identification of the amount and type of flavoring required and selection of the proper amount and type of whey ingredient is critical.



RATIONALE FOR USING WHEY IN PROCESSED CHEESES AND RELATED PRODUCTS

EMULSIFICATION

Whey proteins are very efficient emulsifiers of fat and oil. They form stable emulsions easily and can be used to replace chemical emulsifiers in certain systems. Additionally, the bound fat in whey products is relatively high in phospholipids (e.g., lecithin) adding to the emulsification capacity of whey ingredients. Stable emulsions are highly desirable during grinding, cooking, packaging, and cooling of the cheese mass.

WATER BINDING

Whey proteins also bind high amounts of water through physical and chemical means. This tends to increase mix viscosity. The precise nature of this viscosity increase can be used to specifically manage final mix viscosity. Because of the water binding properties of whey proteins, melt, stretch, spread, and smoothness of finished processed cheeses can be negatively impacted. Thus, low heat pre-treatments are normally desirable when selecting whey ingredients.

VISCOSITY

Whey proteins add body (improves chew and bite) and improve texture (increases smooth/creamy textures; reduces grainy, coarse textures). However, whey proteins do not melt, stretch, spread, or retain finished cheese firmness as do casein proteins. This can be managed by proper selection of the type and amount of whey product used. Viscosity also impacts extrudability, sheeting, slicing, shredding, and packaging fill.

COST EFFECTIVENESS

Much of whey product performance in processed cheeses is the ability to minimize mix ingredient costs. Significant savings can be achieved by properly selecting the right whey products. All whey ingredients can offer these savings opportunities.

BULKING AGENT

Whey ingredients can be used as low cost solids replacers (e.g., cheese, milk solids not fat, milk fat and fat replacers).

SOLUBILITY

Whey products (i.e., proteins) are highly soluble across a wide pH range and stable to added acid. This helps create creamy, smooth, non-gritty textures with little or no powder taste. Whey is a great source of nutrients: high-quality proteins, minerals and vitamins. The price-value relationship is such that there are few equivalent sources of key nutrients. Whey products contain nutrients like calcium and a variety of biologically active components. High protein, low lactose whey ingredient options (WPC80, WPI) can also be used to create cold or hot pack products with low carbohydrate or fat levels.

VISUAL APPEAL

Depending on the mix type, whey products add opacity, whiteness, and “milkeness” to mixes and finished products.



General Functionality Benefits of Whey Products in Processed Cheese Foods and Spreads

Functionality	General Impact	Specific Impact on Processed Cheese Products
Solubility	Smooth texture at most use levels	Creamy texture at high use rates Reduced “gritty” or “powdery” taste
Solubility at various pHs	High solubility across wide pH range	Stable solutions to addition of acid
Water binding	Bind and entrap water	Provide body, texture
Viscosity	Thickening	Provide body, texture
Gelation	Form gel during heat processing	Milk fat replacement
Emulsification	Form stable fat/oil emulsions	Casein protein replacement Prevent oiling off
Foaming	Form stable film	Provide structure
Foam stability	Yield stable structure to whipped foods	Provide stable structure
Opacity	Give opacity to low-fat foods	Add color and appearance improvements
Flavor, aroma	Mild dairy or no flavor	Compatible with other dairy flavors Low flavor impact at recommended usage levels
Nutrition	Source of high quality proteins and calcium	Excellent for enrichment and fortification purposes
Freezing point depression	Salts and lactose reduce mix freezing point	Allows freezing point management for frozen prepared foods

TYPICAL FORMULAS USING WHEY INGREDIENTS

Typical use levels are noted below. All are dependent on the flavor and functional performance of each whey ingredient and any formula specific considerations:

Sweet whey	4-8%
Reduced lactose whey	5-8%
Whey protein concentrate (WPC34,WPC80)	1-5%
Whey protein isolate	0.5-1%

Typical Processed Cheese Food Formulations with Whey Ingredients

Ingredient	Formula using			
	Sweet whey	Reduced-lactose whey	WPC34 and sweet whey	WPI and reduced-lactose whey
Full fat Cheddar cheese	67.00%	66.00%	65.00%	65.00%
Disodium phosphate	1.80%	1.80%	1.80%	1.80%
Trisodium phosphate	0.54%	0.54%	0.54%	0.54%
Salt	0.50%	0.50%	0.50%	0.50%
Skim milk powder	7.63%	7.63%	4.63%	4.10%
Sweet whey	4.50%	—	5.50%	—
Reduced-lactose whey	—	5.50%	—	7.50%
WPC34	—	—	4.00%	—
WPI	—	—	—	1.50%
Cream, 40% fat	2.00%	2.00%	2.00%	2.00%
Water	4.00%	4.00%	4.00%	5.03%
Water as steam	8.00%	8.00%	8.00%	8.00%
Lactic acid, 20%	4.00%	4.00%	4.00%	4.00%
Color	0.03%	0.03%	0.03%	0.03%
Total	100.00%	100.00%	100.00%	100.00%



**Typical Reduced-fat (50%) Processed Cheese Food
Formulations with Whey Ingredients**

Ingredient	Formula using			
	Sweet whey	Reduced-lactose whey	WPC34 and reduced-lactose whey	WPI and sweet whey
Full fat Cheddar cheese*	35.00%	35.00%	35.00%	35.00%
Low-fat cheese*	27.00%	26.53%	25.53%	25.53%
Disodium phosphate	1.80%	1.80%	1.80%	1.80%
Trisodium phosphate	0.54%	0.54%	0.54%	0.54%
Salt	1.00%	1.00%	1.00%	1.00%
Skim milk powder	8.63%	7.63%	6.13%	5.13%
Sweet whey	7.50%	—	—	8.00%
Reduced-lactose whey	—	8.50%	6.00%	—
WPC34	—	—	2.00%	—
WPI	—	—	—	0.50%
10 D.E. Maltodextrin	3.00%	3.00%	3.00%	3.00%
Water	3.00%	3.00%	6.00%	7.00%
Water as steam	8.00%	8.00%	8.00%	7.50%
Lactic acid, 20%	4.00%	4.00%	4.00%	4.00%
Color	0.50%	0.50%	0.50%	0.50%
Enzyme-modified cheese	0.50%	0.50%	0.50%	0.50%
Total	100.00%	100.00%	100.00%	100.00%

* Or use blends of full fat cheddar, low-fat cheddar, "skim" cheese

Typical "Fat-free" (<1.7% fat) Processed Cheese Food Formulations with Whey Ingredients

Ingredient	Formula using			
	Sweet whey	Reduced-lactose whey	WPC34 and reduced-lactose whey	WPI and sweet whey
Fat-free cheese	60.40%	60.40%	58.47%	54.00%
Disodium phosphate	2.00%	1.80%	1.80%	1.80%
Trisodium phosphate	0.60%	0.64%	0.65%	0.64%
Salt	1.00%	1.00%	1.00%	1.00%
Skim milk powder	9.00%	7.00%	3.50%	5.60%
Sweet whey	8.00%	—	—	8.00%
Reduced-lactose whey	—	7.00%	3.50%	—
WPC34	—	—	5.00%	—
WPI	—	—	—	0.50%
10 D.E. Maltodextrin	3.30%	3.30%	2.00%	3.00%
Microcrystalline Cellulose	2.00%	2.00%	2.00%	2.00%
Water	4.04%	7.24%	9.50%	11.40%
Water as steam	4.60%	4.56%	7.52%	7.00%
Lactic acid, 20%	4.00%	4.00%	4.00%	4.00%
Color	0.06%	0.06%	0.06%	0.06%
Enzyme-modified cheese	1.00%	1.00%	1.00%	1.00%
Total	100.00%	100.00%	100.00%	100.00%



IMPACT OF WHEY INGREDIENTS ON THE MANUFACTURE OF PROCESSED CHEESE

**ADDITION OF
OPTIONAL INGREDIENTS
(INCLUDING FLAVORINGS)**

Optional ingredients can be added at the same time as comminuted cheese. When adding whey ingredients care must be taken to minimize lumping. Whey ingredients may need to be added to available process water to allow hydration during mixing and cooking. This can be accomplished by pre-blending whey ingredients into a slurry including all, or part, of the added water. This is most critical in higher protein, higher viscosity whey ingredients. Flavors, acidifying agents, and colors may be added last to insure proper incorporation and reduce flavor loss through the cooking process.

**RECOMMENDATIONS—
PRODUCT AND PROCESS
MODIFICATIONS**

When considering a whey ingredient to use, note the following:

- Balance the viscosity and flow performance of the mix with the whey ingredient of choice and finished product applications (slice, shred, spread, etc.)
- Control total lactose in formulas to minimize lactose crystallization resulting in "sandy" defects and any undesirable non-enzymatic browning (during processing and storage.)
- Understand fully the process conditions (time, temperatures, etc.) being used.
- Regulatory limitations and allowances. Indirect impact of fat, moisture, and total cheese content on whey ingredient use rates.
- How the finished food is to be used, distributed, and marketed. That is, is finished food to be consumed as slice, shred, spread, flavoring, or dry powder?
- Sweet whey (including reduced-lactose whey and demineralized whey) may be the most economic whey ingredient. However, WPCs and WPIs can be effective ingredient choices to manage mix ingredient cost and finished product yields.

When all product and process considerations are taken into account, whey products are viable and valuable ingredients for use in virtually all processed cheese and cheese food mixes.

**CONSIDERATIONS
WHEN USING
WHEY PRODUCTS
IN COLD AND
PASTEURIZED
PROCESSED CHEESE
PRODUCTS**

Selection of the exact proper amount and type of whey ingredient to use is based on the following considerations.

- *How the finished product is to be used.*
- *Regulatory limitations*
- *Marketing*
- *Nutrient or health claims*
- *Amount and type of flavorings.*
- *Finished product features and consumer benefits.*
- *Packaging.*
- *Amount and type of mix ingredients available.*

HOW TO SELECT WHEY INGREDIENTS

Key considerations when selecting a particular type of whey product include:

- Functionality desired
- Flavor impact
- Ingredient costs
- Lactose content
- Acidity
- Whey products and functionality

Depending on the type of product to be made and its intended use, more or less whey protein functionality may be desirable.

MELT AND BODY

Lower protein whey products (e.g., sweet whey) have a tendency to yield weak structure to processed cheese food loaves and increase spread during melt, a desirable feature in some applications. Whey protein concentrates (WPCs), if properly selected and applied, can yield smooth-textured and firm loaves for shredding. However, in such loaves, melt and spread might be limited due to water binding of the whey proteins. Additionally, these latter formulas which have increased viscosities while still hot, may, or may not, be compatible with the manufacture of slices or with finished packaging options. It is normally desirable to use WPCs where proteins are less denatured (low heat process treatments) and, thus, have lower impact on mix viscosity and other functional traits of finished mixes.



LACTOSE CONTENT

Lactose crystallization (sandiness) is a common defect in both cold pack and hot processed cheese foods and spreads. Lactose's ability to crystallize and form hard sand-like crystals can be controlled by limiting the concentration of lactose in the water phase of mixes to be <16% (~<7.5% as is basis).

Lactose can participate in Maillard non-enzymatic browning during manufacture and during distribution of finished processed cheese products. This reaction can affect both color (darkening) and flavor (caramel, cooked, burnt type flavors), therefore keeping lactose concentrations under control is critical. Lactose-reduced whey products such as reduced-lactose whey, whey protein concentrate, and whey protein isolate help minimize lactose crystallization and non-enzymatic Maillard-type browning.

FLAVOR PROFILE

Whey products can affect finished product flavors in several ways.

- whey ingredient flavor quality.
- sweetness.
- whey protein impact on flavor chemicals (added and/or natural.)
- U.S. whey products have a bland, sweet dairy flavor, compatible with many other savory flavorings used in processed cheese products.

INGREDIENT COSTS

The most expensive ingredients in cold pack or hot processed cheese foods and spreads are natural cheese, skim milk solids and milk fat. Whey products can help to keep costs low and still allow for fine flavor, functional performance, and formula versatility (i.e., nutrient content and other labeling claims.) The choice of which whey ingredient(s) to use can be optimized to allow for these objectives to be met.

ACIDITY

Acidifying agents are allowed and used in both cold pack and hot processed cheese foods and spreads. Too much acid, or acid added improperly to mixes, can cause coarse, gritty mouthfeel from precipitated casein. This is why acidity in many processed cheese foods and spreads is limited to pH's >4.5-5.0. Acidity comes from both added acids and dairy ingredients including whey, and it must be controlled appropriately.



Q: What is the proper time and place to incorporate whey ingredients into mixes?

A: Whey ingredients can be added with other optional dairy ingredients. To prevent lumping with products where high viscosity is expected (high protein or pre-denatured whey products) it is advisable to prepare a slurry of whey and available process water. This slurry can then be added to the cooking vessel before final cook temperatures are achieved.

Q: Can I use the same process protocol for the manufacture of low fat or non-fat processed cheese products?

A: Basically, yes—with considerations for other ingredients required for successful formulation. Care is necessary when incorporating microcrystalline cellulose, carrageenan, and skim milk cheese. Hydrocolloids may need to be pre-blended with other dry ingredients and pre-hydration might be required before the cheese and other ingredients are added. Cooking times and temperatures can remain the same.

Q: The term whey flavor sometimes refers to a flavor defect. What is it?

A: "Whey flavor"—also called "cardboard", "oxidized" or "cheesy" flavors—can originate from some whey ingredients, particularly from some sweet wheys. Please consult your supplier if such a defect occurs. Sweet whey should have a mild, dairy and pleasant flavor. When properly selected, stored, and used, whey ingredients can have a wonderful pleasant dairy flavor (or no flavor) highly compatible with a variety of cheese flavors.

Q: How can WPC80 which carry cost premiums to skim milk solids, be cost effective?

A: Several factors impact the cost effectiveness of WPC80 or WPI. The key is to know that these highly functional ingredients can be used at significantly lower levels (0.5-1.0%) than standard sweet whey (3-4%). Secondly, when properly formulated, other more expensive ingredients (hydrocolloid stabilizers, some emulsifiers) can be totally or partially removed from formulas, thereby reducing total formula costs.

Q: Must whey products be added pre-pasteurization?

A: It is always desirable to add whey to mixes pre-pasteurization. This insures proper control of the microbiological quality of the finished mix. Under certain conditions where finished product water activity is low, whey ingredients can be added during the cold process to produce cold packed cheese foods and spreads.

Q: Is there a difference between cold and hot pack processes as it relates to whey protein functionality?

A: Whey protein functionality is virtually left unchanged during cold pack processes. Temperatures for hot process can either adversely or positively affect whey protein functionality. Color and flavor defects can result during unusual heating and slow cooling of products.

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Additional references and background information are available from the U.S. Dairy Export Council.



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