



Our Family's Passion is *Cheese.*

# Cheese Sauces 101

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## **Introduction to Cheese Sauces:**

Cheese sauces are a nonstandardized cheese ingredient based on natural cheese and other ingredients. The result is a consistent, flavorful and functional cheese ingredient that adds value to prepared foods.

Cheese sauces are so much more than simply melted cheese. In fact, cheese sauces are unlike any other cheese ingredient in the marketplace. Since they are nonstandardized, cheesemakers can manipulate the formulation to meet specific criteria (e.g., thick vs. thin, with variations at different temperatures; sharp vs. mild flavor profile; etc.)

Sometimes cheese sauces are very apparent in food formulations, as is the case when combined with pasta or vegetables or served on the side as a dip or condiment. Other times cheese sauces are used as a carrier of other ingredients (e.g., ham and chives in a handheld snack) or as a flavor enhancer (e.g., enchilada). Sometimes cheese sauces become a food manufacturer's signature finishing touch to prepared entrees and other ready-to-eat dishes.

There's no question that cheese is one of the most valued and versatile ingredients for adding flavor, texture, image, nutrition and fun to foods as today's consumers crave cheese in all types of foods. However, food formulators quickly learn when working with cheese that not all cheese ingredients are the same. Natural cheese can vary in moisture content, flavor, age, color, texture, acidity and many other factors. Many food formulators turn to process cheese, specifically process cheese sauces, for their ease of use, consistent smooth texture, natural cheese flavor, physical stability through abuse and phase changes and extensive variety.

The good news is that there's a cheese sauce available for almost all applications. The key is to work with the cheese sauce ingredient supplier to define specifications and ensure the cheese sauce meets all key players' expectations, that of the manufacturer, distributor, retailer and consumer.

This paper discusses how the interactions among cheese components, the use of emulsifying salts and other functional ingredients, and processing conditions (temperature, time and shear) can be manipulated to create cheese sauces with targeted cooking, flavor and textural properties. Furthermore, advancements in recent years have enabled cheesemakers to add value to cheese sauces in terms of nutritional value (e.g., lower sodium, extra calcium and no trans fats).

## Overview of Cheesemaking:

It is imperative to gain an understanding of cheesemaking in order to fully appreciate the science that goes into formulating the right cheese sauce for a specific application.

Simply, cheese is a concentrated dairy food made from milk. It is best defined as the fresh or matured (ripened) product obtained by draining the whey (moisture or serum of original milk) after coagulation of casein, the major milk protein. Casein is coagulated by acid, which is produced through the addition of select microorganisms and/or by coagulating enzymes, resulting in curd formation. Milk may also be acidified by adding food-grade acidulants, which is the process often used in the manufacture of fresh cheese.

Cheese can be made from whole, 2% reduced fat, 1% low-fat or fat-free milk, or a combination of these milks. Statistics indicate that about one-third of all milk produced each year in the United States is used to make cheese, which confirms a very strong user base.

There are more than 200 varieties of cheese produced in the United States. The different ingredients and processes employed during the making, maturing and processing of cheese result in a variety of cheeses that function as ingredients in fresh, refrigerated and frozen prepared foods. Each cheese ingredient has a distinct texture and flavor profile. They also vary in functionality and performance.

Cheeses are categorized in several ways. When it comes to functionality and performance, there is a distinct difference in cheeses described as “natural” and those called “process.” The U.S. Food and Drug Administration (FDA) defines many cheese categories and varieties in Title 21, Part 133 of the Code of Federal Regulations (CFR).

Though the category “natural” is not defined, per se, many varieties of cheese that are considered natural are standardized in the CFR. For practical purposes, natural cheeses are made directly from milk. In fresh, unripened cheese, the curd, separated from the whey, can be formed into cheese immediately (e.g., cream cheese), whereas in matured or ripened cheese, the curd may be further treated by the addition of select strains of bacteria, mold, yeast or a combination of these ripening agents (e.g., Cheddar, Monterey Jack, Swiss, etc.). The bacteria, mold and yeast continue to ripen the cheese over time, changing the cheese’s flavor and texture as it ages.

When choosing natural cheese as an ingredient, it’s important to understand how a cheese will perform in a finished product based on its age and storage conditions. Because natural cheeses are living systems, they continue to change until the all the bacteria, mold and/or yeast are inactivated, which typically occurs during heat processing.

The term pasteurized process cheese and its related terms (pasteurized process cheese food, pasteurized process cheese spread and cold pack), are standardized in the CFR. These cheeses are made by blending one or more natural cheeses into a homogenous mass, heating the mix and adding other ingredients that modify the appearance, texture

and flavor of the cheese. Process cheeses contain more moisture than natural cheeses. These attributes, combined with the fact that process cheese is not a living system and therefore can be consistently produced to meet functional specifications, makes process cheese products appealing to prepared food formulators.

Early attempts at making process cheese were unsuccessful because heated cheeses tend to oil off, and moisture exudation commonly occurs during cooling and storage. Dairy scientists quickly learned to process Cheddar and other types of cheeses with various types of melting salts, now called emulsifying salts.

Today, process cheeses can be tailored to meet application specifications. They are often preferred to natural cheeses in prepared food manufacturing because of their uniform texture and consistent flavor. Managing functionality often requires the cheesemaker to innovate beyond the standards of identity. Cheese sauces, in fact, can be made to order using unique ingredients and processes to get just the right flavor and viscosity.

### **Cheese Sauces Are More Than Melted Cheese:**

Cheese manufacturers are able to provide food formulators with highly functional cheese ingredients when they develop process cheese products that are nonstandardized. An example is those process cheese ingredients referred to as “cheese sauces.”

The term cheese sauce is elusive, since it is not defined by any U.S. regulatory agency. However, manufacturers of high-quality cheese sauce have some very specific criteria for their cheese sauces to meet.

For starters, a high-quality cheese sauce is typically made from one or more varieties of natural cheese. Often the sauce contains the characterizing cheese variety along with other natural cheeses. Natural cheese usage levels can be as high as 50 percent of the total product. In general, process cheese sauces are manufactured from a mixture of various types of natural cheese with the following selection criteria: variety, flavor, ripening stage, texture and acidity. These attributes significantly influence the texture and viscosity of the cheese sauce. Proper selection of natural cheese is of utmost importance to guarantee the manufacture of quality process cheese. The use of natural cheese with microbiological defects needs to be avoided in order to preserve the final quality of the product. Type of starter culture and the enzymes used in the making of the natural cheese ultimately impacts the quality of the finished product, which is why mixtures of natural cheese are often used.

One would think that a cheese sauce would only have as much cheese flavor as the base cheese, but that is not true. Cheese sauce manufacturers are able to boost cheese flavor through the addition of select ingredients. Such cheese flavor boosters provide cheese flavor with less calories and less fat than if the formulator was to simply use more base cheese.

For example, dried and spray-dried cheese, as well as enzyme-modified cheese (EMC) and liquid cheese flavors, can boost the cheese flavor of a sauce. EMCs are special flavor ingredients that blend lipases (natural food-grade enzymes) together with natural cheese to intensify the effect of cheese flavor development.

In addition to natural cheese, high-quality cheese sauces are made with unique combinations of emulsifying salts, hydrocolloids and other ingredients to consistently perform as expected in a specific function. (Table 1 lists the types of ingredients and their main function in cheese sauces.)

It is important to remember that cheese sauces are much more than melted cheese. They are a viscous solution of cheese and other ingredients, a solution that does not melt or solidify but can change viscosities based on application and temperature. Unlike natural cheese, which can separate when heated and then begin to melt, process cheese sauces flow. In formulations, cheese sauces can tolerate high temperatures, along with fluctuations in temperature, during distribution and storage.

**Table 1: Ingredients Often Used in Cheese Sauce Manufacture and Their Function**

<b>Ingredient Type</b>	<b>Function</b>	<b>Examples</b>
Acidifying Agents	Assist with pH control of the final product	Food-grade organic acids, such as acetic, citric, lactic, phosphoric, etc.
Colors	Impart desired color	Annatto, artificial colors, paprika, etc.
Condiments	Impart variety to appearance, texture and taste; give product differentiation	Sterile preparations of fruits, herbs, meat, nuts, spices, vegetables, etc.
Emulsifying Salts	Assist with formation of a physiologically stable product; provide desired texture and viscosity	Sodium phosphates and sodium citrates
Fats/Oils	Provide desired composition, texture and viscosity	Anhydrous milkfat, butter, cream, partially hydrogenated soybean oil, etc.
Flavors	Impart desired flavors, especially when used with young cheeses	Enzyme-modified cheese (EMC), smoke extracts, starter distillate, etc.
Flavor Enhancers	Accentuate flavor	Sodium chloride, yeast extract, etc.
Hydrocolloids	Assist with formation of a physiologically stable product; provide desired texture and viscosity	Carrageenan, guar gum, starch, xanthan gum, etc.
Preservatives	Retard mold growth; prolong shelf life	Calcium/sodium propionate; nisin; potassium sorbate, sorbic acid
Proteins	Provide desired composition, texture and viscosity; assist in the production of a physiochemically stable product	Casein, caseinates, whey, milk ultrafiltrates, milk proteinates
Sweetening Agents	Increase sweetness	Corn syrup, dextrose, hydrolyzed lactose, sucrose

Source: *Innovations in Dairy, Controlling Processed Cheese Functionality*, Dairy Management Inc., May 2004

## **The Basics of Process Cheese and Cheese Sauce Chemistry:**

Understanding the basics of cheese sauce chemistry requires some education in process cheese, and emulsification properties is a great place to start. Natural cheese consists of an oil phase (containing fats and oil-soluble substances) and a water phase (containing a solution of water-soluble proteins and minerals). These two phases are not compatible without some intervention. In cheese, the surface-active casein proteins are soluble in both the oil and water phases and collect at the interfaces between the two creating an emulsion. If the emulsion is just efficient enough to prevent phase separation, it will have large droplets of one phase floating within the other phase. With further processing, emulsification improves. The droplets get smaller, increase in surface area and eventually reach a state of total homogenization.

Emulsification is linked closely with a cheese's textural attributes. Modifying the emulsion helps achieve the desired textural properties in a process cheese. Variables such as cheese type, age and pH; amount of calcium in the calcium phosphate; and the temperatures experienced during processing all affect emulsification properties.

The emulsifying proteins in natural cheese are casein and casein fragments. Most caseins contain calcium phosphate groups on one end, which are water-soluble and carry the majority of the protein's charge. (The organic, nonpolar groups on the other end of the molecule are fat-soluble.) Calcium affects emulsification by influencing overall solubility—the more calcium, the less soluble the water-soluble end of the protein, and the less the protein's ability to emulsify.

In fact, it is the casein from the base cheese that is the primary emulsifier in a process cheese product. The more intact the casein in the natural cheese base, the better its emulsification properties for a cheese sauce. A key factor in formulating any type of process cheese product is determining the relative casein content (RCC) of the base cheese, which is the ratio of the amount of casein nitrogen divided by the total nitrogen in the base cheese. For example, Swiss cheese provides better emulsification than Cheddar cheese because it has a higher relative casein content.

As natural cheese ages, proteins break down into shorter, simplified units via the bacteria, mold and/or yeast that are present and alive and functioning. These smaller units are now more soluble, which increases their flavor strength; but they are poorer emulsifiers. The insoluble substances in natural cheese have no flavor because they can't interact with taste receptors in the mouth.

The process of breaking down the proteins is referred to as proteolysis, with the degree of proteolysis having a major impact on the textural characteristics of any process cheese ingredient made out of natural cheese. This is because the aging process influences the emulsification characteristics of the natural cheese. As a cheese ages, its level of intact casein and its RCC decrease, thus decreasing its emulsifying ability.

Protein associations at a given level of emulsification determine process cheese texture. The short proteins in aged natural cheese have fewer chances than the long proteins in young natural cheese to interact with each other. As a result, an aged cheese tends to produce a shorter, more crumbly texture. The proteins become more water soluble as protein-protein interactions weaken. This situation can temporarily enhance emulsification; but as proteins continue to break down, a decrease in protein-protein interactions leads to a general loss of structure and poor emulsification. To solve this problem, young cheese can be added.

In general, using cheese with increasing amounts of proteolysis decreases a process cheese's firmness and elasticity but increases spreadability and heat-induced flowability in process cheese. A proper blend of young and aged cheese affords optimal flavor and texture in the finished process cheese. Excessive amounts of young cheese cause weak cheese flavor; excessive amounts of aged cheese result in poor body. Modifying RCC is an effective strategy for customizing the flow characteristics of process cheese sauces to meet specific application requirements.

The pH of the natural cheese also affects the emulsifying ability of the protein. It can alter protein solubility and configuration, as well as the ability of emulsifying salts to bind calcium, which is addressed later. Proteins have multiple positively and negatively charged sites positioned along their length. An excess of one type of charge causes an open protein structure due to repulsion between sites with like charges.

Protein charges become more balanced as the surrounding solution approaches the isoelectric point and completely balance at that point. At this pH, the protein curls up, because the opposing charges attract, and because it greatly reduces other protein interactions and solubility.

Casein's isoelectric point is about pH 5.0. Normally, cheese pH is higher than this, producing an excess of negative charge on the protein. As cheese pH is reduced to 5.0, a crumbly texture can develop, due to weakening of protein-protein bonds; and the fat can start to demulsify. Increasing the pH to less than 6.5 improves solubility and strengthens protein bonds, creating a more elastic and better-emulsified cheese.

In general, tolerated pH ranges between 5.2 and 6.2; above and below these values, texture and consistency qualities cannot be achieved.

To adjust pH in process cheese products, organic acids such as vinegar, lactic acid, citric acid, acetic acid and phosphoric acid can be added. Furthermore, the effects of pH are taken into consideration when selecting emulsifying salt(s).

### **The Function of Emulsifying Salts:**

Emulsifying salts are an effective means of manipulating natural cheese. Their primary function is to chelate (bind) the calcium on the water-soluble end of casein and casein fragments. This prevents any oiling-off or moisture exudation during the manufacturing and cooling of process cheese and cheese sauces.

Emulsifying salts are added early during process cheese manufacturing in order to begin destructuring casein. They do this through an ion-exchange process whereby the emulsifying salt exchanges the calcium bound to casein with sodium. Because they are not fat-soluble, these salts do not interact with the fat-soluble portions of the proteins, and only affect the water-soluble portions. This process transforms nonsoluble calcium para-casein into soluble sodium para-casein.

In combination with heat and shear, emulsifying salts contribute a number of important functionalities to process cheese and cheese sauces, including:

- Improving the emulsifying characteristics of casein through the exchange of colloidal calcium with sodium.
- Regulating pH for optimum body and texture (pH depends on cheese pH, buffering capacity and pH of added salt).
- Dissolving protein for integration of fat, protein and water into a uniform smooth mass.
- Increasing cross-linking of caseins.
- Emulsifying free fat.

Emulsifying salts commonly used in process cheese sauce include: sodium citrate, sodium aluminum phosphate, monosodium phosphate, disodium phosphate, trisodium phosphate, tetrasodium triphosphate, sodium triphosphate and sodium hexametaphosphate. All of these salts have a natural tendency to bind calcium, including calcium in casein fragments.

The viscosity of cheese sauce can be managed through emulsifying salt selection. The chain length of the emulsifying salt impacts the cheese sauce's texture. Emulsifying salts that bind weakly to calcium yield a weaker emulsion than those with stronger calcium chelating action. Generally, in very high-moisture cheeses sauces, the shorter chain length emulsifying salts such as monophosphates and citrates provide the least amount of emulsion stability; whereas long-chain polyphosphates can increase the amount of emulsion stability.

Polyphosphates are superior chelators. Their ability to chelate calcium ions increases with their ionizing degree (pH function) and their chain length. Because polyphosphates change as they chelate calcium, cheese sauce manufacturers must carefully select the right blend of emulsifying salts to achieve the desired finished product. This is a carefully skilled science, as in the presence of dairy calcium, polyphosphates hydrolyze and become less and less condensed; the final stages are the formation of diphosphates and

orthophosphates. Knowing how an emulsifying salt functions and transforms is critical to a cheese sauce's success.

Diphosphates have a considerable creamy capacity. As polyphosphates hydrolyze and become diphosphates, they too can provide a creaming effect by their interactions with the proteins. Such a creaming tendency leads to a thicker, creamier texture, an attribute typically desirable in cheese sauce. In practice, blends of emulsifying salts are used to manufacture process cheese sauces since each unique blend is able to produce a signature cheese sauce.

### **Hydrocolloid Addition:**

As mentioned, process cheese and cheese sauce ingredients have a higher moisture content than the natural cheeses from which they are based. This water contributes to the process cheese and cheese sauce's texture, flavor and functionality. The key, though, is to bind the extra water added to these products through the addition of hydrocolloids.

The primary function of all hydrocolloids is alluded to in its name – the prefix “hydro” means water and “colloid” means a gelatinous substance. There are four basic sources of hydrocolloids: algal, such as agar, alginate and carrageenan; animal, such as caseinate, gelatin and whey protein; botanical, such as cellulose, guar gum, konjac, pectin and starch; and microbial, such as gellan gum and xanthan gum.

Basically, hydrocolloids are used in process cheese and cheese sauce making to bind water, which in turn controls viscosity during processing and contributes to the finished texture of the cheese product. Not all hydrocolloids are approved for use in process cheese ingredients. Some of the more commonly used are alginate, carob bean gum, carrageenan, gelatin, guar gum, sodium carboxymethylcellulose, starch, whey protein and xanthan gum.

The process cheese sauce manufacturer must consider processing conditions (e.g., heat and shear) and formulation when selecting hydrocolloids. Some require high-temperature heating to function; whereas, others are affected by pH. Some hydrocolloids form thermoreversible gels where gelation occurs on cooling or heating. Others form nonthermoreversible gels, also called thermally irreversible gels. With these hydrocolloids, gelation may be induced by cross-linking polymer chains. And some hydrocolloids do not form any type of gel at all on their own.

Xanthan gum is quite common in cheese sauce formulations. This nongelling hydrocolloid hydrates rapidly in cold water to give a reliable viscosity. The consistent water-holding ability may be used for the control of syneresis and to retard ice crystallization in frozen cheese sauces. Xanthan gum develops a very high viscosity, even when very little is used. When mixed with guar gum, the viscosity is more than when either one is used alone, so less of each can be used.

Guar gum, too, disperses and swells almost completely in cold water to form a highly viscous solution. It has an extremely high water-binding capacity, providing very high viscosity in water-based systems even at low dosage levels. Guar gum solutions are thixotropic, which means viscosity reduces as agitation or pressure is increased at a constant temperature, and then returns to the same thickness when it is still. This feature is quite important in the formulation of select cheese sauces for specific applications.

Brown seaweed contains alginic acid, which is the basic raw material used in the production of alginate. One of the most distinctive characteristics of alginate is its ability to form gels in the presence of calcium, which gives a glossy look to process cheese sauces. Fully gelled alginate systems are neither shear-reversible nor heat-reversible. For these functions, sodium alginate is often used in cheese sauces.

Plants produce starch through the photosynthesis of sugar. Food starch is primarily derived from corn, wheat, tapioca and potato plants; but other sources, such as rice and arrowroot, find their way into various food products.

The same general chemical and physical considerations apply to all plant starches before they are processed into ingredients. They consist of large molecules composed of chains of glucose units linked together to form one of two polymers. Amylose is the mostly straight-chain polymer, with long-chains of glucose units joined by alpha 1,4 linkages. Amylopectin, the branched-chain molecule, consists of shorter chains of glucose monomers linked by some alpha 1,4 linkages and many alpha 1,6 branch points. The proportion of these two polymers in any given starch granule depends on the plant of origin, which also influences the number of glucose units.

Amylose and amylopectin are inherently incompatible molecules. Amylose has a lower molecular weight with a relatively extended shape; and amylopectin is much larger but also more compact. Amylopectin typically consists of branched chains of 20 to 30 glucose units; each molecule can contain as many as 2 million glucose units. On the other hand, amylose chains vary in length from as few as 200 glucose units to more than 20,000.

Most native starch has about 20 percent to 30 percent amylose (tapioca can have lower amounts), and the remainder is amylopectin. However, plant-breeding techniques have allowed for the development of starches with varying ratios of amylose to amylopectin. For example, the term “waxy” describes starch that is almost completely amylopectin. This takes advantage of amylopectin’s unique functionality as waxy starches form thick, clear pastes but gel only at very high concentrations such as 30%. On the other hand, standard cornstarch, at 25% amylose, forms a gel at a level of 4% to 5%. High-amylose starches, which contain 50% to 70% amylose, have their own set of unique properties: film formers, oxygen and fat barriers, ingredient binders and quick-setting, stable gels.

One way that starch ingredients vary in how they thicken, gel or bind, as well as provide mouthfeel and sheen to a cheese sauce, is their ratio of amylose to amylopectin. Amylose and amylopectin chain length also influences performance.

By molecular design, long, straight-chained amylose is more soluble in water; but it creates a less-viscous solution than branched-chain amylopectin. Simply, amylose gives a short texture and gels upon cooling; whereas amylopectin provides more viscosity and does not gel, because the molecular branching inhibits reassociation.

Manufacturing starch ingredients begins by wet-milling the plant source into a slurry. The starch slurry is then dried, with or without any physical processing. These ingredients are referred to as native starch. The starch slurry can also be modified by chemical and/or enzyme addition. Such starches are referred to as modified. Native cook-up starches have numerous limitations in stability and shelf life. Food products such as cheese sauces, which have a lengthy shelf life, require the use of modified starch.

Finally, whey, in one of its many available forms, is almost always used in process cheese formulation. Pardon the pun, but whey is a natural addition to process cheese since whey is the collective term referring to the serum or liquid part of milk that remains after the manufacture of natural cheese. Whey is transformed into a dry product by different techniques. The quality of the product varies with the technology applied.

Sweet whey, whey protein concentrates 34-80% protein (WPC), reduced-lactose whey, modified whey, demineralized whey and whey protein isolates (>90% protein, WPI) are among the most commonly used whey ingredients in process cheese sauce. Cost effectiveness is a key driver in using whey products in process cheeses since qualitative attributes such as flavor enhancement and functionality justify using optimal amounts of whey products in virtually every formula type. The use of whey ingredient(s) typically results in superior flavor, body and texture. Another advantage of whey products is the potential of improving nutritional attributes in a cost-effective fashion.

Whey proteins are very efficient emulsifiers of fat and oil. They assist casein and the emulsifying salts with forming stable cheese sauce emulsions. Additionally, the bound fat in whey products is relatively high in phospholipids (e.g., lecithin), which adds to the emulsification capacity of whey ingredients.

Whey proteins also bind high amounts of water through physical and chemical means. This tends to increase mix viscosity. The precise nature of this viscosity increase can be used to specifically manage final mix viscosity. Whey proteins add body and improve texture. They do not melt, stretch, spread or retain finished cheese firmness as do casein proteins. This attribute is very desirable in cheese sauces, since cheese sauces are not meant to melt or stretch.

### **Coming Together Under Heat:**

Heat processing is the key stage to process cheese manufacture; it is the stage when all the ingredients come together and form a homogenous mass. Elevating processing temperatures and holding time at maximum temperature increases firmness and elasticity but decreases spreadability and heat-induced flowability of process cheese and cheese sauce products.

Rheological and textural properties of process cheese and cheese sauces are also influenced by cooling rates: a slower cooling rate provides a stronger process cheese product.

Process cheese and cheese sauce products are made by one of these three methods: a discontinuous (batch) kettle cooker, a discontinuous steam-injection system or a continuous steam-injection system.

Discontinuous kettle-cooked products are pasteurized through jacketed systems. Compared to steam injection, the indirect heating of kettle cooking is less abusive, which is critical to the finished product quality of higher-moisture cheese sauces. Less severe heat means more cheese and dairy flavor is preserved.

Discontinuous and continuous vat systems using steam injection as a heating source produce cheese sauces with a higher dairy solids content than batch kettle-cooked sauces. This ensures a consistent cheese flavor profile, smooth texture and the ability to cling to other foods such as pasta and vegetables.

Creaming is carried out under agitation. Cheese remains in the kettle or vat for a duration sufficient to enable the development of protein polymerization reactions. This leads to a thickening of the product. The building of viscosity during this stage is closely monitored in order to stop the reaction at the optimal desired consistency.

An optional homogenization step can be carried out on the product to improve fat emulsion stability while diminishing fat globule size. Homogenization also improves consistency, structure, appearance and smoothness of process cheese sauce.

To render cheese sauce shelf-stable, it undergoes hot-fill, aseptic or retort packaging/processing. This flow of processing helps preserve the organoleptic properties of cheese sauce.

Retorting and aseptic packaging are both somewhat limiting for cheese sauces because of the high temperatures the cheese sauce encounters. Such temperatures promote Maillard browning reactions, which lead to the development of an undesirable brown color, off flavors and loss of cheese identity.

Hot-filling to kill vegetative pathogens, followed by proper cooling, results in a high-quality cheese product that can be stored at refrigerated temperatures or freezing

temperatures. Hot-filled products can also be shelf-stable if formulated to prevent the growth of the pathogen *Clostridium botulinum*. This is accomplished by managing the moisture content, pH and salt content (a combination of sodium chloride and sodium phosphate solids). Proper cooling prevents pathogenic spore germination.

From a safety perspective, emulsifying phosphates possess a bacteriostatic effect on process cheese and cheese sauce products, which provides protection against the growth of *C. botulinum* and other microorganisms. The capacity is higher for polyphosphates than orthophosphates. This can be explained by the fact that calcium forms a complex with emulsifying salts and thus is no longer available to the microorganisms.

In addition, approved bacteriocins such as nisin can be added to the process cheese sauce mixture. Nisin is produced by the fermentation of *Lactococcus lactis*, a bacteria strain which occurs naturally in milk. This strain produces an inhibitory substance that is effective against a broad spectrum of Gram-positive pathogens.

### **Leaders in Cheese Sauce Manufacturing:**

Cheese sauce manufacturing is a learned science. It takes a company focused on cheese to be able to develop a cheese sauce for almost every application. That company is Sargento Foods, Inc., Plymouth, Wisconsin.

In the cheese business for more than 50 years, and formulating cheese sauces for more than 20 years, Sargento markets an extensive line of cheese sauces. (See Tables 2 to 4.) In addition, the company's dedicated scientists are available to work with prepared foods formulators to custom design cheese sauces to meet individualized specifications.

### **Table 2: Cheese Sauces Distributed and Stored at Ambient Temperatures**

Bacon Cheddar  
Blue  
Cajun  
Cheddar  
Cheddar with Picante  
Chipotle  
Jalapeño  
Mozzarella  
Nacho  
Onion  
Ranch  
Roasted Garlic and Parmesan  
Savory Cheddar  
Sharp Cheddar  
Sour Cream  
Southwestern  
Spicy Pepper  
Sweet Cream Cheese – plain  
Sweet Cream Cheese – fruit flavored  
Swiss

### **Table 3: Cheese Sauces Distributed and Stored at Frozen Temperatures**

Alfredo  
Blue  
Chipotle  
Creamy Italian Herb  
Lemon Herb  
Pesto Basil  
Roasted Garlic  
Roasted Red Pepper  
Sharp Cheddar  
Swiss  
Sun-Dried Tomato & Basil  
Three Cheese Italian

### **Table 4: Cheese Sauces Distributed and Stored at Refrigerated Temperatures**

Asiago  
Blue  
Brie  
Cheddar  
Concentrated Sauce - Cheddar  
Irish Dubliner  
Roasted Garlic Fondue  
Southwestern  
Spicy Pepperjack  
Sun-Dried Tomato and Basil  
Swiss

Cheese sauces from Sargento come in a variety of package sizes to meet customers' needs. Smaller pouches start out at 1.5 ounces and can be as large as 20 ounces. Larger pouches range from 2 to 10 pounds. Sauces also come in cups. For single-serve use, those cups start out at 0.5 ounces and go to 4.5 ounces. Larger cups range from 4 to 16 ounces.

Technical advancements in recent years have enabled the scientists at Sargento to provide customers with a variety of value-added formulations. For example, assisting with the desire to label products free of trans-fatty acids, Sargento can formulate many of its cheese sauces using canola or safflower oils, or dairy cream. This replaces the partially hydrogenated oils more traditionally used in cheese sauces because of their partially hydrogenated oils high functionality and economy. However, if eliminating trans fats is a prepared foods manufacturer's goal, Sargento can do it. Anything is possible when you have cheese expertise.

If sodium is a concern, Sargento is able to replace some or all of the sodium chloride in certain cheese sauces with potassium chloride. This results in a lower-sodium cheese sauce, which can often enable a prepared foods marketer to make a low- or reduced-sodium claim. The added potassium also translates to higher potassium levels on Nutrition Facts panels.

With continued concern in the health community regarding the osteoporosis epidemic, Sargento can boost the calcium and vitamin D (aids in calcium absorption) levels in many of its cheese sauces without impacting flavor or functionality. Alone these levels are unlikely to enable a calcium or vitamin D content claim on prepared foods; but combined with other ingredients in the final application, many marketers have been able to make statements such as “good source of calcium,” or “contains added calcium and vitamin D for bone health.”

Sargento has a passion for cheese. The company’s commitment to providing quality cheese is obvious in the fact that its business is one thing and one thing only: cheese. Their cheese expertise comes from food and dairy scientists, microbiologists, certified cheesemakers and a culinary staff. This group of cheese experts has a willingness to share their cheese knowledge and work together with food ingredient partners to reach a mutual goal: satisfied customers.