

# WHEY PROTEIN AND LACTOSE PRODUCTS IN PROCESSED MEATS

By Dr. Jimmy Keaton, Ph.D.

Professor of Meat Science & Technology, Department of Animal Science, Texas A&M University, Texas, USA



*Whey and whey products are used successfully in processed meats (ground meats, emulsion products, coarse ground products, whole muscle products) to improve flavor, texture, emulsification, water binding, cook yield, and finished product functional performance.*

U.S. sweet whey, whey protein concentrates (34–80% protein), and whey protein isolates (>90% protein) are among the most common whey products used in processed meats. Quality improvement, nutritional optimization and cost-effectiveness are key drivers in using whey protein ingredients in processed meats. New processes result in whey protein ingredients with improved flavor, functionality, and economic impact that offer interesting new product development and formulation options to manufacturers worldwide. There may be regulatory restrictions to the use of whey products in processed meats; please check local legislation.

U.S. lactose can be used to partially replace sugar, dextrose, and/or corn syrup solids in processed meats. Key considerations relative to sweetness and cost are necessary to allow for proper formulation. Lactose can be sourced as a component of several U.S. whey ingredients such as sweet whey, or as pure powder.

## WHEY PRODUCTS IN PROCESSED MEATS: AN OVERVIEW

The use of dairy ingredients to replace or supplement the functionality of meat proteins in processed meats is well established. Some of this functionality (emulsification, water binding, and gelation) can come from the highly functional non-casein whey proteins. This can result in improved emulsion stability, slicing characteristics, cook yields (improved water binding), flavor, and reduced costs.

The use of whey proteins can also be considered as partial replacement of meat proteins, partial or total replacement of soy protein products and other non-meat binders/fillers, modified starches and hydrocolloid gums (alginates, gum arabic and others) in processed meats. The result is processed meats with improved functional performance, flavor and cook yields, at significantly reduced costs.



## FUNCTIONAL BENEFITS OF WHEY IN PROCESSED MEATS AND RELATED PRODUCTS

*A range of U.S. whey and lactose ingredients*

*U.S. whey products for use in processed meats include:*

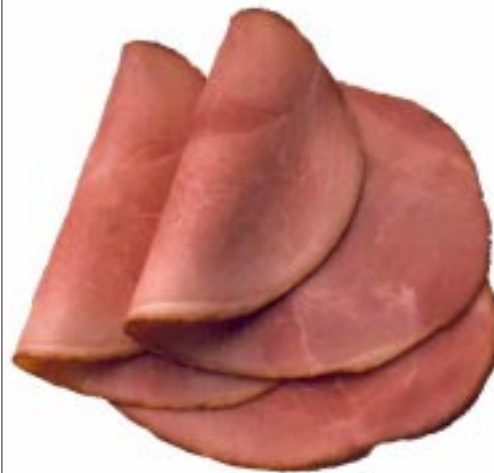
- *Sweet Whey*
- *Reduced Lactose Whey*
- *Demineralized Whey*
- *Whey Protein Concentrate 34% Protein: WPC34*
- *Whey Protein Concentrate 50% Protein: WPC50*
- *Whey Protein Concentrate 80% Protein: WPC80*
- *Whey Protein Isolate 90% Protein: WPI*
- *Lactose*
- *Specially customized products and blends (please consult your U.S. supplier for further information)*
- *Minerals-enriched whey, dairy calcium and related products.*

*Sweet whey, various WPC's (34–80% protein), or WPI (90% protein) are the whey products of choice. These products typically have unique functional advantages, are economical, and readily available. Demineralized whey can be used interchangeably with sweet whey when economically feasible. Delactosed whey can also be used.*

*For processed meats, where emulsification and water binding are critical to economic and finished product success, higher protein levels (34–80% protein) normally offer more functional and economic impact.*

### Functionality of Whey products in Processed Meats

Function	Specific impact
Solubility	Smooth texture at most use levels Creamy textures at high use rates Reduced "gritty," "powdery" taste
Water binding	Binds and entraps water: improves cook yield Provides body, texture Improves sliceability
Viscosity	Thickening Enhances body, texture
Gelation	Forms gel during heat processing Animal/fat replacement possible
Emulsification	Forms stable, fat/oil emulsions Prevents oiling-off and "fat caps" Meat protein replacement
Foaming	Forms stable film Provides structure
Browning	Enhances Maillard, non-enzymatic browning Adds color, visual appeal
Flavor, aroma	Have little or no flavor of their own Compatible with cooked meat flavors Compatible with spice/seasoning blends
Nutrition	Superior amino-acid profile Can serve as source of calcium for enrichment



### WATER BINDING

Whey proteins can bind a high amount of water through physical and chemical means. This aids in improving firmness, texture and retention of moisture during processing and cooking. Reduction of purge (moisture loss) in vacuum-packed meats is also a consideration. This important function can result in significant yield improvements.

### BULKING AGENT

When properly formulated whey ingredients can be used as low cost solids replacers and replacers of removed functionality (fat replacement.)

### VISCOSITY

Whey proteins add positive textural attributes: chew, bite, firmness, and smoothness, non-coarse, non-grainy, non-gritty mouthfeel improvements.

## EMULSIFICATION

Whey proteins are very efficient emulsifiers of fat and oil. They form stable emulsions easily and can be used to totally, or partially, replace chemical emulsifiers, meat proteins, and other non-meat proteins such as soy protein products. Additionally, the bound fat in whey protein products is relatively high in phospholipids adding to the emulsification capacity of any given whey ingredient.

## FLAVOR

Whey products have a sweet/dairy (sweet whey) flavor, to virtually no (WPCs, WPIs) perceivable flavor profile of their own. Consideration should be given to the specific flavor profile of each whey ingredient to be used.

Large molecular weight proteins (such as whey proteins) have the tendency to bind a variety of flavor chemicals. However, the amount and type of whey ingredients used and typical seasoning and spices used in processed meats very rarely impact finished product flavor.

When using whey products to increase finished product yields, care is needed to consider the potential dilution of added spices and seasonings. Slight increases in spices and seasonings may be required to return the resulting extended meat product to the best flavor balance.

## FREEZING POINT CONTROL

Processed meats are not typically frozen for long-term storage, but whey products can offer some degree of cryoprotection when required. Whey products can optimize finished product qualities such as firmness (chew, and bite) and texture (smoothness, graininess.) When properly managed, superior freeze/thaw stability can be achieved. This is due to inhibition of ice crystal nucleation and/or ice crystal growth. Whey proteins and other whey components play a key role in managing ice crystal growth during heat shock and other distribution abuses.

## COST-EFFECTIVENESS

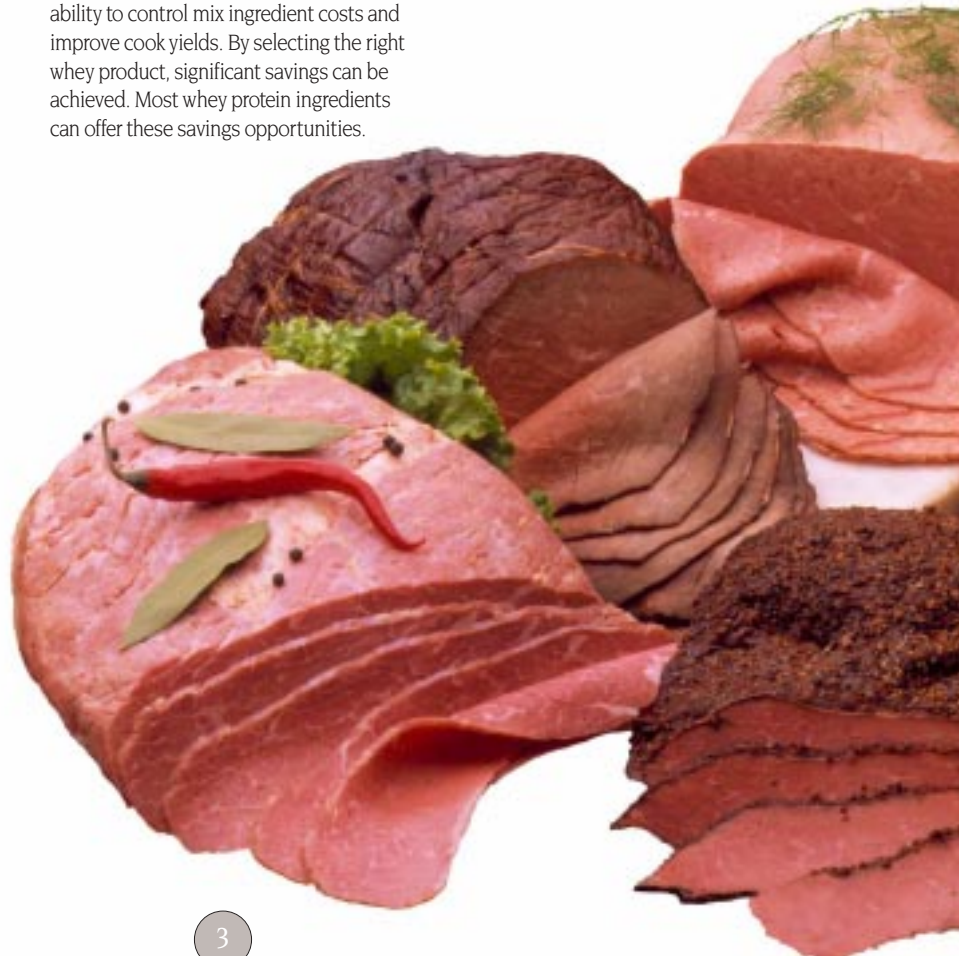
An important aspect of whey product performance in processed meats is the ability to control mix ingredient costs and improve cook yields. By selecting the right whey product, significant savings can be achieved. Most whey protein ingredients can offer these savings opportunities.

## VISUAL

Depending on the mix type, whey products can add opacity to mixes and finished products. This might be a detriment in processed red meats, but it is a positive effect in white meats, particularly in products using mechanically deboned products.

## NUTRITION

The price-value relationship of whey products, in particular whey proteins, is such that there are few equivalent sources of whey. Other valuable nutrients are calcium and a variety of health-enhancing and prebiotic components. The indirect impact on the nutrient content of mixes such as in reduced- or low-fat products is also a valuable contribution of whey products.



TYPICAL FORMULAS USING WHEY INGREDIENTS

Ground Beef Patties with Sweet Whey, WPC34

Ingredients	Fat	Protein	Moisture	CONTROL		SWEET WHEY		WPC34	
				Kg	%	Kg	%	Kg	%
Lean beef	20.0%	18.0%	63.0%	100.00	94.74	96.50	89.52	96.50	85.40
Sweet whey	1.5%	12.0%	3.5%			3.75	3.48		
WPC34	4.0%	34.0%	3.5%					3.95	3.50
Salt, encapsulated				1.25	1.18	1.25	1.16	1.25	1.11
Dextrose				1.00	0.95	1.00	0.93	1.00	0.88
Garlic powder				0.13	0.12	0.13	0.12	0.13	0.11
Hydrolyzed beef stock				0.05	0.05	0.05	0.05	0.05	0.04
Monosodium glutamate				0.13	0.12	0.13	0.12	0.13	0.11
Water or ice				3.00	2.84	5.00	4.64	10.00	8.85
Total				105.56	100	107.81	100	113.00	100
Yield improvement vs. Control							2.25		7.45
Protein content					17.05%		6.53%		16.56%
Fat					18.95%		17.96%		17.22%
Moisture					62.53%		61.16%		62.77%

Procedure:

- (1) Select beef raw material(s)
- (2) Grind coarse, formulate to final fat target
- (3) Add water or ice while blending
- (4) Add dry ingredients while blending
- (5) Blend to uniform mix
- (6) Form into patties, stuff into chubs
- (7) Note: Keep meat and final mix at -2° to -3°C

Polish-style Sausage with Sweet Whey, WPC34 or WPI

	CONTROL		SWEET WHEY		WPC34		WPI90	
	Kg	%	Kg	%	Kg	%	Kg	%
Lean beef	66.70	61.59	80.00	59.01	80.00	49.35	80.00	43.70
Lean pork	33.30	30.75	45.00	33.19	60.00	37.01	70.00	38.24
Sweet whey			4.28	3.15				
Whey protein concentrate					4.80	2.96		
Whey protein isolate							2.75	1.50
Salt	2.25	2.08	2.25	1.66	2.25	1.39	2.25	0.123
Dextrose	2.00	1.85					2.00	1.09
Ground white pepper	0.25	0.23	0.25	0.18	0.25	0.15	0.25	0.14
Garlic powder	0.13	0.12	0.13	0.09	0.13	0.08	0.125	0.07
Nutmeg	0.13	0.12	0.13	0.09	0.13	0.08	0.125	0.07
Ground celery	0.13	0.12	0.13	0.09	0.13	0.08	0.125	0.07
Coriander	0.13	0.12	0.13	0.09	0.13	0.08	0.125	0.07
Sodium Erythorbate	0.06	0.05	0.06	0.04	0.06	0.03	0.055	0.03
Modern cure (nitrite/salt)	0.25	0.23	0.25	0.18	0.25	0.15	0.25	0.14
Ice	3.00	2.77	3.00	2.21	14.00	8.64	25.00	13.66
Total	108.33	100	135.61	100	162.13	100	183.055	98.903
Yield improvement vs. control, kg				27.28		53.80		74.75
Yield improvement vs. control, kg, 90% cook yield				24.55		48.42		67.275
Protein, %		16.01		16.24		15.57		15.01
Fat, %		18.46		18.86		18.62		18.05
Moisture, %		60.33		59.52		61.67		63.59

Procedure:

- (1) Select, chill and temper raw materials
- (2) Coarse grind beef (or pork) lean, coarse grind pork trim
- (3) Add 1/2 ice, 1/2 dry ingredients until particle size is similar to 6mm grind
- (4) Keep at temperature <2°C
- (5) Place pork trim (fat trim) into chopper
- (6) Add remaining ice and dry ingredients
- (7) Chop until 3.5mm grind
  - Vacuum stuff into casings
  - Heat-process according to appropriate time, temperature, humidity schedule for sausage type
  - Chill to <5°C, vacuum pack, store and distribute at <2°C

Option A: Paddle blender

- (1) Combine meat ingredients in paddle blender
- (2) Add seasonings, dry ingredients, water
- (3) Blend to uniform mix, regrind through 3-6mm plate

Option B: Bowl chopper

- (1) Place beef (or pork) lean in bowl chopper





**Cured Italian-style Sausage, reduced fat formulas with WPC34, WPI**

Ingredients	CONTROL		25% REDUCED FAT WITH WPC34		50% REDUCED FAT WITH WPI	
	Kg	%	Kg	%	Kg	%
Lean beef	60.00	56.52	55.00	58.72	60.00	65.63
Pork trim	40.00	37.68	18.00	19.22		
WPC34			5.00	5.34		
WPI					3.00	3.28
Salt	2.00	1.88	2.00	2.14	2.25	2.46
Corn syrup solids	0.50	0.47				
Garlic powder	0.12	0.11	0.12	0.13	0.12	0.13
Ground pepper	0.05	0.05	0.05	0.05	0.05	0.05
Whole fennel seeds	0.06	0.06	0.06	0.06	0.06	0.06
Sodium erythorbate	0.06	0.05	0.06	0.06	0.06	0.06
Modern cure (nitrite/salt)	0.25	0.24	0.24	0.27	0.25	0.27
Black pepper	0.13	0.12	0.13	0.14	0.13	0.14
Ice	3.00	2.83	13.00	13.88	25.50	27.89
Total	106.17	100.01	93.66	100.01	91.42	99.97

Procedure:  
See procedure for Polish-style sausages.

**Frankfurter/Bologna with WPC34, WPI (90% protein)**

Ingredients	Fat	Protein	Moisture	CONTROL		WPC34		WPI90	
				Kg	%	Kg	%	Kg	%
Lean beef	20.0%	18.0%	63.0%	21.5	15.96	12.0	7.76	20.0	11.56
Pork trim	40.0%	10.0%	49.0%	78.5	58.25	88.0	56.89	90.0	52.02
WPI	1.5%	90.0%	3.5%					3.0	1.73
WPC34	4.0%	34.0%	3.5%			4.68	3.03		
Salt				2.25	1.67	2.25	1.45	2.25	1.3
Corn syrup solids				2.00	1.48				
Hydrolyzed milk proteins				1.00	0.74	1.00	0.65	1.00	0.58
Hydrolyzed beef stock				0.50	0.37	0.50	0.32	0.50	0.29
Sodium tripolyphosphate				0.45	0.33	0.45	0.29	0.45	0.26
Frank/bologna seasoning				0.50	0.37	0.50	0.32	0.50	0.29
Sodium erythorbate				0.06	0.04	0.06	0.04	0.06	0.03
Modern cure (nitrite/salt)				0.25	0.19	0.25	0.16	0.25	0.14
Ice				27.70	20.56	45.00	29.09	55.00	31.79
Total				134.71	100	154.69	100	173.01	100
Yield improvement vs. Control, kg							19.98		38.30
Yield improvement vs. Control, kg cook yield							17.98		34.47
Protein content					8.97		8.35		9.05
Fat					26.53		24.45		23.17
Moisture					59.20		57.10		57.36

- Procedure:
- (1) Select and chill meat raw materials
  - (2) Grind beef lean to desired size, grind pork trim to desired size
  - (3) Emulsify lean beef in bowel chopper
  - (4) Add 1/2 ice, 1/2 cure ingredients, chop until batter is created
  - (5) Keep at temperature <18°C
  - (6) Vacuum stuff into casings: small diameter for frankfurters, large for bologna
  - (7) Heat-process per appropriate time, temperature and humidity schedule for frankfurter or bologna
  - (8) Chill to <5°C, store and distribute at <2°C

**Injected Boneless Ham, 40% Pump, with WPC60, WPC80 or WPI**

Pump ingredients (kg)	Control	WPC60	WPC80	WPI
Salt	7.89	7.89	7.89	7.89
Lactose	5.72	5.72	5.72	5.72
Sodium tripolyphosphate	1.11	1.11	1.11	1.11
Sodium nitrite	0.05	0.05	0.05	0.05
Sodium erythorbate	0.16	0.16	0.16	0.16
Water, chilled	85.07	80.57	81.67	82.07
WPC60		4.50		
WPC80			3.40	
WPI				3.00
Total Brine	100	100	100	100
% added protein		2.70%	2.72%	2.70%
Added protein at 40% pump		0.90%	0.90%	0.90%

- Processing of Injected Ham and Other Whole Muscle Meats:
- (1) Select, chill, temper and weigh deboned meat raw material(s) (such as ham)
  - (2) Prepare formula and brine for % pump desired
  - (3) Dissolve sodium tripolyphosphate first, add other dry ingredients
  - (4) Pump whole, deboned muscle meat to 20–60% pump, as desired
  - (5) Place whole muscle meat into vacuum tumbler 3–4 hours
  - (6) Remove whole muscle meat (such as ham) from tumbler
  - (7) Combine muscle meat as desired, stuff into netting
  - (8) Process (cook) in smokehouse to internal temperature of 69–71°C
  - (9) Chill, slice if desired and vacuum pack



**Regulatory Considerations**

There are no international standards (e.g. Codex Alimentarius) for processed meats. In the U.S., whey protein ingredients are limited by protein content. Non-meat protein ingredients (including whey protein ingredients) are limited to 3.5% (finished product basis) if the ingredient is less than 90% protein (dry weight basis.) If greater than 90% protein (such as whey protein isolate), non-meat proteins are limited to 2.0% (finished product basis).

Also, in the U.S., whey ingredients (all) can be used up to 8% (finished product basis) in standardized meat-containing items such as chili and meat sauces. In non-standard products containing meat (for example, “imitation” meats, nutrient modified meats, soups, stews, etc.) there are no specific limitations for the use of whey or lactose ingredients. In these latter applications, limitations are based on amounts “sufficient for purpose.” Please check local product legislation.

Consideration of applicable national standards of identity and nutrient content claims are also needed for products such as “low fat” or “reduced fat” processed meats. Whey protein products offer significant functional and nutritional performance in such products.

## SELECTING WHEY INGREDIENTS: KEY CONSIDERATIONS

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

### NUTRIENT OR HEALTH CLAIMS

If specific nutritional claims such as nutrient content (high calcium) or health (low fat) claims are to be made, processed meats must be engineered to comply. Whey products offer significant sources of high quality protein and dairy minerals such as calcium and phosphorous. Development of new "fat modified" products is possible using select WPC-75 up to WPI-90. See formulation examples.

Additionally, WPCs and WPIs offer indirect impact on formulas where fat and/or sugar reduction are made by replacing removed fat or sugar functionality.

### AMOUNT AND TYPE OF FLAVORINGS

Most spice and seasoning preparations are highly compatible with whey ingredients. Where formulas result in increased yields, minor modification of spice/seasoning blends may be necessary to prevent dilution of desirable flavor profiles.

### AMOUNT AND TYPE OF MIX INGREDIENTS AVAILABLE

The functional protein content of whey products is critical. It is necessary to insure that the application of any given whey ingredient is compatible with local regulatory restrictions. Whey, particularly sweet whey, adds some degree of sweetness to any mix. Depending on formula specifics, it may be possible to reduce added sweeteners, using whey for improved consumer acceptability.

Where there is very little interaction between components of whey ingredients and added chemical emulsifiers, there can be significant interaction between components of whey and stabilizer gums (e.g., free calcium and low methoxyl pectin).

### PROCESSING CONDITIONS

The use of whey protein or lactose products does not significantly change the processing or the conditions under which processed meats are prepared. Care does need to be taken in handling and adding whey and lactose to insure full and complete hydration and functionality.

### ECONOMICS

Whey products add protein and bind water in processed meats formulas, yielding significant mix ingredient and yield improvement cost savings. Whey products play a significant role in reducing ingredient costs and improving finished product yields.





**Q:** What are “typical” recommended use rates for sweet whey, WPC’s and WPI’s in processed meats?

**A:** There are no “typical” use rates for whey ingredients. Actual use rates are very much dependent on all the key considerations affecting processed meat compositions and the individual functionality of the specific whey ingredient to be used.

In the United States, standards limit the use of whey products as follow: (% of finished product basis):

Sweet Whey	3.5% maximum
WPC34	3.5% maximum
WPC60 to 80	3.5% maximum
WPI	2.0% maximum

However, in general, the following initial recommendations (% of finished product basis) can be considered guidelines:

Sweet Whey	2.5–3.5%
WPC34	2.5–3.5%
WPC60 to 80	2.5–3.5%
WPI90	1.0–2.0%

For formulated products such as chili and sauces, the use of up to 8% whey ingredients is possible. There is no limit on the use of whey ingredients in non-specific meat products without standards of identity or compositional standards. These products might be “imitation” meats, nutrient modified meats, and meat containing products such as soups and stews.

**Q:** “Whey flavor” is considered a flavor defect? Doesn’t using whey add “whey flavor”?

**A:** “Whey flavor,” also called “cardboard,” “oxidized” or “cheesy” flavors, can be sourced from whey ingredients, particularly sweet wheys. Good quality U.S. Whey products will not have such profiles. WPCs and WPIs have virtually no flavor of their own. Whey products have a pleasant dairy flavor (or no flavor) highly compatible with processed meats and spice/seasoning blends.

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

**A:** Several factors impact the cost effectiveness of WPCs and WPIs. These highly functional ingredients can be used at significantly lower levels (0.50–1.5%) than standard sweet whey (2.50–3.50%). Furthermore, their use may help replace or displace other more expensive ingredients (hydrocolloid stabilizers, modified starches, and some emulsifiers. With proper formula adjustments, increased yields can be achieved by producing quality products with higher moisture contents. This results in a significant reduction in meat ingredient use rates.

U.S. Dairy Export Council, *Reference Manual for U.S. Whey Products*, 1997

Price, J.F. and Schweigert, B., 1971, *The Science of Meat and Meat Products*, Second Edition

Romans, J.R., et. al., 1994, *The Meat We Eat*, 13th Edition, Interstate Publishing

Pierson, A.M. and Gillett, T.A., 1996, *Processed Meats*, Third Edition, Aspen Press

Hedrick, H.B, 1994, *Meat Science*, Third Edition, Kendall-Hunt Publishing



U.S. DAIRY EXPORT COUNCIL®

MANAGED BY  
DAIRY MANAGEMENT INC™

Published by U.S. DAIRY EXPORT COUNCIL®  
Fax: U.S.A. (703) 528-3705

**U.S. Customers please contact DMI at:**  
Tel: 1-800-248-8829  
Fax: (847) 995-1738

