Processors' Guide & Formulations

Whey-Based Beverages

Market and Trends
Ingredients Specifications
Operations Principles
Processes
Starter formulations
Consumer Segmentation

Prepared for the Pacific Coast Coalition by the California Dairy Innovation Center, October 2024.

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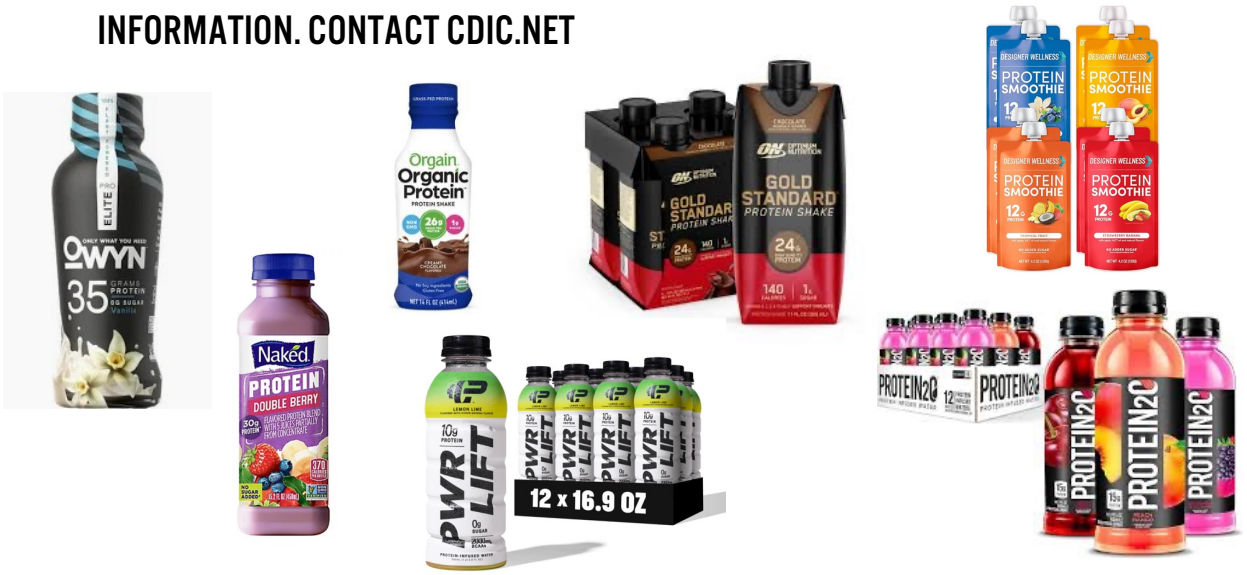
Market Expectations

COMPETITIVE LANDSCAPE: FOR THE LATEST MARKET INFORMATION. CONTACT CDIC.NET



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Dairy Ingredient Functionality

INGREDIENTS

Hydrolysates

Whey Protein Isolates

Whey Protein Concentrates

Liquid Whey Stream

Functional Whey (i.e. Clear Whey)

Follow links for ingredient descriptions and specifications

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Dairy Ingredient Functionality

WHEY PROTEIN ISOLATE (WPI)

- Is a highly purified form of whey protein produced via filtration or ion exchange chromatography
- Products that have low pH, Sports Drinks, Culture Dairy, ideal for post workout supplement to help deliver crucial amino acids
  - Often preferred most for RTD
- Improves muscle mass and tissue repair
- Protein purity above 90% (dry basis)
- Compared to WPC (on next slide) contains higher protein, contains less than 1% lactose, lower fat, and absorbs faster
- More expensive than WPC
- Functionality
  - Low fat content
  - Low in lactose
  - Low residual sodium content
  - Easily digested
  - Particularly high in branched chain amino acids (BCAAs) for sports nutrition market

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Dairy Ingredient Functionality

WHEY PROTEIN CONCENTRATE (WPC)

- Purified form of protein produced via filtration of whey
- Products used to replace dairy (cream, fresh dairy) and lower calorie, high acid beverages
- Protein purity 35-80%
  - Common form is WPC80 (>80% protein dry basis)
  - Or WPC35 (>35% protein dry basis)
- Rich in vitamins and minerals
- Has higher viscosity as compared to isolates
- Contains higher levels of lactose and fat than WPI, especially for lower grades of WPC
- Flavor: neutral, milky

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Dairy Ingredient Functionality

WHEY PROTEIN HYDROLYSATE

- A MIXTURE OF PARTIALLY DIGESTED WHEY PROTEIN
- Used in sports and fitness beverages
  - Protein shakes, meal replacement drinks, recovery beverages
- Helps support muscle growth and recovery
- GRAS Ingredient
- Functionality:
  - Emulsification: ability to bind fats and water
  - Foaming: creates stable foam
  - Gelation: can form gels at certain concentrations and pH
  - Water Binding: ability to bind water
  - Flavor: mild, brothy, malty
  - Texture: makes product smoother and less gritty

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Dairy Ingredient Functionality

FUNCTIONAL WHEY

- Many suppliers produce whey protein ingredients with specific functionality for specific product applications, including:
- Pre-Acidified WPI (pH <4 in solution)
  - High heat stability
  - High Acid Stability for high acid beverages
  - Some offer high clarity for clear beverages
  - Great for mixing for fruit or other highly acidic components
- Clear WPI
  - Similar to functionality of standard WPI but focused on clarity in products
  - Ideal for clear sports drinks, either RTD or RTM
  - Dissolves completely without milky residue, resulting in clear products

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Dairy Ingredient Functionality

FUNCTIONAL DIFFERENCES

	HYDROLYSATES	WPC	WPI	LIQUID WHEY	FUNCTIONAL WHEY
Pros	• Improved Solubility • Fast Absoption • Enhanced Flaovr • Imrpove bioavailability	• High Protein • Digestibke • Enhance Texture • Versatile • Cost Effective	• High Protein Content • Low Lactose Content • Quick Absorption • Improves Recovery for athletes	• Nutrient Dense • Digestible • Cost Effective • Can enhance texture and stability	• Improved texture and mouthfeel • Versatile • High Protein Content • Enhanced Nutritional Profile
Cons	• Loss of Nutrients • Increase Cost • Can become bitter • Can Denature	• Higher Lactose Content • Can produce off flavors	• Cost • Excessive intake is bad for digestion • Lack of essential nutrients	• Sedimentation during storage • Flavor • Lactose High	• Lactose High • Cost

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Dairy Ingredient Functionality

HIGH ACID VS LOW ACID

	HIGH ACID (pH < 4.6)	LOW ACID (pH > 4.6)
Processing Conditions for Shelf Stable	Hot Fill	Retort & UHT
	Heated >189F – 2minutes	Retort – 250-300F, 20-40min UHT-above 275F, 2-5 seconds
	Pose less Pathogen Risk due to low pH	UHT generally aseptically packaged
Processing Conditions for Refrigerated	Pasteurized and then must be kept refrigerator	ESL – Extended Shelf Life Undergo UHT but not packaged aseptically

Watchout:

- Fruit Concentrate
  - When fruit is added it may affect the protein in multiple ways. pH will be affected the most, and since pH has an effect on the stability of whey protein it is important to ensure

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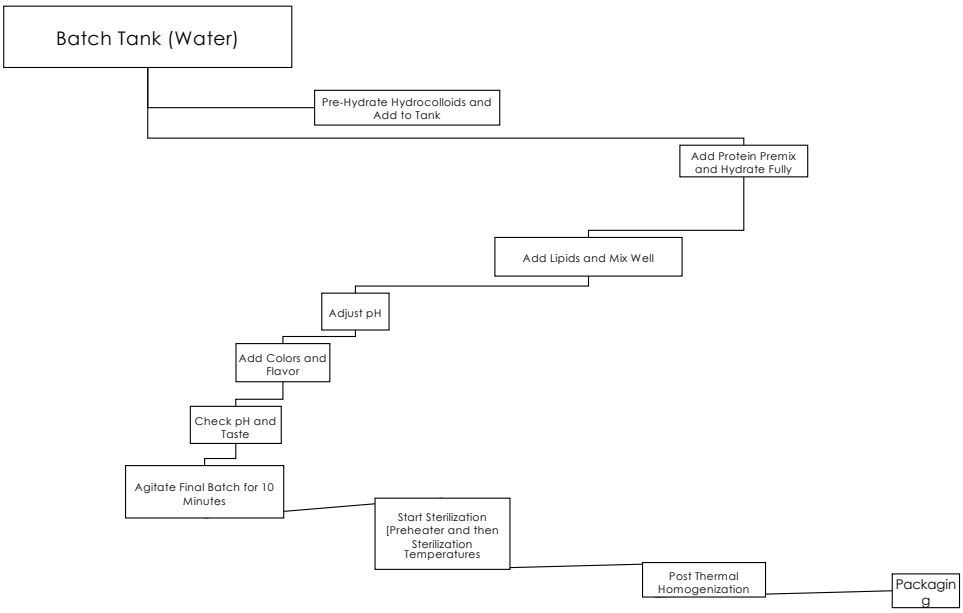
General Process for Manufacturing



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Scale Up and Commercialization

PACKAGING

- Selection based on processing method

	COLD FILL	HOT FILL	PASTEURIZATION	RETORT	ASEPTIC
Glass	X	X	X	X	
Hot Fill Plastic	X	X			
Cold Fill Plastic	X				
Retort Plastic				X	
Metal		X	X	X	X

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Scale Up and Commercialization

PROCESSING TYPES

- Thermal Treatment [see table to the right]
  - Heated to 70-80C and then cooled to 4C
  - High Acid Shelf Stable ---[add condition]
  - High Acid Aseptic [add conditions]
- Fermentation
  - Can be fermented with Lactic acid bacteria, yeast or kefir
  - Adds flavor and texture
- Homogenization
  - Increases smoothness by reducing particle size of whey protein aggregates

Type of Thermal Treatment	Definition	Time/Temp
Hot Fill	Process of filling packaging with heated, commercially sterile product.	161 F for 15 sec
Aseptic	Sterile product in sterile container, ideal for low-acid products	280F-302F for ½ sec
Retort	Sterilize or Pasteurize food in packaging	245F for 12-20 minutes

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Troubleshooting

PROTEIN CONSIDERATIONS AND WATCHOUTS

- Thermal stability of proteins during processing is one of the most important considerations for whey protein–based beverages
  - Whey proteins denature and can potentially aggregate due to temperature, acidity, mineral (salt)
  - This can lead to gritty texture, sedimentation, or excessive fouling on processing surfaces
  - Solutions:
    - Lower processing temperatures to minimize denaturation (not always an option, especially for UHT)
    - Adjust pH to be acidic can improve protein solubility and stability. stabilize pH to 3.7 or lower and regulate amount of minerals added by adding an acid (i.e phosphoric acid)
    - Use of phosphate buffers (dipotassium phosphate) in neutral pH products to reduce pH shift during heating
    - Addition of stabilizer (gums) can prevent the protein from aggregating
    - Presence of ionic calcium is problematic – limit calcium addition or use chelated forms of calcium
- Viscosity Challenges
  - Whey protein can be known to increase viscosity of beverages over time
  - Solution: Adding shear thinning agents or stabilizers (gums) can reduce viscosity under shear stress or simply reducing the amount of protein in formula

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Scale Up and Commercialization

PROCESSING CONSIDERATIONS

- Processing Considerations
  - Aeration- be careful not to add excess air will lead to excess foam leading to flocculation in heat treated drinks
  - Acidification Step critical to ensure solution passes through isoelectric point of protein, may need to increase acid to ensure buffering
  - pH suddenly drops after heating?
    - May be due to maillard browning, protein unfolding and dissociation, or protein aggregation.
    - **Make sure to adjust pH to 3.3-3.35 prior to heating**
  - Protein Separating- take a look at rehydration, important that allowing enough time in processing to rehydrate the protein
    - May require high speed mixtures and water at temperatures less than 100F
    - Mix protein with sugars and other dry ingredients
    - Allow for minimum 20 min to maximize hydration

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Scale Up and Commercialization

WHEY BEVERAGE NEEDS

- Generally whey based beverages need:
  - Acidulants (i.e. phosphoric acid, citric acid) to bring starting pH from 6.5 to >3.5
  - Flavors - require heavier flavor usage
  - Sweeteners (as typically not sweet)
  - Minerals – clarity of beverage is dependent on amount of mineral ions *adding salt may increase aggregation in thermally processed drinks (decreasing its stability)
  - Stabilizers/Emulsifiers to stabilize protein through thermal processing

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Scale Up and Commercialization

NEXT STEPS

1. Perform a pilot trial at a CMO (Contract Manufacturer or lab facility)
2. Perform a consumer testing study
3. Start shelf-life study
4. Determine your cost of goods (COGS) t determine financials and overall cost per unit and margins
5. Secure vendors and suppliers and obtain lead times for supply. This will enable you to develop a timeline to commercialization.
6. Determine your distribution options and where you want to launch (regional vs. national)

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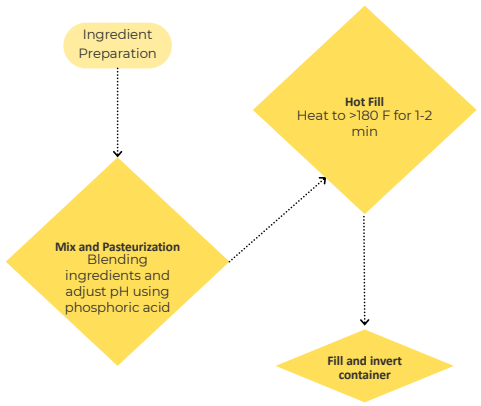
Starter Formulas

HIGH PROTEIN SPORTS DRINK

Ingredient	g/100 g	USE
Water	85.43	Hydrate
Fructose	9.00	Enhance recovery after workouts
WPI	5.00	Emulsifier, increase viscosity
Natural Flavor	0.05	Flavoring
Phosphoric Acid	0.37	adjusts pH
Potassium Sorbate	0.04	Preservative to inhibit mold and yeast growth
Salt	0.04	Flavor Enhancer, Electrolytes
Calcium Chloride	0.02	Replace electrolytes
Potassium Chloride	0.01	Replace electrolytes



Target pH: 3.0–3.8
Temperature: >180F for up to 2 min
Product will be shelf stable

Source: https://www.walshmedicalmedia.com/open-access/whey-based-beverage-its-functionality-formulations-health-benefits-and-applications-2157-7110-1000495.pdf

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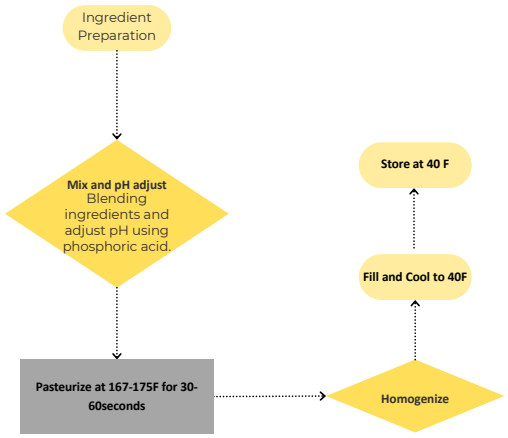
Starter Formulas

PROTEIN FRUIT-BASED BEVERAGE

INGREDIENT	g/100 g	USE
Water	80.57	Hydrate
Sugar	9.33	Bulking Agent, add Sweetness
WPI	4.7	Emulsifier, increase viscosity
Pectin	1.30	Stabilizer
Juice Concentrate	5.09	Flavor
Phosphoric Acid	0.35	Preservative– reduce pathogen growth in final product
Milk Calcium	0.31	Fortification to improve nutrition of overall product



pH 3.5-4.5
Heat: 170 F 30-60 seconds
Product will require refrigeration (alternate is to hot fill)

Source: https://www.walshmedicalmedia.com/open-access/whey-based-beverage-its-functionality-formulations-health-benefits-and-applications-2157-7110-1000495.pdf

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Market Expectations

MARKET SIZE [2023-2030]

- RTD
  - Market size fin 2023 - $1.56 Billion
- Estimated market size in 2028 - $2.26 Billion
- 2023-2028 (CAGR) – 7.72%
- Largest markets
  - North America with Asia Pacific growing the quickest
- Expected CAGR growth of 6.5% from 2023-2030.

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Market Expectations

CONSUMER SEGMENTATION

- People striving to incorporate better nutrition in daily lives
- Particularly looking for whey-based protein consumption for building blocks post workout recovery
- Focus on nutrition as it relates to exercise/activity
  - Sports Nutrition, bodybuilding, weight loss, agility, etc.

Category Drivers

- "Weekend Warriors", health and wellness driven individuals, and Healthy Agers
- Definitive move from Sports Nutrition focus to mass market selling
- Primarily gender driven with more males purchasing high protein beverages.

Nutrition

- Low to moderate level of protein delivery driven by mass market consumers.
- Improved nutritional value is a desire – plant-based options need assistance in flavor and texture. Benefits are in lactose free claim and consumers desire for "dairy-free". This should be observed as a threat to dairy but also an opportunity to provide hybrid options.
- Flavor, price, and nutritional value are key drivers for consumers.

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Market Expectations

TYPES OF BEVERAGES

Types	Whey Benefits	Type of Whey	Product Examples
Alcoholic Beverage/Brewing or Nonalcoholic	Has high salt content, ability to bind to carbonic acid, develops caramel like flavor similar to malt/barley	Fermented Whey	Wheyward Spirit
Flavored Fruit Drinks	Fortification of fruit drinks	Protein Isolates/Concentrates	Latella, Morea
Sports Drinks	Increase performance time to fatigue, reduce poste exercise muscle damage, and enhance muscle glycogen repletion	Protein Isolates/ Concentrates	Gatorade, Isostar, Lucozade Sport

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Labeling, Regulatory, Packaging

LABELING & REGULATION

- 50 grams of protein per day based on a 2000 calorie diet is still recommendation from FDA
- Clean label, list surfactant for instantized proteins (i.e. sunflower or soy lecithin).
- RTD beverages – TetraPak, cans, PET bottles, glass bottles
- High Protein Claim--- 4.5 g of protein per 3 oz
  - In order for a food to be High in protein food must contain 20% or more of recommended DV
    - i.e. contains 20% of the energy value

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For more information please consult www.dairypcc.net

The PCC-DBII is part of a national initiative to help the dairy industry address ongoing supply chain and food system challenges by offering resources for: Business plan development, Marketing and branding, and Increasing access to innovative production and processing techniques to support the development of value-added products.

This initiative currently operates in six states — Arizona, California, Nevada, New Mexico, Oregon, and Washington — and is supported by collaborative partners and grant funding which will make more than $11.4 million available to regional dairy businesses for innovation-related investments.

Additional information for California processors and entrepreneurs available at www.cdic.net

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