Defining Clean Label

The food industry has done a wonderful job developing products that meet the needs of consumers. We have never had such a great variety of convenient, affordable and easy-to-prepare consumer food products. Years of research led to the creation of new ingredients and processes that helped make our food safer, longer lasting and capable of being stored from ambient temperatures to frozen, always ready to be prepared at any point in its shelf life. Now prepared foods taste good and have an appealing texture and appearance. Yet, these technological advancements also created processed foods with long lists of unfamiliar ingredients. If you are a food scientist, you could tell consumers the purpose of each ingredient. You also could tell them a food company doesn’t typically use unnecessary ingredients because it is interested in controlling costs and not having to purchase more ingredients or add to its list of approved suppliers. At the end of the day, though, the industry needs to make it easier for consumers to understand food product ingredients.

More consumers today read ingredient legends on food products. They are more aware of what they eat and how food contributes to a healthy lifestyle. Clean label has no clear definition. However, it’s one of the top five U.S. food and drink market trends listed by Mintel in 2015. Products with a clean label typically mean foods with fewer ingredients, and those ingredients are easy to understand and don’t have chemical-sounding names. It also suggests the food does not contain preservatives or artificial flavors, colors or sweeteners. Clean label also implies the foods are not processed or minimally processed. To some people, it could even include the use of only nongenetically modified organisms (GMO) or organic ingredients. Even specific ingredients, such as high fructose corn syrup and hydrogenated oils, have been targeted in recent years. It is common to see products that are “free from” these sugar and fat sources to emphasize they are clean label. Clean-label trends align with knowing where your food comes from, buying local and purchasing less processed food.

Many products already considered healthy by consumers are some of the first products to follow this trend. One of these products is breakfast cereal. Many breakfast cereals already are clean label, but children’s cereals can contain artificial colors and flavors to achieve the flavor and color intensity that attracts children. Major breakfast cereal manufacturers now are removing artificial colors and flavors to meet the needs of consumers who are concerned about these. Breakfast cereals are just one example of numerous food and beverage segments targeting the clean-label trend. Each of these applications can capitalize on this trend through incorporating more dairy ingredients.
Simplicity of Milk

Milk could be classified as one of the cleanest foods sold to consumers today. It has no additives other than vitamins A and D, and, in pasteurized form, it is minimally processed. Milk has been used as an ingredient in foods for centuries, in everything from soups, sauces, salad dressings, casseroles, cookies, cakes, breads, puddings, confections and, of course, cheese, yogurt and ice cream. It contributes carbohydrates, proteins, fats and minerals that provide functionality, flavor and nutrition to all of these foods. With the development of drying technology, it became even easier to use milk as an ingredient because its shelf life was extended from a few weeks to two years. Nonfat dry milk (NFDM) is the milk ingredient that became more practical to use on an industrial scale.

As the dairy industry advanced and cheese production grew, whey could be dried to produce an ingredient that also could be used in food. Whey ingredients provided many of the same nutrients and some of the same functionality at a lower cost than NFDM. Once membrane filtration was developed, whey protein concentrates (WPC) became available. It was no accident that WPC34, the first WPC introduced, had 34% protein, the same level of protein in NFDM. WPC34 soon became a lower-cost substitute for NFDM.

FIGURE 1. CHEESE & WHEY PRODUCTION

We now have even higher-protein WPC and whey protein isolates (WPI) and a similar list of protein ingredients made from milk called milk protein concentrates (MPC) and milk protein isolates (MPI). All of these dairy ingredients are made through simple filtration processes that concentrate the proteins and remove the lactose and minerals through their differences in molecular weight, followed by evaporation and spray-drying. The lactose and mineral stream from these processes can even be dried into whey or milk permeate or purified lactose. These manufacturing processes are considered physical separations and so could be categorized as clean label by most consumers.

## Dairy Nutrition

When it comes to nutrition, there are few food options that rival dairy ingredients. Two types of dairy proteins, caseins and whey proteins, are considered to have the highest protein quality of all food proteins. Both proteins are rich in essential amino acids, and whey proteins are known to have high levels of the branched chain amino acids: leucine, isoleucine and valine. Fat is a necessary part of the daily diet, and milkfat supplies essential vitamins, minerals and fatty acids for the body. Milkfat contains vitamins A, D, E and K. In the past, milkfat was criticized for its saturated fat content. Although additional research is underway and more research needs to be done, recent evidence has indicated that not all saturated fatty acids are associated with risk for cardiovascular disease. Instead, emerging research suggests that some fatty acids found in dairy are linked to a reduced risk for heart disease.

Milkfat is available in many forms, such as butter, cream, dried cream and anhydrous milkfat. The lactose in milk is a carbohydrate source that provides energy like other sugars, but with a lower glycemic index. The vitamins and minerals found in milk and many dairy ingredients, such as calcium, magnesium, potassium and phosphorus, also provide important nutrients for the daily diet.
Functionality of Dairy

Due to its unique composition, dairy ingredients have multiple functionalities. Dairy proteins have the ability to provide properties such as whipping, emulsification, gelation, water binding, solubility and browning. Milkfat has its own set of functional properties, such as creaming, whipping, layering, shortening and flavor. Lactose behaves like sucrose with its ability to melt and recrystallize, but it is 60% less sweet than sucrose. It also is a humectant and contributes to Maillard browning when combined with protein. The minerals in dairy ingredients are especially functional in the formation of acid gels with casein, such as cheese and yogurt. All of these properties contribute to the flavor, function and nutrition of the finished food product. It is important to understand how dairy ingredients can function in different food categories to help achieve their full potential as a clean-label ingredient.

Using Dairy for Clean Label

There are clean-label opportunities for dairy ingredients in bakery products, beverages, dairy products, desserts, soups, sauces and prepared dinners. For example, dairy ingredients serve as good substitutes for hydrogenated fats, chemical emulsifiers or less clean label-friendly carbohydrates across each of these applications.

Bakery Products

**FAT FUNCTIONALITY**

Many bakery products use hydrogenated oils (shortening) as their source of fat. Hydrogenated oils were invented in the early 1900s and gradually replaced butter and lard as the fat source of choice for bakery products.\(^8\)

Since that time, the healthfulness of fats and oils has continued to evolve with the reformulation of tropical oils, such as coconut and palm kernel oil 25 years ago. The new formulation removed saturated fat content and replaced it with “healthy fats” derived from vegetable oils. These hydrogenated vegetable oils were able to replace the functionality of tropical oils in baked products and confections, but they, too, fell under scrutiny.

Hydrogenation isomerizes a portion of the fat molecules, changing their natural cis form to the trans configuration. By 1999, trans fats were identified as a health risk because they raised total blood cholesterol levels.\(^9\) Trans fats occur naturally in animal fats, but the health news has changed as it relates to milkfat. Although additional research needs to be performed, emerging research indicates that there is no association between heart disease and consumption of dairy products.\(^6\) Studies also have shown that people who consume high-fat dairy products are no more likely to develop cardiovascular disease or Type 2 diabetes than those consuming low-fat dairy products.\(^10\) Many researchers also believe that high-fat dairy products are less likely to contribute to obesity than low-fat dairy products.\(^10\) Because many bakery products had butter origins, it should be easy to switch back to formulating with butter.

Butter has a standard of identity and must contain a minimum of 80% milkfat.\(^11\) The remaining portion is water, nonfat milk solids and salt. Because of this composition, butter is not a 1-to-1 replacement for partially hydrogenated
vegetable oil, which is 100% fat. The melting characteristics and crystallization behavior of fat are used as predictors of functionality in the food industry. Butter has a range of high, medium and low melting fats that give it its unique functionality and flavor. One of butter’s best attributes is its flavor, and this is the one attribute that has been difficult to replicate in margarines or with a combination of shortening and added butter flavors. Most baked products — especially pastries, cookies, cakes and breads — benefit from the flavor, functionality and clean label of butter.

**IMPROVING TEXTURE, FLAVOR AND APPEARANCE**

For decades, dry milk and whey products have been used in the baking industry to provide multiple functionalities, such as browning, water binding, egg replacement, fat replacement, nutritional enhancement and shelf-life extension. Typically, lower-protein ingredients, such as permeate or sweet whey, have been used to provide browning characteristics that contribute to a golden crust color and development of caramelized flavors. The lactose in these ingredients functions as a humectant, therefore tenderizing crumb textures. Evaluation of milk permeates in breads has shown improved crust color and softening of crumb texture. Bakeries that quit using dairy ingredients in the past turned to the addition of caramel colors and added flavors to provide a similar effect. These ingredients are not as clean label as dairy. Higher-protein ingredients, such as WPC, have been used for fat replacement, egg replacement, moisture retention and shelf-life extension. WPC has been evaluated in breads and frozen dough products, and improvements in gluten structure and water binding have been found with heat-modified WPC products.

Fermented skim milk, buttermilk and acid whey have helped reduce staling in bread products. Many other ingredients, such as modified food starches, emulsifiers and hydrocolloids, have similar functions in baked products, but without the clean-label appeal. In protein bar applications (cold-extruded), whey protein hydrolysates have been used to reduce bar hardening over time while also contributing valuable whey protein. Less clean label-friendly ingredients that contribute similar properties to reduce bar hardening include emulsifying salts and sugar alcohols, such as glycerol or maltitol.

Cheese is a dairy ingredient that isn’t always associated with baked products, but it is important to products such as cheesecake, cheese pastry, cheese bread and cheese crackers. Natural cheese is used for its flavor and functionality, and, with an ingredient legend that only contains milk, cultures, coagulant and salt, it is perfect for clean label. Cream cheese provides a soft, creamy texture and tart flavor to cheesecake and cheese fillings. Modified food starch and cream cheese flavors would be part of the non-clean label alternative.

**Beverages**

Milk, the original clean-label dairy beverage, has been consumed for centuries. Today, we have milk and dairy ingredients used in many forms, including ready-to-drink and dry-mix beverages. No matter what the nutritional goals are for your beverage, there is a dairy ingredient that can meet your needs.
DRY MIXES

Sweet whey and dairy product solids (milk or whey permeate), among other ingredients, provide an economical source of dairy loaded with milk minerals, such as calcium, magnesium, potassium and phosphorus, perfect for a hot cocoa mix or even for a dairy-based isotonic dry mix. If protein enhancement is the goal, then either a milk protein or whey protein ingredient will work. For better dispersibility, an instantized whey protein is recommended. Making a high-protein dry mix with dairy protein is as easy as adding a clean-label sweetener and natural flavor to the protein ingredient. For a thinner, more refreshing consistency, once water is added, choose a whey protein because it will typically bind less water than a milk protein. If a thicker, more viscous beverage is desired, choose a milk protein. If a fruity beverage mix is desired and dry acids will be added to accentuate the fruit flavors, whey protein is recommended because the casein in milk proteins will lose solubility below pH 6, and once the dry mix is added to water, it might have a grainy texture.

READY TO DRINK

Ready-to-drink beverages can be pasteurized, hot filled, ultra-high temperature (UHT) pasteurized and/or retorted to ensure their safety. Whey proteins have been used in beverages under all of these conditions with varying levels of success due to their sensitivity to heat. The pH of the beverage is one of the most critical parameters when choosing between a milk or whey protein. Because milk proteins contain predominantly casein, they are the most heat-stable of the dairy ingredients, as long as the pH of the drink is above 6.0. This characteristic makes milk proteins well-designed for low-acid beverages that are UHT or retort processed. Whey proteins can be used in beverages under these conditions, but it is best when they are used in combination with a milk protein because the casein will provide a chaperone effect and give the whey protein more heat stability. Milk proteins, such as MPC, MPI or micellar casein, are good choices for low-acid beverages. Dissolving these powders in water with a high-speed mixer followed by a minimum of an hour of hydration time is important to obtain the best functionality and heat stability. For the best heat stability, it also is recommended to use a minimum of 50% of the protein as casein and maintain the pH between 6.8 and 7.0 for a low-acid beverage that will be UHT or retort processed. If hydration time and solubility are concerns, using ultrafiltered (UF) milk, sometimes referred to as liquid MPC, has been a good option for some manufacturers of high-protein beverages. UF milk has a clean dairy flavor, good functionality and heat stability. To maintain a cleaner label and avoid higher levels of buffering salts and stabilizers, use higher levels of milk proteins and minimize the addition of whey proteins under these conditions.

For high-acid beverages (pH <6.0), whey proteins are the best choice. Hot fill processing is sufficient to make a shelf-stable beverage in the acid category. Hydration is still important for good whey protein functionality in beverages, though 30 minutes is sufficient time. Whey proteins improve their solubility and heat stability as the pH is decreased below their isoelectric point range (pH 4.5-5.5). Beverages between pH 3.5 and 4.5 tend to be cloudy whether a WPC or WPI is used due to electrostatic interactions between protein molecules. Clear beverages can be achieved below pH 3.5 by using a WPI because it contains little fat, and the protein molecules have a high positive charge and lower electrostatic interactions. At this low pH, it is as simple as adding an acid, natural flavor, clean-label sweetener and maybe a natural color, to make a thirst-quenching protein drink that provides high-quality protein.

If overall nutrition is the goal for a ready-to-drink high-acid beverage, then dairy product solids are a good choice for a thirst-quenching beverage with a high mineral content. Both milk and whey permeates have been used for beverage applications, and when combined with lactose hydrolysis, provide added sweetness without added sugar. Milk mineral ingredients derived from permeates also have been developed. These can provide dairy-based calcium, magnesium, potassium and phosphorus that offer a much simpler approach to mineral fortification than the addition of ingredients such as calcium carbonate and others.
Dairy Products and Desserts

Dairy products, such as yogurt and ice cream, have standards of identity in the U.S. that include minimum amounts of nonfat milk solids.25,26 Desserts, such as pudding, do not have a standard of identity, but traditionally have been dairy-based. These products also allow other ingredients to be used as part of the total solids of the product. They include cream, nutritive and non-nutritive sweeteners, starches, hydrocolloids and emulsifiers. As costs for dairy solids have fluctuated and consumers have requested lower-fat products with longer shelf lives, manufacturers have increased their dependence on nondairy ingredients, such as starches, hydrocolloids and emulsifiers, to provide texture and texture stability. Many of these ingredients, including some sweeteners, are not considered “clean label” as per the current consumer trends.

YOGURT

Yogurt is a good example of a product that evolved to become predominantly a fat-free product that utilized modified food starch and hydrocolloids for a smooth mouthfeel and creamy texture. Combinations of heat-modified whey protein and buttermilk protein concentrates have been used to replace fat in yogurt.27 Whey proteins often have been a part of yogurt formulations to reduce the dependence on starches and hydrocolloids, when the economics made sense, to increase viscosity and reduce syneresis.28 Research using modified whey proteins showed a positive impact on water-holding capacity and viscosity when compared with the use of starch in yogurts.29,30 Whey proteins also have been compared with caseinates in yogurt and resulted in a better water-holding capacity and smoother texture.31

Clean-label yogurts are much more common today, and Greek-style yogurts are a good example of how using more dairy can provide improved body, texture and taste. Greek-style yogurts are traditionally strained yogurts that utilize Quark cheese type separators or ultrafiltration membranes to concentrate the dairy proteins while removing water, lactose and minerals. Many of the U.S. Greek-style yogurts typically have 10% protein, which is about three times the protein in a conventional yogurt. If you don’t have straining equipment, another way to achieve this level of protein is through the addition of dairy proteins, such as MPC, MPI, micellar casein, WPC or WPI. There is an industry standard defined for concentrated milk proteins, which includes MPC, MPI and micellar casein ingredients. Micellar casein will have a higher level of casein than the roughly 80% casein in an MPC or MPI.32 Micellar casein concentrates (MCC) with 58% and 88% protein have been evaluated in fortified Greek-style yogurts at protein levels of 9.8% and compared with control-strained Greek-style yogurt. The 58% protein MCC produced a yogurt with similar physical properties to the control.33

ICE CREAM

Milk and whey proteins traditionally have been used in ice cream to contribute to nonfat-milk-solids content and to replace fat, provide stabilization and enhance protein. Ice creams have increased their dependence on fewer clean-label ingredients to provide some of these same benefits at a lower cost. Ice cream has a standard of identity in the United States that defines its composition as no less than 10% milkfat and no less than 10% nonfat milk
solids. Any whey or modified whey products can contribute up to 25% by weight of the total nonfat milk solids of the finished ice cream. If the product is called a frozen dessert, there is no need to limit whey ingredient use. The current U.S. standards allow for the addition of other optional dairy ingredients such as “skim milk, that may be concentrated, and from which part or all of the lactose has been removed by a safe and suitable procedure” in a concentrated or dried form. This description would include ingredients such as UF milk, MPC and MPI. Early research on ice creams made with UF milk used at varying replacement levels of nonfat milk solids showed improved body, texture and heat-shock stability compared with ice creams made with WPC.

Whey ingredients have been evaluated and used extensively in ice cream and frozen desserts. For fat replacement, both MPC and WPC have been evaluated. WPC has worked better for fat replacement in ice cream than MPC. The proteose-peptone whey fractions have been used in combination with WPC as replacements for emulsifiers in ice cream. The results showed that the physical and sensory properties of the ice cream were as good as or better than the control with monoglycerides and diglycerides used as emulsifiers.

Whey protein phospholipid concentrate, a coproduct of WPI, and delactosed permeate, a coproduct of lactose manufacture, have been blended and evaluated in ice cream. These whey ingredient blends produced ice creams with similar mean ice crystal size, higher melt rate and reduced fat destabilization as compared with the control.

Other WPC coproducts, such as whey permeates, have been used in soft serve ice cream and other frozen desserts. MPC products with 56% and 85% protein have been evaluated as a portion of the nonfat milk solids in a standard ice cream with 11% nonfat milk solids and 12% fat without significant changes to the physical properties of the ice cream. Increasing the protein content of ice cream became popular during the low-carbohydrate diet trends of the mid-2000s. Both MPC and WPC have been researched to increase protein content from 4.9% to 7.2% in ice cream with favorable storage stability and sensory results.

PUDDING

Like other dairy-based food products that don’t have a standard of identity, pudding is an example of a product that uses many other ingredients to provide its characteristic texture. Consumers still have the opportunity to make puddings with milk and few other ingredients other than cornstarch and flavor. Refrigerated or shelf-stable puddings rely more on the addition of modified food starch, vegetable fats, emulsifiers and hydrocolloids. Like other food products developed to provide convenience at low cost, puddings have used less dairy and more ingredients that are not clean label.
Prepared Dinners, Sauces and Soups

Cheese always has been a part of products such as sauces and soups. Using less cheese and more starches, vegetable fats, cheese flavors, emulsifiers and hydrocolloids has become more common to reduce cost. It is always possible to go back to using more cheese. Today, there are hundreds of cheeses that can deliver new flavors to soups and sauces. When cheese is combined with a dairy ingredient that contributes to the water binding and mouthfeel of the product, such as MPC or WPC, a more clean-label product can be created. MPC is more heat stable and typically will bind more water than a WPC, so MPC may be the best choice in a retorted shelf-stable soup or sauce. If increased protein is a nutritional goal for a soup or sauce, then MPC80, MPI or micellar casein would be a good choice.

Prepared dinners, sauces and soups often are high in sodium, and typical sodium substitutes are not clean label-friendly. Dairy product solids provides salty characteristics that can help with sodium reduction. Up to 75% sodium reduction has been achieved with the addition of dairy product solids in many products, including soups and sauces. It is recommended to use 10 to 11 grams of dairy product solids to replace 1 gram of salt. Using this level of dairy product solids also will replace some of the other macro ingredients and, sometimes, added flavors.

Summary

Milk and all of its ingredients always have been some of the most healthful clean-label ingredients to use in food. In the quest to formulate food products with fewer ingredients that are more consumer-friendly, food scientists can turn to dairy for a diverse group of highly functional, flavorful and nutritious ingredients. The dairy industry will continue to do research to support the use of dairy ingredients in foods that consumers can be happy about eating. Visit ThinkUSAdairy.org for more information and formulations that use dairy.
References


