U.S. WHEY PROTEINS IN READY-TO-DRINK BEVERAGES

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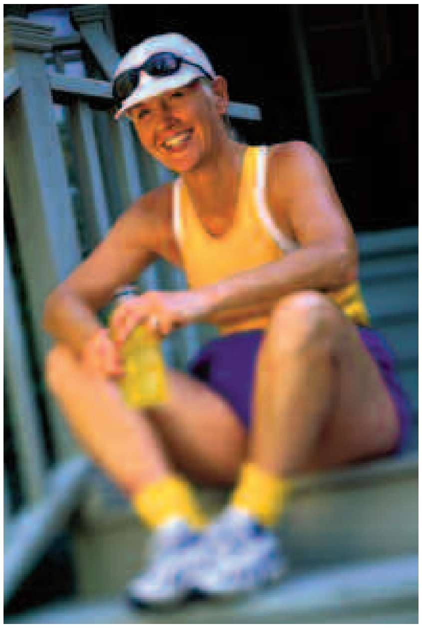
Ready-to-drink beverages offer the advantages of convenience and portability to today's busy consumers. They also provide an opportunity to incorporate exciting packaging and innovative ingredients, such as carbonation. While this category includes both refrigerated and shelf-stable beverages, demand is stronger for shelf-stable products which offer ease of distribution and storage.

Whey proteins are often the preferred source for ready-to-drink (RTD) protein beverages because of their excellent nutritional qualities, bland flavor, ease of digestibility, and unique functionality in beverage systems.

The nutritional and functional characteristics of whey proteins are described in detail in several other publications available from the U.S. Dairy Export Council (www.usdec.org).

This monograph focuses on the various aspects of formulating and manufacturing ready-to-drink (RTD) beverages using whey protein isolate (WPI) and whey protein concentrate (WPC) as the source of protein.

The application of whey proteins to dry mix beverage formulations is common, but the creation of ready-to-drink beverages requires far more technology.



Beverages developed for the sports nutrition market are particularly likely to contain whey proteins which are incorporated for their unique nutritional benefits for athletes (please see USDEC's monograph: U.S. Whey Proteins in Sports Nutrition). Some medical and therapeutic nutritional beverages also include whey proteins because of their abundant supply of essential amino acids for protein synthesis, digestibility and health benefits. Whey proteins are often added to milk-based infant formulas to make whey-predominant mixtures, hence providing a whey to casein protein ratio closer to that of human milk. Two newer categories are smoothie-type beverages, which contain a combination of fruit juice and milk or whey protein, and protein waters which incorporate flavors and colors for product interest.

The source of whey protein may be various whey protein concentrates (defined as having 34-89% protein), whey protein isolates (containing 90-92% protein), or whey peptides, which provide distinct nutritional and functional advantages. In some cases, whey proteins are combined with other proteins such as vegetable- or casein-based ingredients to create a particular overall amino acid composition or textural character, but the vegetable-derived proteins in particular may present serious flavor and mouthfeel challenges for the formulator. These mixtures can be very difficult to stabilize due to multiple ingredient interactions before or after thermal processing. Dairy proteins themselves display a wide range of isoelectric points and molecular sizes, and commercial whey protein ingredients are comprised of several different molecular species.

The interdependence of all the features of a finished ready-to-drink beverage is such that none of the product characteristics can be selected without consideration of the other parameters. Regardless of the particular type of beverage desired, the following factors must be identified and evaluated before beginning the formulation and process development:

1) Define desired packaging, transportation and storage environment, which will determine appropriate manufacturing process.
2) Describe product in terms of pH range and approximate cost targets / limits.
3) Decide upon general nutritional composition, which is shown on the product nutrition label and required to satisfy a nutrition claim.
4) Identify non-protein ingredients needed or desired.
5) Determine compatibility of items 1, 2, 3, and 4.

NEW PRODUCT– GENERAL DESCRIPTION

The percentage of protein in the desired beverage will determine the available processing and packaging options. Whey proteins can be soluble and stable over a wide pH range, yet their natural gelation abilities are an important consideration because of their temperature- and concentration-dependent behavior. Concentrations of sugars and mineral ions in the beverage solution also affect whey protein behavior during processing and throughout shelf life. The interactions are very formula specific, so it is important to perform benchtop and pilot plant simulations before finalizing a formulation.

This section focuses on acidified whey protein-based beverages, which can be successfully made at concentrations of up to 8 or 10% protein, depending on the source of protein and degree of thermal processing.

Environment Selection

Generally, the pH (acidity) of the product determines its processing requirements in terms of safety and storage stability. Except for juice products, there are no U.S. Food and Drug Administration (FDA) thermal processing requirements for acid (< pH 4.6) products. Please check country specific regulations when formulating such products to ensure compliance with local requirements.

There are four basic categories of products of shelf-stable RTD beverages:

1) Aseptically processed commercially sterile beverages.
2) Retort processed commercially sterile beverages.
3) Tunnel pasteurization.
4) Hot-filled or pasteurized cold-filled beverages.

While some beverages can be cold-filled without thermal processing, beverages containing dairy proteins will require some type of thermal process to ensure shelf stability.

Neutral pH beverages

Aseptically and retort processed commercially sterile beverages (categories 1 and 2) are typically represented by the neutral pH, shake-type products. They will generally have a pH of somewhere between 4.6 and 7.5, depending upon the nominal flavor such as strawberry (more acidic) or chocolate (more neutral). These products must either be thermally sterilized (rendered "commercially sterile") via aseptic processing or retort processing, or they must be pasteurized and refrigerated until consumed. Whey proteins are sometimes included in these products but are generally not the predominant proteins in these formulations.

The prevalent proteins are those containing casein proteins such as milk protein concentrate. Often the neutral pH drinks, like the shake products, use a retort or UHT process which is a high heat treatment. Whey proteins that are not modified to have more heat stability will not be stable as the sole protein ingredient at levels above 3% protein. Unmodified whey proteins will gel or precipitate under these conditions unless a stabilizing system is used. Using casein proteins in combination with whey proteins will provide some protection and heat stability to the whey proteins because they will interact with casein and remain soluble versus interacting only with whey proteins and risking forming a gel or precipitating.

The main difference between retort and aseptic processing is:

- In retort processing, a container is filled with the beverage, sealed, and the entire container and its contents are heated to achieve sterility.
- In aseptic processing, the container is sterilized and filled with a sterilized beverage inside a sterile chamber where the container is also sealed.

Generally speaking, the R&D processing and packaging costs for aseptic and retort beverage development are greater than those for hot-fill and cold-fill beverages.

Acidified whey protein beverages

Hot-filled or pasteurized cold-filled beverages and tunnel pasteurized (categories 3 and 4) are typically represented by the acidified whey protein beverages and are generally formulated to a pH range of 2.8 to 4.0. They are commonly subjected to a mild thermal pasteurization process, after which they are generally considered to be shelf-stable at room temperature.

In the pH range of 2.8-3.5, beverages formulated with WPI will have a high clarity/ low turbidity even at high levels of protein. The ability to make a clear protein-fortified beverage is unique only to whey proteins. A low level of fat and minerals in the WPI will deliver the highest clarity/ lowest turbidity.

Thermally processed acidic beverages may be filled while hot into containers which can withstand high temperatures (hot-fill). In the acidic environment, the hot liquid product essentially sterilizes the containers, which have already been prerinsed with ozonated water or other methods of destroying airborne contaminants. Hot-filled containers may be metal, glass or certain plastic bottles designed to withstand the filling temperatures and the subsequent vacuum created during product cooling.

Cold-fill is similar to hot-fill in that the product is thermally processed. However, unlike hot-fill, a cold-fill product is immediately cooled to less than 38°C (100°F) prior to filling. Cooling the product right away allows less vitamin degradation and variations of flavor that may be found with hot-fill processing.

Tunnel pasteurization of sealed metal cans or glass bottles is adequate for acidic protein beverages, and is the only practical method for pasteurizing carbonated beverages. Tunnel pasteurization is historically the common method for pasteurizing beer, but it can also be very useful for acidic beverages containing protein. However, few manufacturers have this capability.

Packaging Selection

Packaging selection (glass, plastic, multilayer, flexible or rigid metal) is an important determinant of beverage processing conditions and product stability, and it influences the costs of manufacturing and distribution. In summary the possibilites are:

	Process				
Bottle	**Cold-Fill**	**Hot-Fill**	**Tunnel Pasteurization**	**Retort Sterilization**	**Aseptic Sterilization**
Glass	•	•	•	•	
Hot-fillable plastic	•	•			
Cold-fillable plastic	•				
Retortable plastic				•	
Multilayer					•
Metal		•	•	•	•

WHEY PROTEIN INGREDIENT CONSIDERATIONS

The most important component of an acidified whey protein RTD beverage is obviously the whey protein ingredient!

The key factors to be considered when selecting a whey protein are a) the whey protein's method of isolation which determines the composition of the WPC or the WPI and b) a consistent source and manufacturing process to produce the ingredient.

The compositional differences between ion exchange and membrane filtered WPI are explained in other publications available from USDEC, ingredients suppliers and other sources. Primary differences are the mineral and the glycomacropeptide content, both of which may affect suitability for a particular application. Whey protein concentrates 80% (WPC 80) are manufactured by membrane filtration processes. Fat and ash contents can vary among WPC 80s, as can flavor profiles.

From a nutritional standpoint, a manufacturer will want to select the ingredient which best matches their requirements: from total protein or mineral concentration to the presence of a particular whey fraction or amino acid. The best strategy for a manufacturer is to work closely with suppliers at the very early stages of the development process. Many U.S. suppliers offer guidance, typical formulations and technical assistance to support their customers when developing products.

It is important to strive for a consistent lot-to-lot ingredient supply, and it may be necessary to develop a simple test which describes performance relative to the intended use, which goes beyond information provided in a standard specification or certificate of analysis. This is particularly true if the product and process are less robust to variations and if the beverage contains a protein level on the high end of the practical range. Again, close and early collaboration with a U.S. supplier is an important success factor.

NON-PROTEIN INGREDIENT CONSIDERATIONS

Following are some of the other categories of ingredients frequently required or desired in whey protein RTD beverages. Their careful selection and laboratory evaluation are important when developing a shelf-stable product with excellent flavor and good consumer appeal. In all cases, please check country specific regulations when formulating these products to ensure compliance with all local requirements.

Acidulants

Whey protein's strong buffering capacity requires the use of considerable amounts of acid in the formula to bring the starting pH from around 6.5 down to 3.5 or lower. The most common acids used for making high-acid whey protein beverages are:

1) Phosphoric – a strong acid with a fairly plain flavor impact.
2) Hydrochloric – a strong acid with less desirable palatability, but may be used in medical nutritionals because it is the same acid found in the gastric system.
3) Citric – a weaker acidulant but very desirable for its contribution to the overall flavor profile of a fruit-flavored beverage. Citric acid is not recommended as the sole acidulant for very high protein drinks because of the extreme tartness imparted when used at high levels.
4) Malic – a weaker acid similar to citric acid but useful as an adjunct to formulas with apple or berry flavors, due to its natural presence in those fruits.

Carbon Dioxide (carbonation)

Carbonation is featured in this section because it should indeed be considered an ingredient, as much as a process, and because of its impact on acidity. There is increasing interest in improving the nutritional profile of carbonated soft drinks by adding whey protein.

Flavors

Whey proteins, unlike some vegetable protein sources, are widely compatible with, and even complementary to, many popular flavors. Acidified whey protein beverages are also less prone to the flavor adsorptive effects of other proteins in beverages, a phenomenon which would require heavier flavor usage (and cost).

Sweeteners

There are many choices of caloric and natural or artificial reduced-calorie and non-caloric sweeteners suitable for use in whey protein beverages. These include:

1) Sugars such as sucrose, fructose and high fructose corn syrup.
2) Sugar alcohols such as lactitol and erythritol.
3) Artificial high-intensity sweeteners including sucralose and acesulfame potassium.
4) Natural high-intensity sweeteners such as those derived from citrus extracts.

The selection of sweeteners can impact mouthfeel and protein stability in a formula-specific manner. However, the choice of a sweetener is usually directed by calorie and flavor requirements. Note that in a particular protein RTD formulation, one sweetener may work well as the sole source of sweetness, but a combination of two often provides the best overall sweetness impact and compatibility with the base flavor.

Colors

Colors may be either artificial or natural, with light stability an important consideration when using transparent or translucent bottles. The slow degradation of ascorbic acid (Vitamin C) in beverages can, via its peroxide breakdown product, slowly decolorize beverages during shelf life. Color suppliers can offer guidance to manufacturers during the development process.

Fruit Juices

Juices are an excellent choice for creating flavorful whey protein isolate beverages and increasing consumer appeal. The use of natural juices may affect pasteurization requirements. The pH of the whey protein isolate in solution should be adjusted with the appropriate acidulant systems before combination with juices, because the protein will otherwise buffer the juice acids and possibly irreversibly change the product characteristics.

Minerals

The stability and clarity of acidified whey protein beverages is believed to be affected by the amount of mineral ions, such as sodium or calcium, present in the system. Therefore, mineral selection and level of fortification may be limited by their effect on the final beverage. In general, adding salts increases aggregation in thermally processed whey beverages, thus decreasing stability.

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Vitamins

As with any food or beverage product, vitamins must be chosen and formulated according to their compatibility with the overall system. Most water-soluble vitamins are fairly stable in acid environments. However, consideration must be given to color and flavor contribution, processing losses and light stability for a RTD in a transparent or translucent bottle. Ingredient interactions should also be considered.

Stabilizers and Emulsifiers

Stabilizers and emulsifiers can be very important to neutral, shake-type beverages, especially when mixtures of proteins and/or cocoa powder are used. Carrageenan, cellulose gel and cellulose gum are stabilizers used in neutral beverages with added protein. Pectin is used for whey protein beverages in the pH range between 3.5 and 4.6 to protect and stabilize the proteins during thermal processing and throughout their shelf life. Stabilizers are generally not needed below pH 3.5 in acidified whey protein isolate RTD beverages.

Emulsifiers like mono- and diglycerides and buffers such as tetrasodium pyrophosphate are commonly used in neutral pH beverages using whey proteins along with other milk proteins. Establishing the ideal levels of stabilizers, buffers and emulsifiers are especially important to ensure long-term stability of protein fortified beverages in the acid and neutral category.

Preservatives

Acidified whey protein beverage formulas can include chemical preservatives such as sorbates and benzoates to control the growth of yeasts, molds and bacteria that could lead to product spoilage.

Nutraceuticals

Whey protein drinks are considered high-value nutritional beverages, and are often fortified with additional nutritional components such as plant sterols to lower cholesterol, lutein to improve eye health, or ma-huang or guarana which are reported to boost energy. Live and active cultures are frequently incorporated into cultured dairy beverages containing whey proteins. This latter category is usually pasteurized, cultured and stored refrigerated to preserve the probiotic health effects, although some products do receive heat treatment and are thus shelf-stable.

PROCESSING CONSIDERATIONS

Attention should be given to the development of a validated, definable and repeatable process for preparing each batch of beverage. This includes batching temperatures, mixing procedures, ingredients' addition order, in particular acidulants, and, of course, the thermal process used for pasteurization or sterilization.

Consistent use of the whey protein ingredient in the preparation of each batch for example, the order of ingredient addition, the method of pH adjustment, and temperature exposures/treatments is also very important and should be carefully monitored and controlled to ensure success.

The first step is usually the rehydration of the powdered protein. This step often leads to most problems in terms of time required and foaming. It is recommended to mix in whey protein ingredients with high-speed mixers and to allow hydration in roughly half of the formula water at temperatures less than 38°C (100°F), with slow agitation. The whey protein ingredients can be mixed in with sugars and other dry ingredients during the hydration step. Hydration time should not be less than 20 minutes to maximize heat stability and shelf stability of the whey protein ingredient.

The manufacturer should be careful to minimize air incorporation during all steps of processing. The formation of excessive foam can lead to flocculation when the drink is heat-treated and in the case of stabilized beverages, some syneresis or separation may occur.

Order, method and rate of addition of ingredients are important to a particular product. This is particularly critical for the acidification step, which generally takes a protein solution at around pH 6.5 and passes it through the zone of isoelectric points of the major proteins around pH 4.5. Whey proteins have a high buffering capacity so formulations with high levels of protein will require high levels of acid for pH adjustment.

Acidified whey protein drinks typically experience a decrease in pH after heat treatment. This decrease in pH is likely due to the following: 1) initial stages of Maillard browning, 2) unfolding of proteins causing a change in the dissociation constant of some functional groups and 3) aggregation of proteins which alters the dissociated state. The pH shift that occurs will depend on the level of protein used. For example, if a final pH of 3.2 is desired, for a beverage containing 5% protein, then it is recommended that the drink be adjusted to pH 3.3-3.35 prior to heat treatment.

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FINISHED PRODUCT HANDLING: ENVIRONMENTAL CONDITIONS DURING DISTRIBUTION, STORAGE

Marketers of whey protein beverages must be familiar with the possible exposure to environmental extremes throughout various distribution channels, locations and climates. Not only are extremes of heat and cold undesirable, but repeated cycling between lesser extremes of heat and cold may have unexpected and unwelcome effects on product stability. Manufacturers new to a market may want to consult with representatives of their distribution and storage partners early on in the development process to obtain information on typical conditions. Accelerated storage studies at various temperatures will help model shelf life and help predict changes in nutritional contents, flavor, acceptability, stability and other physical or chemical parameters.

USE OF WHEY PROTEINS IN PROTEIN RETORT BEVERAGES

Information in this section is provided courtesy of Dairy Management Inc., which funded the research by Dr. Ron Richter, Department of Animal Science, Texas A&M University, Texas, USA.

The objective of Dr. Richter's research was to develop beverages with high whey protein content that could withstand commercial retort sterilization and study their stability during storage.

Heat Stability

Heat treatment necessary to sterilize beverages caused instability and aggregation of the whey proteins when the concentration was greater than 1%. The addition of food additives improved the stability of the beverages and the level of protein possible to incorporate.

Phospholipids: Regular, hydrolyzed and acetylated lecithins improved the heat stability of emulsions containing up to 5% whey proteins. Modified lecithins with higher hydrophilic-lipophilic balance (HLB) values provided more protection against heat denaturation than regular lecithin. The protective effect of lecithins against heat aggregation was only evident in beverages containing fat. The mechanism by which lecithin improved heat stability is associated with protein-lecithin interactions mainly at the interface of the fat droplet.

Polyphosphates improved the heat stability of whey protein beverages. Polyphosphates with a degree of polymerization of approximately 4 units were the only effective polyphosphates for beverages containing more than 5% protein. By using polyphosphates, it was possible to create clear retorted beverages containing up to 5% whey protein without added fat. The mechanism by which polyphosphates improved heat stability might be associated with changes in the structure of water that prevents aggregation of whey proteins.

Hydrocolloids – usually required in formulations to improve the long-term stability of emulsions and provide desired texture and viscosity – were found to have a detrimental effect on the heat stability of whey protein emulsions, most probably through thermodynamic incompatibility that locally increased the concentration of proteins and promoted heat aggregation.

Emulsion Stability

The pressure applied during homogenization had the greatest impact on the fat droplet particle size and surface area, which influence the emulsion stability. Emulsions containing acetylated lecithins were the most stable against creaming. Improvement in emulsion stability with phospholipids seems to be associated with a more negative charge at the interface of the fat droplet.

Storage Stability

Optimization of the parameters showed that emulsions containing 5% protein and 3% fat formulated with 0.3% lecithin and homogenized at 90 MPa had the best stability when tested over 28 days of storage. However, creaming of the emulsions was still evident.

The use of additives able to increase the viscosity without affecting the heat stability of the emulsion is needed to improve the creaming stability of whey protein retort beverages. Another approach could be the incorporation of casein proteins such as found in milk protein concentrate. Caseins have a disordered molecular structure and can protrude longer distances from the fat droplet interface increasing the steric repulsion and improving the heat and emulsion stability.

In summary, the selection of ingredients to increase heat and emulsion stability depends on the beverage composition, and many options are available. Please contact your U.S. supplier of dairy ingredients for assistance in developing successful beverage products.

BEVERAGES FORMULATIONS

The formulations in this section are provided as a starting point for product development purposes. Adjustments may be necessary, depending upon the exact nature of ingredients used, processing and storage variables, local regulations, and target consumer preferences in each market. Please consult your U.S. whey protein supplier for additional information.

Also check local regulations for use of additives and labeling requirements.

The formulations are courtesy of the Dairy Ingredients Applications Laboratory, Wisconsin Center for Dairy Research, Madison, Wisconsin, USA. The laboratory is supported by Dairy Management Inc., Rosemont, Illinois, USA and the Wisconsin Milk Marketing Board.

Adequate Hydration Time Means Increased Clarity of WPI Beverages

A challange of incorporating WPI into clear beverages is that heating often causes cloudiness of the beverage. But a simple and inexpensive way to increase clarity is to allow adequate hydration time of the WPI in solution before heat treatment. Turbidity less than about 40 NTU is considered clear to the consumer.

Procedure:

- Blend dry ingredients.
- Mix with water.
- Allow mixture to hydrate 20 minutes.
- Heat solution to 88°C (190°F) for 2 minutes.

Benefit:

- By using adequate hydration time, turbidity of the solution after heat treatment is reduced about 50%.

WPI Solution Turbidity Over Time Solution of 25g/L protein, pH 3.2. Heat treatment of 88°C (190°F) for 2 minutes.

Hydration Time (min)	Before Heating (NTU)†	After Heating (NTU)†
0	55	79
10	52	39
20	49	38
30	49	37
40	47	39
50	47	38
60	47	37
70	47	39
80	46	37
130	46	38

†NTU = Nephelos Turbidity Units
Data courtesy of UW-Madison, Dr. M. Etzel.

Isotonic Drink with WPI

Ingredients	Usage Level (%)
Water	85.43
Fructose	9.00
WPI	5.00
Phosphoric acid	0.37
Natural mango flavor	0.05
Yellow color	0.04
Potassium sorbate	0.04
Salt	0.04
Calcium chloride	0.02
Potassium chloride	0.01
Total	**100.00**

Procedure:

1. Reconstitute WPI in formula water (at ambient temperature) with a high-speed mixer and allow to hydrate 20 minutes with little agitation.
2. Mix in fructose, salts, flavor and color.
3. Use 85% solution of acid to adjust pH to 3.2.
4. Heat to 90°C (195°F) for 45 seconds.
5. Fill containers and cool to 4°C (40°F).

Nutritional Content per 100 grams

Calories	50 kcal
Total Fat	0 g
Saturated Fat	0 g
Trans Fat	0 g
Cholesterol	0 mg
Sodium	20 mg
Total Carbohydrate	9 g
Dietary Fiber	0 g
Sugars	9 g
Protein	5 g
Vitamin C	0 mg
Vitamin B_1	0 mg
Vitamin B_2	0 mg
Calcium	2 mg

Low pH Juice Drink with WPI

Ingredients	Usage Level (%)
Water	80.73
High fructose corn syrup	9.40
WPI	4.70
Apple juice concentrate-70 Brix	4.70
Phosphoric acid solution-85%	0.35
Natural berry flavor	0.10
Red color	0.02
Total	**100.00**

Procedure:

1. Reconstitute WPI in formula water (at ambient temperature) with a high-speed mixer and allow to hydrate for 20 minutes.
2. Mix in high fructose corn syrup, juice, flavor and color.
3. Use 85% solution of acid to adjust pH to 3.2.
4. Heat to 90°C (195°F) for 45 seconds.
5. Fill containers and cool to 4°C (40°F).

Nutritional Content per 100 grams

Calories	60 kcal
Total Fat	0 g
Saturated Fat	0 g
Trans Fat	0 g
Cholesterol	0 mg
Sodium	0 mg
Total Carbohydrate	11 g
Dietary Fiber	0 g
Sugars	7 g
Protein	4 g
Vitamin C	0 mg
Vitamin B_1	0 mg
Vitamin B_2	0 mg
Calcium	0 mg

Meal Replacement Drink with WPC 80

Ingredients	Usage Level (%)
Skim milk	93.00
Granulated sugar	4.70
WPC 80	1.40
Vanilla extract	0.50
Mono & diglycerides	0.20
Carrageenan	0.10
Tetrasodium pyrophosphate	0.10
Total	**100.00**

Procedure:

1. Disperse all ingredients into skim milk at 4°C (40°F) with a high-speed mixer.
2. Check pH and adjust to 7.0-7.1 by adding tetrasodium pyrophosphate.
3. Hydrate for 20 minutes.
4. Check pH and re-adjust to 7.0-7.1 if necessary by adding tetrasodium pyrophosphate.
5. Heat to 85°C (185°F).
6. Homogenize: first stage at 250 Bar (24.82 MPa, 250 kg/cm² or 3600 psi) and second stage at 48 Bar (4.82 MPa, 49 kg/cm² or 700 psi).
7. Cool to 25°C (77°F).
8. Bottle.
9. Retort with rotation at 10 rpm at 120°C (250°F) for 4 to 5 minutes.

Nutritional Content per 100 grams

Calories	60 kcal
Total Fat	1 g
Saturated Fat	0.5 g
Trans Fat	0 g
Cholesterol	5 mg
Sodium	110 mg
Total Carbohydrate	9 g
Dietary Fiber	0 g
Sugars	9 g
Protein	4 g
Vitamin C	0 mg
Vitamin B_1	0 mg
Vitamin B_2	0 mg
Calcium	120 mg

Low Sugar Drink with WPC 80

Ingredients	Usage Level (%)
Water	90.62
WPC 80	5.29
Cream	2.11
Pectin	1.37
Phosphoric acid	0.28
Mango flavor	0.20
Sucralose	0.10
Red color	0.02
Yellow color	0.01
Total	**100.00**

Procedure:

1. Hydrate stabilizer in half of the formula water at 85°C (185°F) and let swell for 10 minutes.
2. Agitate at 85°C (185°F) until completely dissolved, allow to cool to 60°C (140°F).
3. At the same time, reconstitute WPC in the remaining formula water at ambient temperature with a high-speed mixer, add cream and let hydrate for 20 minutes with little agitation.
4. Add WPC solution to stabilizer solution and add sweetener, flavor and colors.
5. Use 85% solution of acid to adjust pH to 3.8.
6. Homogenize: first stage at 250 Bar (24.82 MPa, 250 kg/cm² or 3600 psi) and second stage at 48 Bar (4.82 MPa, 49 kg/cm² or 700 psi).
7. Heat to 88°C (190°F) for 45 seconds. Cool to 24°C (75°F).
8. Fill containers and cool to 4°C (40°F).

Nutritional Content per 100 grams

Calories	30 kcal
Total Fat	1 g
Saturated Fat	0.5 g
Trans Fat	0 g
Cholesterol	5 mg
Sodium	15 mg
Total Carbohydrate	2 g
Dietary Fiber	0 g
Sugars	0 g
Protein	4 g
Vitamin C	3.6 mg
Vitamin B_1	0.02 mg
Vitamin B_2	0.05 mg
Calcium	24 mg

Juice Drink with WPC 80

Ingredients	Usage Level (%)
Water	79.57
Granulated sugar	8.33
WPC 80	5.20
Juice concentrate, peach	5.09
Pectin	1.30
Milk calcium	0.31
Phosphoric acid	0.20
Total	**100.00**

Procedure:

1. Hydrate stabilizer and sugar in half of the formula water at 85°C (185°F) and let swell for 10 minutes.
2. Agitate at 85°C (185°F) until completely dissolved, allow to cool to 60°C (140°F).
3. At the same time, reconstitute WPC and milk calcium in remaining formula water at ambient temperature with a high-speed mixer and let hydrate for 20 minutes with little agitation.
4. Add juice, WPC and milk calcium solution to stabilizer solution.
5. Use 85% solution of acid to adjust pH to 3.8.
6. Homogenize: first stage at 250 Bar (24.82 MPa, 250 kg/cm² or 3600 psi) and second stage at 48 Bar (4.82 MPa, 49 kg/cm² or 700 psi).
7. Heat to 80° (175°F) for 45 seconds. Cool to 24°C (75°F).
8. Flavor with juice concentrate and add colors for desired tint.
9. Fill containers and cool to 4°C (40°F).

Nutritional Content per 100 grams

Calories	70 kcal
Total Fat	0 g
Saturated Fat	0 g
Trans Fat	0 g
Cholesterol	0 mg
Sodium	20 mg
Total Carbohydrate	12 g
Dietary Fiber	0 g
Sugars	11 g
Protein	4 g
Vitamin C	9 mg
Vitamin B_1	0.02 mg
Vitamin B_2	0.05 mg
Calcium	96 mg

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