U.S. WHEY INGREDIENTS IN NUTRITION BARS AND GELS

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The nutraceutical confectionery market enjoys double-digit growth and product diversification continues to make this category strong and exciting. Diversification occurs in many areas including forms, products and ingredient benefits. The most recent growth was found in bar, gel and paste products formulated with higher levels of protein, including whey proteins. These products offer unique nutritional benefits to both general or "casual snacker" consumers, as well as those with specific health, diet, energy or sports focus.

This monograph reviews the processing conditions and formulations of nutraceutical confectionery products, including nutrition bars, their coating, and energy gels and pastes.

Whey proteins are essential ingredients in nutrition bars and they are emerging as key ingredients in energy gels and pastes. The mild flavor of whey protein ingredients makes them compatible with a wide variety of flavors and guarantees high consumer acceptability. Recent advances in U.S. whey protein ingredients allow nutraceutical manufacturers to create products with increased protein levels, better/cleaner taste, superior texture stability and a longer shelf life.

For example, protein bars' quality and shelf life have benefited by the introduction of specialized hydrolyzed whey protein mixes.

The use of whey proteins in sports and snack products delivers the nutrients shown to positively affect body composition. Research has demonstrated that whey proteins are critical for muscle recovery and growth. They are also one of the very few ingredients shown to modulate the immune functions.

NUTRITION BARS

Nutrition bars can be manufactured cold or baked. The cold-manufactured bars are made using either an extrusion process or binders (sugar syrups) that allow the bar components to stay together in a set shape. The bars' texture ranges from that of granola cereal to chewy nougat. Often, bars will be coated in chocolate or other flavors. Whey proteins are key elements in the formulation of sports and snack bars given their functionality and excellent nutritional characteristics. The characteristics of the ingredients used, as well as the desired eating qualities, will determine the processing conditions chosen for manufacturing a bar. Processing conditions and formulations are discussed in the following sections.

COLD-PROCESSED BARS

EXTRUDED BARS

Extruded bars represent one of the most common type of bars available on the market. These bars are formulated to be cold-extruded, and then are often coated with a compound or chocolate coating.

The bar itself typically contains:

- Protein ingredients, oils, flavors, nuts or other inclusions; vitamins and minerals are often included.
- Other carbohydrates and/or fibers to add bulk and/or reduce calories.
- A combination of sugar syrups and sugar alcohols to keep the water activity below 0.60, to avoid mold or bacterial issues, and help keep the texture of the bar soft throughout its shelf life.
- Glycerin, a common ingredient in all high-protein bars, helps to reduce water activity, keeps the dough pliable and less sticky and helps to maintain bar softness during shelf life.

The ingredients are mixed together to form a dough. Usually, mixers will be jacketed to control temperatures and to keep the dough at a consistency that minimizes stickiness and retains softness for ease of extrusion. The dough is then placed in the hopper of the extruder for forming. As the dough is extruded out in a rope, it is usually rolled and then cut to size. The bar sometimes goes through a drying and coating process before it is individually packaged. This type of bar can be expected to have a shelf life of up to 1 year. Good formulation and packaging are critical to help maintain optimal taste and texture during shelf life.

High-Protein Bars

This category of bars contains the highest levels of protein found in any bar. Commercial bars are available with up to 50% protein. The challenge lies in delivering a high level of protein in a bar that also has good taste and texture. Whey ingredients like whey protein isolate (WPI), whey protein concentrate with 80% protein (WPC 80) and whey protein hydrolysate (alone or in combination with other milk and vegetable proteins) are common. A bar containing a combination of WPI and whey protein hydrolysate will help to maximize the protein levels and minimize bar hardening, which often occurs in high-protein bars. Because the hydrolyzed whey proteins do not tend to draw moisture away from the other ingredients in the bar, adding a small amount of whey protein hydrolysate (2-20%) will help to improve the shelf life by maintaining a softer texture. Many U.S. whey ingredient manufacturers have specifically designed their hydrolyzed whey protein ingredients for bar applications. Please consult your U.S. supplier for more information.

Whey protein hydrolysates also offer the benefits of enhanced absorption in the body because they are somewhat pre-digested. Hydrolyzed proteins offer other nutritional properties such as reducing blood pressure. A detailed description of the health benefits of whey proteins is presented in the USDEC nutrition monograph "*Health Enhancing Properties of Whey Proteins and Whey Fractions*," available at www.usdec.org.

U.S. Whey Ingredients Composition and Advantages in Bar Applications

Whey Ingredient	Protein (%)	Carbohydrate (%)	Fat (%)	Minerals (%)	Advantages
WPI	90-92	0.5-1	0.5-1	2-3	• Highest protein levels • Lowest levels of lactose and fat
WPC 80	80-82	4-8	4-8	3-4	• High levels of protein • Low levels of lactose and fat
WPC with 34 to 79% protein and modified WPC	34-79	Varies	Varies	Varies	• Cost-effective option to add functional and nutritional ingredients • Clean label
Hydrolyzed whey protein (HWP) and blends of HWP, WPC and WPI	80-92	Varies	Varies	Varies	• Improves shelf life and raises the protein level • Clean label • Faster protein absorption and digestibility
Extruded whey proteins (whey crisp)	40-80	Varies	Varies	Varies	• Adds textural variety • Equilibrates moisture over time
Dairy calcium and milk minerals	1-8	1-6	<0.5	76-77.5	• Excellent source of calcium • Balanced mineral blend
Nonfat dry milk	34-37	49-52	0.6-1.25	8.2-8.6	• Clean flavor and label • Excellent nutrition
Lactose	0.1	99-100%	0	0.1-0.3	• Limited sweetness • Synergistic effect on flavor and color development • Lower glycemic index carbohydrate

High-Protein Bar: Berries

Ingredients	Usage Level (%)
WPI and whey protein hydrolysate	32.3
Maltitol	13.0
Glycerin	13.0
Cocoa butter	7.8
Whey crisp (50% protein)	5.2
Rolled oats	4.5
Dried apples	4.5
Rice protein	2.5
Inulin	1.3
Masking flavor	0.6
Strawberry flavor	0.5
Chocolate compound coating	14.8
Total	**100.0**

Procedure:

1. Melt cocoa butter and mix with glycerin, maltitol and flavors.
2. In a separate bowl, dry blend all remaining ingredients except the whey proteins and compound coating.
3. Combine liquid mix from step 1 and dry blend from step 2 until well blended.
4. Mix in the WPI and whey protein hydrolysate until wet, being careful not to over mix.
5. Roll out and cut into bars or extrude.
6. Coat with chocolate compound coating (see formula in the coating section of this monograph).

Nutritional Content per 100 grams

Calories	400 kcal
Total Fat	12 g
Saturated Fat	6 g
Trans Fat	0 g
Cholesterol	0 mg
Sodium	280 mg
Total Carbohydrate	36 g
Dietary Fiber	2 g
Sugars	14 g
Protein	36 g

Formula courtesy of Glanbia Nutritionals USA.

Balanced Nutrition Bars (40-30-30)

A 40-30-30 bar is formulated to provide 40% of its calories from carbohydrates, 30% of its calories from fat and 30% of its calories from protein. These bars first became popular in the 1990s with the introduction of the Zone Diet, developed by Dr. Barry Sears. Whey proteins are used in the majority of these bars commercially. Whey protein isolate (WPI), whey protein concentrate with 80% protein (WPC 80) and whey protein hydrolysate are all commonly used. Other modified whey sources such as high-fat WPCs could also be used in this bar type. They would contribute typically 60-80% protein and provide up to 15-20% fat, primarily phospholipids from milk. The added fat provided through the use of these ingredients will reduce the need to add other fats and oils in the bar to meet the 30% of the calories from fat requirement. Since 30% of the calories from protein translates into about 15 grams of protein in a 50 gram bar, the protein level is considered more moderate than the high-protein bars.

40-30-30 Bar: Peanut Butter

Ingredients	Usage Level (%)
High fructose corn syrup	33.0
WPI	25.0
Whey protein hydrolysate	12.0
Sugar	6.0
Honey	6.0
Canola oil	5.0
Ground peanuts	5.0
Peanut butter	5.0
Roast peanut extract	1.0
Peanut flavor	1.0
Liquid vanilla extract	1.0
Total	**100.0**

Procedure:

1. Mix high fructose corn syrup, honey, oil and flavor extract at low speed for 3 minutes.
2. Add remaining ingredients except chopped peanuts. Mix for 5 minutes.
3. Blend in chopped peanuts.
4. Press the protein mass on a tray before cutting or extrude the dough.
5. Enrobe protein bar with compound chocolate (20% coating by weight).
6. Pack and seal.

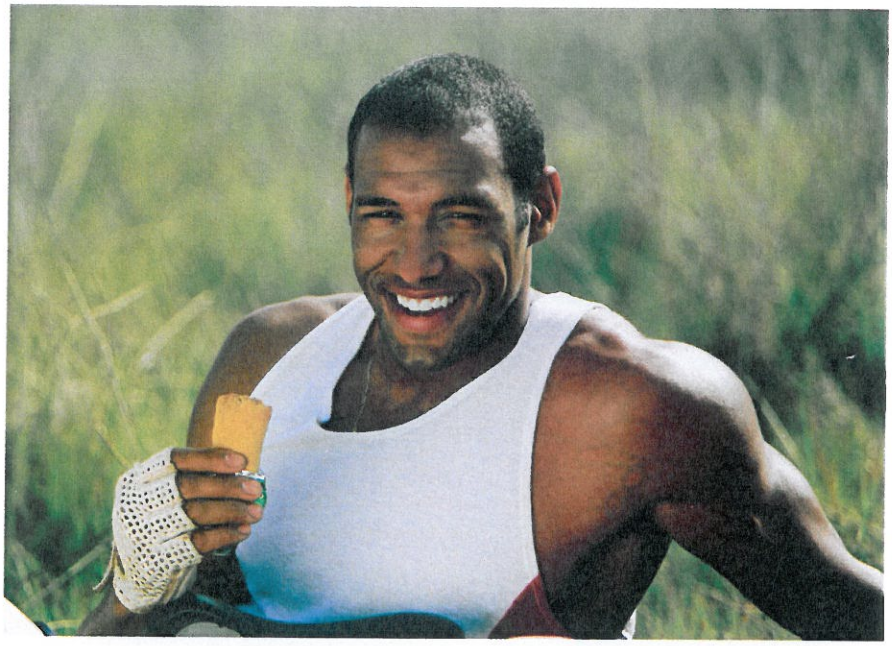
Nutritional Content per 100 grams
Coated bars: 80% filling, 20% coating

Calories	420 kcal
Total Fat	15 g
Saturated Fat	3 g
Trans Fat	0 g
Cholesterol	0 mg
Sodium	30 mg
Total Carbohydrate	43 g
Dietary Fiber	1 g
Sugars	40 g
Protein	30 g

Low-Carbohydrate Bars

Low-carbohydrate bars are formulated to maximize protein and minimize carbohydrates. These bars are often very similar to the high-protein bars and balanced nutrition bars in term of protein level; however, they use high levels of fiber and sugar alcohols, in combination with non-nutritive sweeteners, to achieve the desired "net carbohydrate" level and sweetness. Examples of commonly used sugar alcohols are maltitol, sorbitol, xylitol, lactitol and erythritol. Although it is not approved by the U.S. Food and Drug Administration (FDA), the "net carb" approach – figuring the total carbohydrate level and subtracting the amount of fiber and sugar alcohol from the total carbohydrates – has been a common practice in the industry. Fibers and sugar alcohols will also contribute fewer calories to a formulation than a typical carbohydrate. Fibers usually contain less than 0.5 kcal/g and sugar alcohols contain between 0.2-3 kcal/g.

The sugar alcohols are also added to help to keep the water activity low. Even with this reduced water activity, bar stability and textural changes reduce the product's shelf life and consumer acceptability. While various methods exist to lessen this effect, the Center for Dairy Research at the University of Wisconsin-Madison made a recent discovery. The addition of sodium polyphosphate at 0.3% to the basic formula of a low-carbohydrate bar significantly increased shelf life stability by maintaining the softness of the bar over a 4-month period.



Low-Carbohydrate Bar: Chocolate

Ingredients	Usage Level (%)
WPI	30.1
Maltitol syrup	24.8
Vegetable shortening	14.8
Plum paste	13.2
Milk minerals	5.5
Cocoa powder, dutched	3.5
Almond meal	3.5
Crystalline sorbitol	1.6
Water	1.5
Oat fiber	0.5
Glycerin	0.5
Sodium polyphosphate	0.3
Salt	0.2
Total	**100.0**

Procedure:

1. Place dry ingredients in a mixing bowl and dry blend for 30 seconds.
2. Add shortening, glycerin and plum paste and mix on the lowest speed for 3 minutes or until evenly mixed.
3. Add phosphate to formula water to solubilize.
4. Pour maltitol syrup, then phosphate solution over this mixture and mix until the product comes together to form a soft dough (approximately 2 minutes).
5. Sheet dough to 10 mm (0.4") thick. Cut into bars 3 x 7 cm (1.2 x 2.8").
6. Coat with bittersweet chocolate or low-carb compound coating, removing excess. Place at 5°C (40°F) and allow coating to set.

Nutritional Content per 100 grams
Coated bars: 70% filling, 30% coating

Calories	430 kcal
Total Fat	23 g
Saturated Fat	4 g
Trans Fat	0 g
Cholesterol	0 mg
Sodium	70 mg
Total Carbohydrate	41 g
Dietary Fiber	3 g
Surgars	14 g
Sugars Alcohols	18 g
Protein	23 g

Whey Proteins Functionality

Whey proteins offer numerous functional benefits to food formulators. Some of the functional properties associated with whey proteins include high solubility, water-binding, gelation or thickening, foaming, emulsification, flavor and color generation.

The functional characteristics of whey proteins need to be considered when developing food applications. For example, some of the color and flavor attributes are obtained during the Maillard reaction. This reaction occurs between a reducing sugar (in this case lactose) and an aminio acid (from the whey proteins) and usually requires the addition of heat. The Maillard reaction contributes to the golden-brown color obtained during baking or cooking, as well as the sweet caramelized flavor notes associated with baked products and caramel confections.

SOFT OR HARD CHEWY BINDER GRANOLA CEREAL BARS

The commercial bars that fit into this category are characterized by their textural appeal. They are formulated using grains like oats and rice crisps, along with nuts and/or other inclusions, and are held together by sugar syrups such as brown rice, honey or corn syrups. Like the other cold-extruded bars, granola bars also need to be formulated to a water activity below 0.60.

A typical granola bar has about 6-7% protein. A granola bar with added protein might have up to 30% protein. To maintain the crunchy texture with the added protein, extruded whey protein commonly referred to as whey crisp can be substituted for the rice crisp products. The extruded whey crisp can contain as high as 80% protein. The protein contribution of whey crisp in bars can be shown by comparing the protein level in a bar made with 100% rice crisp against a bar made with 100% whey crisp (with 80% protein); the 3% protein level of the bar increases to 23% protein by using whey crisp. Other high-protein whey ingredients such as WPI or WPC 80 could also be added to increase the protein level to 30%.

High-Protein Granola Bar: Whey Good Bar

Chewy Granola Bar

Ingredients	Usage Level (%)
Granola cereal	35.4
Whey crisp 50%	18.4
Corn syrup 62/43	10.0
High maltose rice syrup 42 DE	6.6
Invert sugar syrup	5.3
Vegetable oil	5.4
WPI and whey protein 5.1 hydrolysate mix	
Dry roasted whole almonds	2.7
Corn syrup solids 25 DE	2.6
Sorbitol USP	2.4
Water	2.2
Honey	1.1
Dairy calcium	0.9
Dried coconut, unsweetened	0.8
Nonfat dry milk	0.8
Salt	0.2
Bourbon vanilla extract	0.1
Total	**100.0**

Caramel Layer

Ingredients	Usage Level (%)
Corn syrup 42\43	30.7
Sugar, granulated	24.9
Water 1	18.5
Water 2	6.4
Butter, lightly salted	6.2
Dairy calcium	6.2
WPC 34	6.0
Soybean lecithin oil	0.5
Salt	0.4
Flavors (caramel, dairy and vanillin)	0.2
Total	**100.0**

Bar Ratios

Chewy granola bar	53.8%
Caramel layer	23.1%
Milk chocolate coating	23.1%

Procedure:

Chewy Granola Bar

1. Combine granola cereal, coconut, almonds, whey crisp, dairy calcium and mixture of WPI and whey protein hydrolysate.
2. Combine remaining ingredients, except vanilla.
3. Heat syrup to 88°C (190°F).
4. Add cooked syrups to the dries in a mixer, add the vanilla extract and coat until uniform.
5. Compress into a 1.4 cm (0.6") thick sheet that is 31 x 45 cm (12 x 18") and cool.
6. Apply caramel to granola base at 23% (see caramel formulation).
7. Cut into bars 3.18 x 10.16 cm (1.3 x 4") to a weight of 45 grams.
8. Enrobe with milk chocolate to a weight of 60 grams or 23% chocolate.
9. Package.

Caramel Layer

1. Mix WPC 34 in water 1.
2. Combine corn syrup, sugar, butter, lecithin oil, salt, water 2 and a quarter of the whey mixture.
3. Mix together for several minutes to emulsify. Bring to a boil.
4. Stir in the remainder of the whey mixture. Cook to 115°C (240°F) while stirring constantly until 83 Brix is reached.
5. Add dairy calcium and flavors; mix well.
6. Pour over granola slab at 23%. Cool.

Nutritional Content per 100 grams

Calories	415 kcal
Total Fat	15 g
Saturated Fat	7 g
Trans Fat	0 g
Cholesterol	15 mg
Sodium	208 mg
Total Carbohydrate	63 g
Dietary Fiber	2 g
Sugars	37 g
Protein	12 g

USDEC formula produced by Knechtel Laboratories.

BAKED BARS

These bars require baking to form their final texture.

The baked bar process is similar to the cold-extruded process for the mixing and forming of the bar. Many of the same ingredients are used such as sugar syrups, sugar alcohols, glycerin, oils, protein ingredients, flavors, emulsifiers, and a variety of grains, nuts, crisps and other inclusions. Like cold-processed bars, baked bars can be enrobed or coated with flavored chocolate or compound coatings after they cool.

The main difference between the cold-processed and baked bars is the moisture content of the dough. In the baked bars the dough can have more water because much of it will be baked out. Nevertheless, in dough with added protein, it is important to minimize the water to avoid stickiness as this might make machining difficult. Minimizing mixing time is also recommended to prevent "over-working" the proteins. The texture of baked bars is shorter and drier than the cold-extruded bars, which are dense and chewy.

Baked bars are formulated much like an intermediate moisture food where the overall finished moisture can be 4-8%, but the water activity will still need to be below 0.60 to prevent yeast and mold growth. Generally, because of the protein's water-binding characteristics, it is more challenging to produce baked bars with high protein levels. WPC 80 and WPI are good sources of protein to use for baked bars. Whey crisp can also be added to raise the protein content and modify the texture of the bar.

Grain-Based Bars

Typical grain-based bars like cereal bars, breakfast bars or other snack bars have low levels of protein. However, they have the other benefits of grains such as fiber content and a "whole grain appeal." They are often high in sugar, but the fact that they are made with grains such as oats, rice and wheat give them a healthy image. A typical cereal bar is a co-extruded product having a grain-based outer dough with a fruit filling. It often contains 2.5% protein, 8% fat, 73% carbohydrate and 2.5% fiber. The addition of WPI or WPC 80 to the outer dough could potentially raise the protein level of the finished bar to 8-10% and reduce the carbohydrates by an equivalent amount.

Breakfast bars are another form of grain-based bars high in carbohydrates that could benefit from added whey protein. A typical breakfast bar contains 6% protein, 10% fat, 74% carbohydrate and about 6% fiber. When compared with typical cereal bars, breakfast bars have additional protein because they lack a fruit filling and they often contain dairy ingredients and/or nuts, which contribute to the protein content. The addition of whey crisp, WPI, WPC 80 or other modified whey protein ingredients will help to add additional protein and increase the nutrient density of a bar designed as breakfast or meal replacement. A formula is presented illustrating the ingredients and procedures to make this type of grain-based baked bar.

Grain-Based Bar:
Dulce de Leche Oatmeal

Ingredients	Usage Level (%)
Corn syrup 42 DE	26.1
Whey crisp (60% protein)	16.7
Rolled oats, "old-fashioned"	12.5
Rolled oats, "quick"	12.5
Caramel bits, fat-based	8.5
Apple-based fat replacer	7.7
WPI	5.7
Water	4.5
Butter, unsalted	4.0
Glycerin	0.9
Flavor, dulce de leche	0.8
Sodium bicarbonate	0.1
Total	**100.0**

Procedure:

1. Combine oats, fat replacer, sodium bicarbonate and WPI in the bowl of a large mixer. Mix on low for 1 minute.
2. Add corn syrup, butter, dulce de leche flavor, glycerin and water. Mix on low for 1 minute.
3. Add whey crisp and caramel bits, and mix briefly (just until mixture is combined).
4. Sheet dough to 10 mm (0.4") and cut into 7.5 x 3.75 cm (3 x 1-1/2") pieces. Place on parchment-lined pans so they are not touching one another.
5. Bake in reel oven at 204°C (400°F) for 7 minutes.

Nutritional Content per 100 grams

Calories	350 kcal
Total Fat	8 g
Saturated Fat	5 g
Trans Fat	0 g
Cholesterol	10 mg
Sodium	75 mg
Total Carbohydrate	54 g
Dietary Fiber	2 g
Sugars	18 g
Protein	19 g

BAR COATING

Compound coatings can add flavor, texture and stability to bars. Typical compound coatings are selected because of their health benefits, cost and ease of handling.

Chocolate flavored coatings are most popular, but vanilla, peanut butter, caramel and yogurt flavored coatings are also common. Coatings typically contain cocoa, fractionated vegetable oils, sugar, soy lecithin and flavors.

Presently, compound coatings formulated with no or zero trans or hydrogenated fats are popular because of their health appeal. These coatings are new and some processing and handling difficulties are still being experienced. A simple substitution of the new fats into the older formulation is generally not possible because the new fats do not perform as well and/or taste as good as the traditional ones.

Most dairy or milk type compound coatings contain approximately 3-7% protein. If higher protein levels are desired, the best whey protein ingredients to maximize protein in a coating are WPI and WPC 80. While they can be easily incorporated without affecting the coating's physical properties, their moisture levels and particle size may cause viscosity and/or textural changes (grittiness). WPI or WPC 80 should be added prior to refining and viscosity adjustments.

If a formulator's interest is just developing a good flavored coating, then using ingredients such as sweet whey, deproteinized whey and/or demineralized whey are good options. Depending on existing cost parameters, any of these ingredients will offer benefits to a bar coating. Demineralized whey has the mildest flavor of these ingredients due to its lower mineral content. This ingredient is widely used in chocolate and other flavored coatings. The lactose provides good crystallization properties and a smooth mouthfeel in the finished product. Sweet whey can also be used in coatings to provide more dairy flavor with the benefits of lactose crystallization and a smooth mouthfeel. Deproteinized whey is a newer ingredient for coatings. Coatings often will not need the protein found in sweet whey or demineralized whey, so the composition of deproteinized whey works well. A formula made with sweet whey can often be converted to deproteinized whey because the main difference in composition will be the lack of protein in the deproteinized whey.

Coatings are discussed in greater detail in the USDEC applications monograph *"Whey Products and Lactose in Confectionery Applications,"* available at www.usdec.org.

Protein Fortified Chocolate Compound Coating

Ingredients	Usage Level (%)
Sugar	43.9
Vegetable fat, 38°C (100° F)	40.0
WPI	7.6
Dutched cocoa 10/12 powder	7.6
Sorbitan tristearate	0.5
Soy lecithin	0.2
Vanilla extract (dry)	0.1
Flour salt	0.1
Total	**100.0**

Procedure:

1. Melt fat (not over 38°C (100°F)) and mix in lecithin and sorbitan tristearate.
2. Combine dry ingredients in Hobart mixer.
3. Add enough fat to mixture to make a refiners paste.
4. Refine on three-roll refiner (three passes) to a particle size below 25 microns.
5. Place fines back into Hobart and use a mantel for heat. Conch coating for 4 hours at a temperature not above 66°C (150°F).
6. Add remaining fat to coating.
7. Add any flavors desired.
8. Place into chocolate melter not above 54°C (130°F).

Nutritional Content per 100 grams

Calories	580 kcal
Total Fat	42 g
Saturated Fat	26 g
Trans Fat	0 g
Cholesterol	0 mg
Sodium	45 mg
Total Carbohydrate	48 g
Dietary Fiber	2 g
Sugars	43 g
Protein	9 g

Note: A yogurt compound coating can be created using 7-9% dry powdered yogurt instead of cocoa powder and 3-8% levels of WPI. *Fat and sugar levels adjusted to suit tastes and process conditions.*

Chocolate Coating with Deproteinized Whey (Permeate)

Ingredients	Usage Level (%)
Powdered sugar	44.00
Cocoa butter	26.35
Chocolate liquor	15.00
Whey permeate	14.40
Soy lecithin	0.15
Vanillin	0.05
Flour salt	0.05
Total	**100.00**

Procedure:

1. Melt cocoa butter (not over 38°C (100°F)) and mix in lecithin.
2. Melt chocolate liquor.
3. Combine dry ingredients in Hobart mixer and add melted chocolate liquor.
4. Add enough fat to mixture to make a refiners paste.
5. Refine on three-roll refiner (three passes) to a particle size below 25 microns.
6. Place fines back into Hobart and use a mantel for heat. Conch coating for 4 hours at a temperature not above 66°C (150°F).
7. Add remaining fat to coating.
8. Add any flavors desired.
9. Place into chocolate melter not above 54°C (130°F).

This chocolate coating must be tempered before use.

Nutritional Content per 100 grams

Calories	530 kcal
Total Fat	35 g
Saturated Fat	20 g
Trans Fat	0 g
Cholesterol	0 mg
Sodium	260 mg
Total Carbohydrate	59 g
Dietary Fiber	0 g
Sugars	54 g
Protein	3 g

Standard of Identity

In the U.S., chocolate is a "Standard of Identity" product and formula modifications are somewhat limited or prohibited. Please verify country specific regulations. Also, chocolate requires special processing parameters during its enrobing processes (tempering).

NUTRITION GELS AND PASTES

As the nutraceutical market matures, it continues to create new and novel products for its loyal consumers. While bars dominate the market, new forms such as gels, pastes or jellies are being offered to capture the "on-the-go" consumer. These delivery systems provide a fast-acting, easy to digest source of nutrients.

Depending upon the market and product composition, these new gel products are consumed in lieu of drinks, energy bars, or as a meal replacement or supplement. Because of the convenient format (small, easy to carry and consume), these products are a popular sports or outdoors nutrition item.

All of the new gel products provide more energy (calories) per ounce than sports drinks and are easier to digest than solid bar items. They are generally an aqueous blend of simple and complex carbohydrates, protein, vitamins and minerals. Their density allows them to frequently deliver the same nutrient load as a small snack or meal replacement bar, offering these benefits in a convenient format.

Because of their convenience and versatility, gels are becoming the ultimate fast food, meal replacement or supplement – depending upon their composition and consumer target.

Recent studies have shown that endurance athletes report feeling a "boost" in energy as quickly as 5 minutes after consuming these types of products. If consumed every 30 to 45 minutes during longer training sessions and races stretching past 60 minutes, these products seem to help delay muscular fatigue, raise blood sugar level and enhance performance. Proteins in these products have been shown to help minimize muscle damage, improve endurance and aid in recovery.

Gel Properties

Under specific conditions, whey proteins form non-reversible gels. Gel characteristics depend upon the protein concentration, the pH of the solution, calcium and sodium ion concentration. Manufacturers of snack/sports gels may wish to obtain products with different visual appeal and texture. The simple modification of a few production parameters will allow various levels of whey proteins to be incorporated and different product characteristics to be reached.

For example, gels formed in solutions with 3-5% protein and at a temperature of 55-70°C (131-158°F) tend to be more translucent and softer. More opaque gels are formed when higher protein concentrations (10%) are heated to higher temperatures (90-100°C (194-212°F)). In acidic conditions, gels tend to be opaque, wet and weak. In neutral and higher pH solutions, gels tend to be more translucent and elastic. The nature of the gel can also be modified by changing the type of sugar used in the formulation. In an experiment, WPI gels were prepared from solutions containing ribose or lactose at pH values ranging from 6 to 9. The gels with added lactose had no color development, whereas those with added ribose were orange/brown. Furthermore, carbohydrates which favor the Maillard reaction and the covalent cross-linking of proteins may increase the gel fracture modulus, thereby having an affect on the mouthfeel and stability of the gel.

The gel properties can be manipulated to suit an individual manufacturer's needs by modifying the process conditions and varying the formulation. The unique gelling properties of whey proteins are useful to manufacturers of gels who wish to incorporate as much protein as possible per volume unit to maximize the nutritional impact of the product.

U.S. Dairy Export Council®

Managed by Dairy Management Inc.™

Published by U.S. Dairy Export Council®
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