

Agenda

- Dairy Ingredient Composition
- Dairy Ingredient Functionality
- Dairy Applications
 - Dairy Beverages
 - Yogurt
 - Frozen Desserts
- Food Applications
 - Bakery
 - Confections
 - Nutrition bars





Dairy Ingredients

- Whole Milk Powder
- Skim Milk Powder
- Milk Protein Concentrate
- Milk Protein Isolate
- Micellar Casein
- Milk Whey Protein (Native Whey)
- Sweet Whey
- Whey Protein Concentrate
- Whey Protein Isolate
- Hydrolyzed Whey Proteins
- Whey Permeate



Whey Ingredient Composition

Composition (%)	*Dairy Product Solids	Sweet Whey	WPC34	WPC80	WPI
Fat	1.0	1.1	3.0	5.0	0.5
Moisture	4.0	4.0	4.0	4.0	4.0
Protein	5.0	12.9	35.0	80.0	90.0
Ash	9.0	8.5	6.0	4.0	2.0
Lactose	75.0	73.0	51.0	4.0	1.0

*Alternate names for permeate ingredients: Permeate, whey permeate, milk permeate, dairy product solids, modified whey, deproteinized whey, whey solids, milk solids



Milk Protein Ingredients

Product	Protein %	Fat %	Lactose %	Ash %	Moisture %
MPC 40	39.5 min	1.25 max	52.0 max	10.0 max	5.0 max
MPC 42	41.5 min	1.25 max	51.0 max	10.0 max	5.0 max
MPC 56	55.5 min	1.50 max	36.0 max	10.0 max	5.0 max
MPC 70	69.5 min	2.50 max	20.0 max	10.0 max	6.0 max
MPC 80	79.5 min	2.50 max	9.0 max	8.0 max	6.0 max
MPC 85	85.0 min*	2.50 max	8.0 max	8.0 max	6.0 max
MPI	89.5 min*	2.50 max	5.0 max	8.0 max	6.0 max

ADPI, 2016

(*) Protein content $\geq 85.0\%$ is reported on a dry basis, all other parameters are reported “as is”



Micellar Casein

Product	Protein %	Fat %	Lactose %	Ash %	Moisture %
42	41.5 min	1.25 max	51.0 max	6.0 max	5.0 max
70	69.5 min	2.50 max	16.0 max	8.0 max	6.0 max
80	79.5 min	3.00 max	10.0 max	8.0 max	6.0 max
85	85.0 min*	3.00 max	3.0 max	8.0 max	6.0 max
90	89.5 min*	3.00 max	1.0 max	8.0 max	7.0 max

ADPI, 2016

(*) Protein content over $\geq 85.0\%$ is reported on a dry basis, all other parameters are reported “as is” No standard ratio of casein:whey protein but typically altered from 80:20.



Milk Whey Protein Standard

Product definition: Obtained from bovine milk or skim milk by the removal of casein and non-protein constituents from milk so the finished dry product contains not less than 25% protein. It is obtained by microfiltration and/or chromatography of milk or skim milk and may be preceded by or followed by ultrafiltration, nanofiltration....

Product	Protein (%)	Fat (%)	Lactose (%)	Ash (%)	Moisture (%)
mWPC 34	33.5 min	2.0 max	55.0 max	7.5 max	6.0 max
mWPC 80	79.5* min	2.0 max	13.0 max	5.0 max	6.0 max
mWPC 90	89.5 min	1.5 max	4.0 max	4.5 max	6.0 max

ADPI, 2017

*Protein content $\geq 79.5\%$ is reported on a dry basis, all other parameters are reported “as is”

Names: milk whey protein, native whey protein, milk derived whey protein, milk soluble protein



Characteristics of Caseins and Whey Proteins

Caseins	Whey Proteins
Random Coil	Ordered structures
Reasonable essential AA content	Good source of essential AA
Poor in sulfur AA	High in sulfur AA
Present as colloidal suspension	Soluble, globular
Very stable to heat (even boiling)	Readily denatured
Non-crystalline	Crystalline



Functional Properties of Milk Proteins

Caseins	Whey Proteins
Fat emulsification	Gelation
Foaming	Foaming
Soluble at pH >6	Soluble at any pH
Water binding	Heat sensitive
Precipitation by Ca ⁺⁺	
Precipitation by chymosin	
Heat stable	

Early. 1992. The Technology of Dairy Products



Functional Properties of Milkfat and Lactose

Milkfat	Lactose
Air incorporation	Low sweetening power (29-37% of sucrose)
Creaming	Humectant
Flavor	Browning (Maillard)
Flavor Carrier	Suppresses sucrose crystallization
Gloss	Free flow agent
Heat transfer medium	
Layering	
Shortening	
Anti-staling	

Early. 1992. The Technology of Dairy Products

Heat-Induced Changes in Milk Proteins

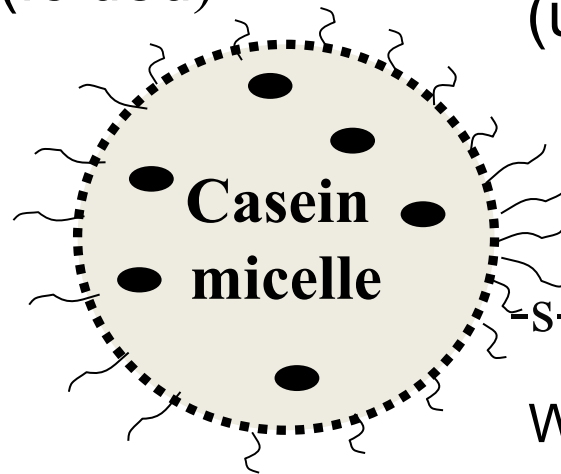


Native whey
Protein (folded)

heat →



Denatured whey protein
(unfolded)



Whey proteins become associated
with casein micelles

Disulfide bond -S-S-

Free sulphhydryl group -SH

● Colloidal calcium
phosphate (CCP)

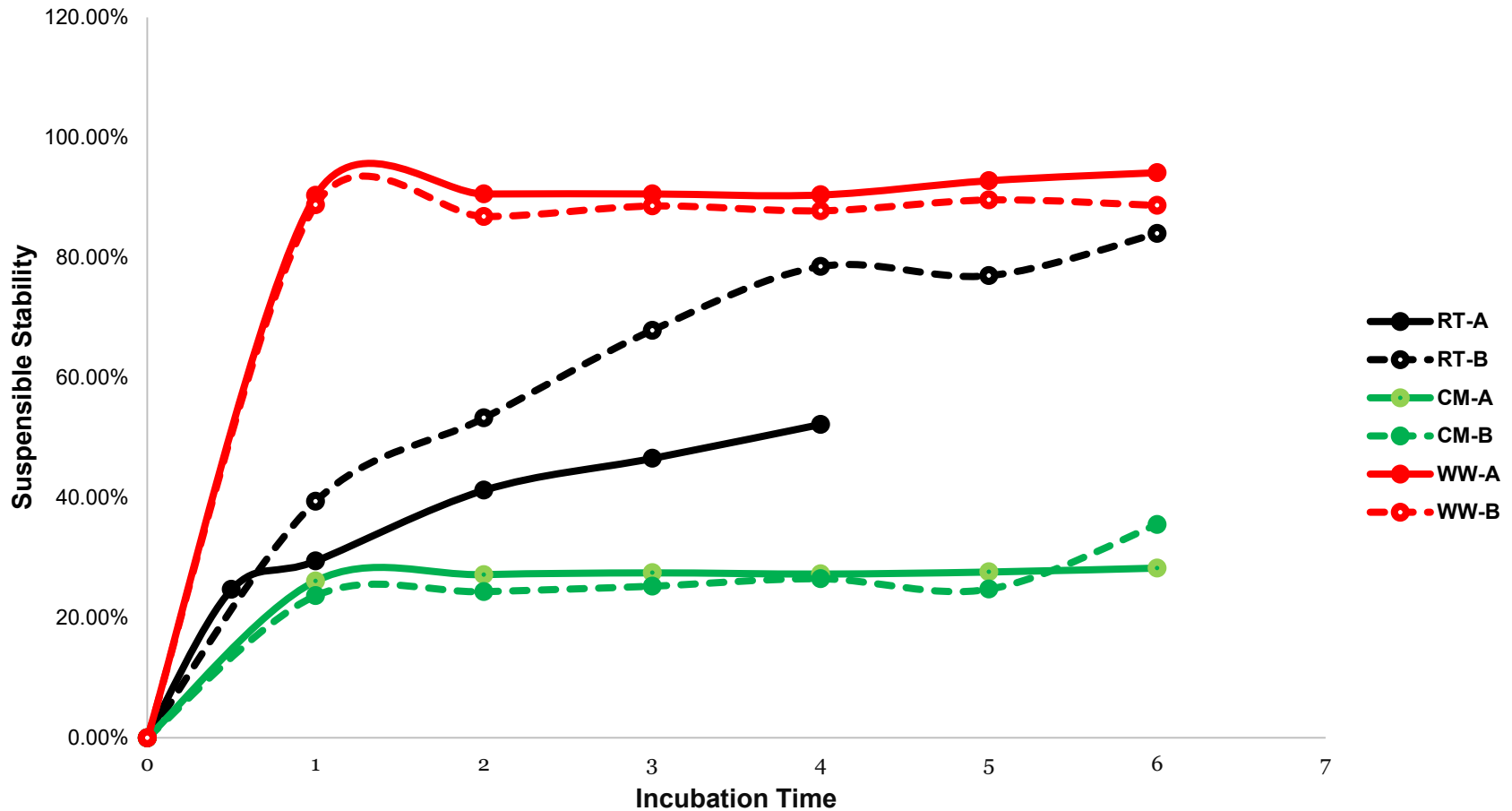


Tips for Using Dairy Proteins

- **Hydration of Dairy Protein Ingredients is Key**
 - Should mix in WPC with a high speed mixer and allow 30 minutes of hydration time with slow agitation to provide protection during heating process (temp of water or milk $<60^{\circ}\text{C}$ (140°F))
 - Mix in MPC with a high speed mixer and hydrate for at least 12 hours in cold temperatures or 1 hour at 50°C (122°F) for MPC80 and higher
 - Inadequate hydration will lead to loss of heat stability and ultimately loss of solubility
 - Chalky mouthfeel is often a sign of inadequate hydration



Hydration Profile of two MPC85



RT – Room temperature water (21C)
CM – Cold milk (4C)
WW – Warm water (50C)

Beverage Opportunities

- Meal Replacements
- Sports Drinks
 - Recovery Drinks
 - Isotonics
 - Body Building/Muscle Building
- Energy Drinks
- Smoothies/Yogurt Drinks/Juice Drinks
- Waters
- Tea
- Coffee
- Carbonated drinks





Factors that Influence the Functional Properties of Dairy Proteins in Beverages

- Hydration Conditions and Time
 - A well hydrated protein ingredient will have better heat stability and solubility
- pH
 - Caseins and whey proteins will behave differently at different pH
- Ionic strength
 - Generally the higher the ionic strength the greater the possibility for protein-protein interaction and loss of heat stability for whey proteins, divalent ions such as calcium and magnesium are more reactive (JL. Xiong J. Agric. Food Chem. 1992, 40, 380-384)
- Protein concentration
 - Higher concentrations of protein (>7%) are more challenging



Which Dairy Ingredient?

- Desired composition
- The choice of the protein ingredient should be based on the pH of the drink.
- Remember the solubility characteristics of casein and whey proteins at different pH
- Consider the type of heat processing



Low Acid Beverages

- pH 6.5-7.0, HTST, UHT or Retort
- Often a combination of milk proteins and whey proteins are used.
- More difficult to reach 10% protein, hydrolyzed whey proteins can help here too.
- Stabilizer choice depending on types of proteins and level, homogenization needed for higher levels of protein.
- Buffers definitely needed for UHT and retort conditions.



Processing Steps for Neutral pH Beverages

- Mix milk protein and whey protein in water with a high speed mixer at 50°C (122°F).
- Add other ingredients such as sweeteners, colors, stabilizers and flavors and allow mix to hydrate for 1 hour with slow agitation.
- Add pH adjusting ingredients such as buffers to reach pH 6.8-7.0.
- Heat to 140°C (284°F) for 3-6 seconds
- Homogenize at 2500 psi/700 psi
- Cool product to 22°C (72°F).

Low Acid Beverages



12 g protein/240 ml



30 g protein/453 ml



20 g protein/240 ml



20g protein/355 ml



10 g protein/300 ml



16g protein/240 ml



Using Permeates in Beverages

- Permeate provides nutrition
 - Benefits of high mineral content add an important source of nutrients-clean label
 - Lactose provides energy
- Well suited to dry mix beverages
 - Flowable
 - Enhances flavor
- In RTD beverages or yogurt drinks
 - Lactose can be hydrolyzed to provide sweetness with less added sugar



Dairy Mineral Thirst Quencher

Nutrition Facts

Serving Size (makes 8 fl oz) (20g)
 Servings Per Container

Amount Per Serving

Calories 70 **Calories from Fat 0**

% Daily Value*

Total Fat 0g **0%**

 Saturated Fat 0g **0%**

 Trans Fat 0g

Cholesterol 0mg **0%**

Sodium 100mg **4%**

Potassium 400mg **11%**

Total Carbohydrate 18g **6%**

 Dietary Fiber 0g **0%**

 Sugars 17g

Protein 1g

Vitamin A 0% • Vitamin C 0%

Calcium 8% • Iron 0%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

Calories:	2,000	2,500
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Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Potassium		3,500 mg	3,500 mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:

Fat 9 • Carbohydrate 4 • Protein 4



Dairy product solids, sugar, malic acid, natural lemon flavor

Beverages Using Permeate (USDEC)



Yogurt Products

- Yogurt
 - Stirred
 - Set
 - Natural
 - Fruit on the bottom
 - Drinking
 - Non-diluted
 - Diluted (with juice or syrup)
 - Greek yogurt
 - Frozen yogurt
 - With functional ingredients



NOW WITH LGG™!





Desired Yogurt Ingredient Functionality

- Low cost with high level of functionality
- Easily incorporated
- Develops viscosity/gel
- Improves texture and consistency
- Provides no off flavors
- Reduces syneresis

Defects Caused by Poor Hydration

- Graininess
 - Loss of protein solubility
- Syneresis
 - Poor stabilization due to lack of milk and or whey protein functionality



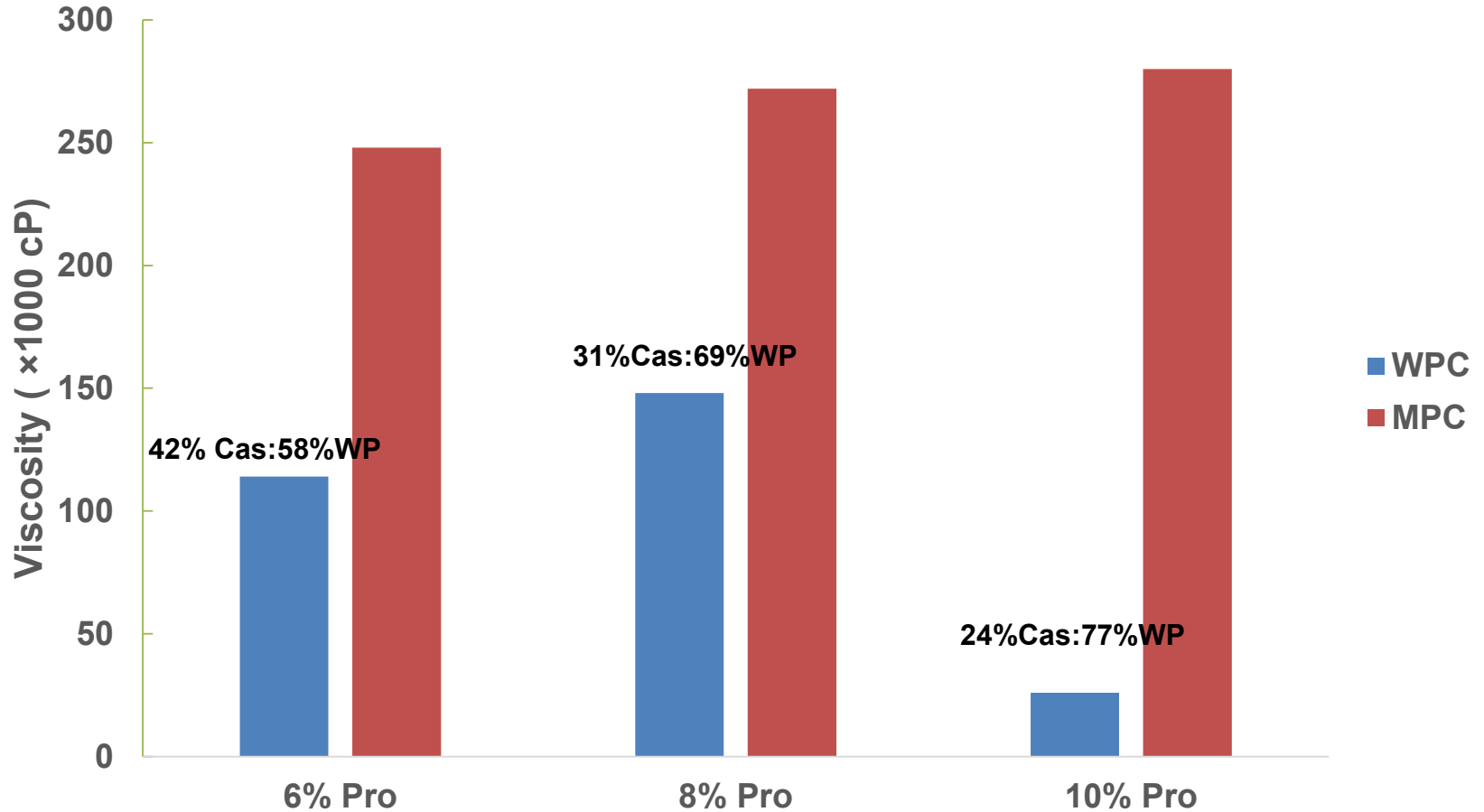


Whey or Milk Protein?

	Whey Protein	Milk Protein
Pros	Short hydration time Prevent syneresis Stabilizer Increase firmness/viscosity Shorter gelation time	Clean taste/flavor, color Firmer gel
Con	Tan color Whey flavor Grainy & Weak if add too much	Takes time to hydrate or grainy Too firm if add too much



Viscosity of Yogurts with WPC and MPC at Different Protein Levels



68C for 30 minutes

High Protein Yogurts 10% Protein



UF milk



MPC



MPC and WPC

Yogurts with MPC



Mexico



Chile



Thailand



Netherlands



Turkey

Yogurts with WPC



South Africa



U.S.



Canada



Spain



Canada



Mediterranean Yogurt Drink

INGREDIENTS

	Usage Levels (%)
Milk, reduced-fat	90.21
Milk permeate (dairy product solids)	6.49
Nonfat dry milk	0.92
Cucumber puree	2.20
Natural lemon flavor	0.15
Yogurt culture (CHR Hansen YCX11)	0.02
Probiotics (CHR Hansen F-DVSABC)	0.01
Total	100.00

NUTRITIONAL CONTENT

U.S. Label

Nutrition Facts

Serving Size 1 cup (240 ml) (227g)
Servings Per Container

Amount Per Serving

Calories 160 **Calories from Fat 35**

% Daily Value*

Total Fat 4g	6%
Saturated Fat 2g	10%
Trans Fat 0g	
Cholesterol 15mg	5%
Sodium 130mg	5%
Total Carbohydrate 24g	8%
Dietary Fiber 0g	0%
Sugars 24g	
Protein 8g	16%

Vitamin A 8% • Vitamin C 2%

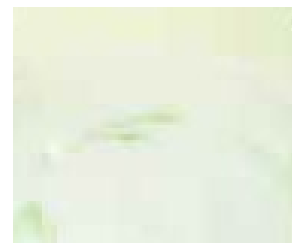
Calcium 50% • Iron 0%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

		Calories: 2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g
Protein		50g	65g

Calories per gram:

Fat 9 • Carbohydrate 4 • Protein 4



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Blue Raspberry Hydration Yogurt Drink

Ingredient	%
Reduced fat milk	91.91
Milk permeate	6.26
Milk protein isolate	1.19
N&A Blue raspberry flavor	0.30
Natural Blue color	0.17
Pectin	0.10
Lactase enzyme	0.05
Mild 1.0 culture-Chr Hansen	0.02
Total	100.00

Nutrition Facts	
1 servings per container	
Serving size	8 oz (240 ml)
Amount per serving	
Calories	170
% Daily Value*	
Total Fat 4g	5%
Saturated Fat 2.5g	13%
Trans Fat 0g	
Cholesterol 20mg	7%
Sodium 210mg	9%
Total Carbohydrate 23g	8%
Dietary Fiber 0g	0%
Total Sugars 23g	
Includes 0g Added Sugars	0%
Protein 10g	20%
Vitamin D 3mcg	15%
Calcium 357mg	25%
Iron 0mg	0%
Potassium 631mg	15%
<small>*The % Daily Value tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.</small>	



Coffee Yogurt Frappe

INGREDIENTS

	Usage Levels (%)
Milk, low-fat	97.10
Whey protein concentrate 80	1.13
Bourbon — Indonesian Vanilla Blend 2X (Nielsen-Massey)	0.75
Yogurt stabilizer — Denali Ingredients SP1037A	0.50
Coffee - Colombian freeze-dried	0.40
Lactase enzyme — DuPont Danisco	0.05
Caffeine	0.04
Yogurt culture — Chr Hansen Yofast 21	0.02
Stevia leaf extract — Cargill RA80	0.01
Total	100.00



NUTRITIONAL CONTENT

U.S. Label

Nutrition Facts

Serving Size 8 Fl. Oz. (240 ml)
Servings Per Container

Amount Per Serving	
Calories 120	Calories from Fat 20
% Daily Value*	
Total Fat 2.5g	4%
Saturated Fat 1.5g	8%
Trans Fat 0g	
Cholesterol 10mg	3%
Sodium 130mg	5%
Potassium 400mg	11%
Total Carbohydrate 14g	5%
Dietary Fiber 0g	0%
Sugars 12g	
Protein 10g	20%
Vitamin A 2%	Vitamin C 0%
Calcium 30%	Iron 0%
Riboflavin 30%	Phosphorus 25%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	2,000	2,500
Total Fat	Less than 65g	80g
Saturated Fat	Less than 20g	25g
Cholesterol	Less than 300mg	300mg
Sodium	Less than 2,400mg	2,400mg
Potassium	3,500 mg	3,500 mg
Total Carbohydrate	300g	375g
Dietary Fiber	25g	30g
Protein	50g	65g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Frozen Desserts





Whey Permeate in Soft Serve Ice Cream

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Study conducted in 2011



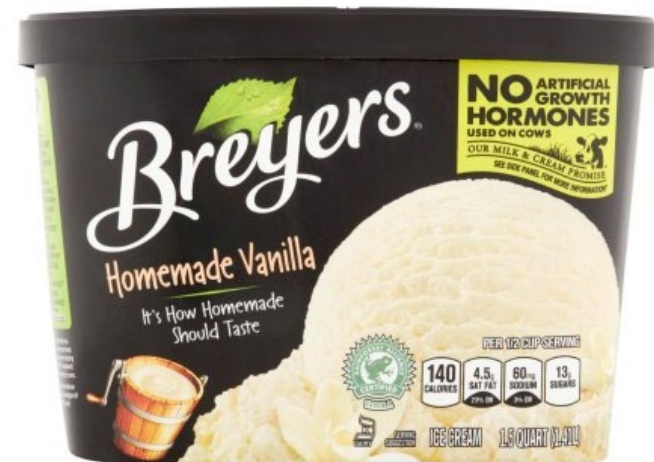


Mix Formulations

Mix Formulation	Control (NFDM)	Test 1 (SWP)	Test 2 (WP)
	%	%	%
Cream (30% fat)	16.7	16.7	16.7
Sugar	10	10	10
NFDM	11.3	8.2	8.2
Sweet Whey	-	3.1	-
Whey Permeate	-	-	3.1
Corn Syrup Solids	10.5	10.5	10.5
Stabilizer/Emulsifier	0.3	0.3	0.3
Water	51.2	51.2	51.2
TOTAL	100%	100%	100%

Whey in Ice Cream

- Ingredients:** Milk, Cream, Sugar, Corn Syrup, **Whey**, Egg Yolks, Vegetable Gums (Carob Bean, Tara, Guar), Mono and Diglycerides, Salt, Natural Flavor, Annatto (For color)



Tips for High Protein Ice Creams

- MPC/MPI/Micellar casein will provide the best heat stability at high concentrations
 - They also have very high water binding ability and can thicken a mix too much
 - Hydration of MPC/MPI/Micellar casein ingredients is critical
- Remember that whey protein is not very heat stable
 - It is always better to have more casein than whey protein
- Keep your eye on the freezing point
 - Hardness and no melt defect are common



Using Whey Protein



5% protein



12.3% protein

Using MPC or MPI



6.3% protein



7.8% protein



8.6% protein



9.2% protein

Bakery Applications

- **Whey, Permeate**

- Sweet Goods
- Bread
- Crackers
- Cookies

- **WPC**

- Prepared mixes
- Cakes & Muffins
- Soft Cookies



- **Whey Functionality**

- Flavor
- Soft Crumb
- Shorter Dough Time
- Color/Appearance
- Sodium reduction

- **WPC Functionality**

- Crumb softening, Color, Flavor
- Fat or Egg replacement
- Gelation, foaming

Confections

- **Whey, Lactose, Permeate**
 - Caramels
 - Toffee
 - Nougat
 - Compound Coating
 - Icings
 - Decorations
- **Functionality**
 - Color
 - Sweetness
 - Flavor
 - Texture
 - Foaming
- **Milk or Whey proteins**
 - Protein fortified coatings



Nutrition Bars

- WPC, WPI, MPC, MPI, Whey Protein Hydrolysates (WPH)
 - Combinations of proteins better for bar hardening
- Functionality
 - Nutrition
 - Texture
 - Flavor



Resources

www.ThinkUSAdairy.org

U.S. DAIRY PROTEINS AND PERMEATES IN READY-TO-DRINK BEVERAGES

Ready-to-drink beverages offer the advantages of convenience and portability to today's busy consumers. They also provide an opportunity to incorporate innovative and exciting functional ingredients and packaging technologies. While this category includes both refrigerated and shelf-stable beverages, demand is stronger for shelf-stable products which offer ease of distribution and storage. However, refrigerated beverage sales are surging, as they can be perceived by consumers to be more fresh and natural than shelf-stable products. Dairy proteins are often the preferred source for ready-to-drink protein beverages because of their excellent nutritional qualities, mild flavor, ease of digestibility and unique functionality in beverage systems. More in-depth descriptions of the nutritional and functional characteristics of whey and milk protein, as well as whey and milk permeate, are available in online publications from the U.S. Dairy Export Council at www.ThinkUSAdairy.org.

This monograph focuses on the aspects of formulating and manufacturing ready-to-drink (RTD) beverages using proteins from milk, including whey protein isolate (WPI), whey protein concentrate (WPC), milk protein isolate (MPI), milk protein concentrate (MPC) and micellar casein concentrate (MCC) as the sources of protein. It also addresses the use of U.S. milk and whey permeate ingredients in RTD beverage formulations.

The use of dairy proteins in dry mix beverage formulations is common, but the creation of ready-to-drink beverages requires far more technology, processing expertise and careful ingredient consideration.

The Ready-to-Drink Beverage Market

Growth in the beverage market is shifting toward drinks that offer improved nutrition and diverse consumer benefits. Diets high in protein can help promote satiety, curb hunger and preserve lean body mass. Protein is the most sought out nutrient by U.S. shoppers according to the *Food and Health Survey* from the International Food Information Council Foundation,¹ and research shows consumers not only seek out protein beyond traditional meat sources, but also find dairy protein to be a high-quality alternative.² Protein drinks and shakes continue to attract new audiences, and non-traditional dairy beverages can help consumers achieve their protein intake goals.



Technical Report: Whey Protein Heat Stability

Written by: Kimberlee (K.J.) Burrington
Reviewed by: Shantanu Agarwal



As part of a growing health and wellness trend, food and beverage manufacturers are boosting the protein content of products. Many food and beverage manufacturers use whey proteins as the protein source of choice for product innovation. Expanded utilization of these ingredients holds great potential for creating even more new formulation possibilities through improvements in whey quality and performance.

This report summarizes recent research on improving the heat stability of whey protein ingredients, thus helping product developers utilize them in more applications. Whey, by definition from the Code of Federal Regulations, is the liquid substance obtained by separating the coagulum from milk or cream in cheese making. Whey proteins represent about 20 percent of the milk proteins, which remain in the serum phase during the process of making cheese and are later processed into many different ingredients. The primary whey proteins are beta-lactoglobulin (β -lg), alpha-lactalbumin (α -lac), bovine serum albumin, immunoglobulins and proteose peptones.¹

A unique set of proteins with special physical properties, whey proteins are a component of many commercial ingredient blends that contribute to the flavor, texture and nutrition of a wide variety of food products. The high level of essential amino acids, especially branched-chain amino acids, makes whey protein a sought-after nutritional ingredient. The physical properties of whey protein ingredients give them versatility across many food applications. One specific aspect of whey protein that may be challenging for some formulations is sensitivity to heat. Consequently, the Dairy Research Institute[®], established under the leadership of America's dairy farmers through the dairy checkoff program, has supported a variety of research that aims to improve whey protein's performance in higher heat processing.

Whey Protein Characteristics

Whey Protein Ingredient Composition

Whey protein ingredients include whey protein concentrates (WPC) and whey protein isolates (WPI), which typically range in protein from 25 to 90 percent protein.² Beta-lactoglobulin and α -lactalbumin are the predominant whey proteins, representing up to 70 percent of the total protein (Table 1). The characteristics of these two proteins account for many of the physical properties of whey protein ingredients.

Table 1. Whey Protein Composition²

Whey Protein	WPC %	WPI %
α -lactalbumin	12 to 16	14 to 15
β -lactoglobulin	50 to 60	44 to 69
Glycomacropeptide (GMP)	15 to 21	2 to 20
Serum albumin	3 to 5	1 to 3
Immunoglobulins	5 to 8	2 to 3
Lactoferrin	<1	Not reported

¹Walstra P, Wouters JTM, Geurts TJ. *Milk Components, Dairy Science and Technology*. 2nd ed. CRC Press:2006:Chapter 2.
²Foegeding EA, Luck P, Verdhanebuthi B. *Encyclopedia of Dairy Sciences*. 2nd ed. Elsevier Ltd.:2011:Whey Protein Products.



Resources

(www.ThinkUSAdairy.org)

Dairy Ingredients Functionality and Composition Reference Guide



U.S. DAIRY INGREDIENTS IN YOGURT AND YOGURT BEVERAGES

The popularity and consumption of conventional yogurt, higher protein yogurt and yogurt beverages continues to grow as people around the world enjoy the taste, creamy texture and convenience as well as recognize the health and wellness benefits associated with consuming these fermented dairy foods. U.S. dairy ingredients from milk and whey are well suited to provide nutrition, function and flavor attributes which enhance the value and cost effectiveness of all types of yogurt products. These benefits appeal to manufacturers, retailers and most importantly, consumers.



A wide variety of U.S. dairy ingredients are available for use in the manufacture of yogurt and yogurt beverages including: sweet whey powder (SWP), whey protein concentrate (WPC), whey protein isolate (WPI), modified WPC/WPIs, ultrafiltered (UF) milk, skim and whole milk powder (SMP, WMP), milk protein concentrate (MPC), milk protein isolate (MPI), micellar casein concentrate (MCC) and other dairy derived ingredients.

The potential benefits of formulating yogurt products with dairy ingredients include:

- Improved texture by increasing viscosity and firmness.
- Reduction of syneresis.
- Standardization of the protein content, which helps maintain product consistency.
- Replacement of non-dairy ingredients for a cleaner, more consumer-friendly label.
- Improved flavor, as compared to using non-dairy ingredients.
- Enhanced nutritional composition due to the addition of protein, minerals and other bioactive components.

Research suggests that proteins and bioactives in dairy can help stimulate the growth of probiotic bacteria (in the product and in the consumer's gut) by exerting a prebiotic effect; positively influence cardiovascular health; build muscle mass; prevent muscle loss; and promote optimal health.

Thank You

- USDEC
- Dairy Farmers of Wisconsin
- National Dairy Council/Dairy Management, Inc.

