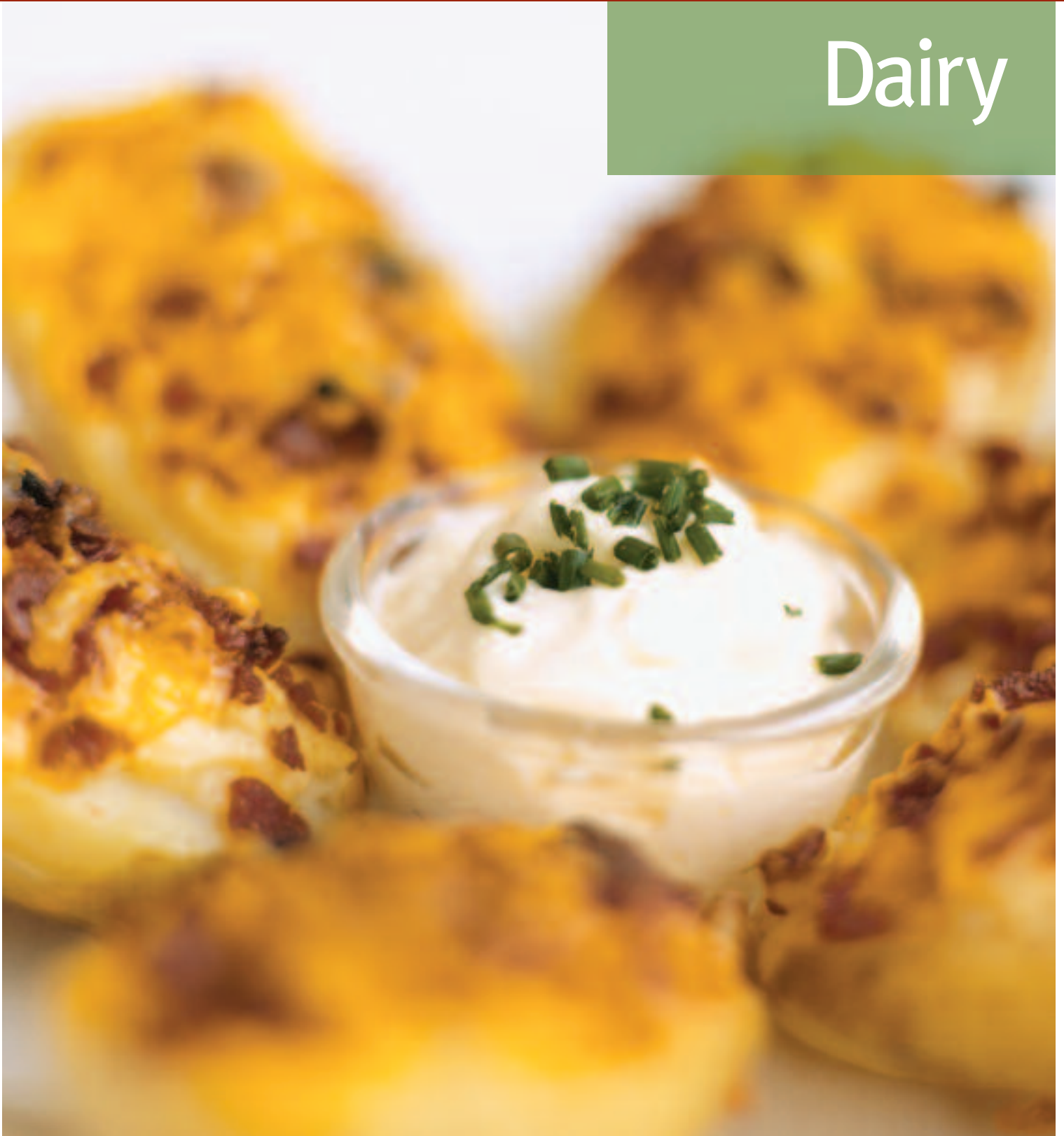


Dairy





Dairy

APPLICATIONS OF FOOD PHOSPHATES

THERE ARE HUNDREDS OF PRODUCTS IN THE MARKET MADE FROM MILK OR ITS COMPONENTS (WHEY PROTEIN, CASEIN, MINERALS, ETC.). PHOSPHATES ARE KEY INGREDIENTS IN PRODUCING DESIRED FINAL PRODUCT CHARACTERISTICS SUCH AS APPEARANCE, FUNCTIONALITY AND SHELF LIFE OR IN FACILITATING MANUFACTURING.

ICL orthophosphates, pyrophosphates and polyphosphates perform the following functions in dairy products:

- Aid emulsification by interacting with proteins.
- Buffer products within the desired pH range.
- Stabilize casein in milk against heat coagulation.
- Disperse flavors and proteins in reconstituted milk powders.
- Coagulate proteins to enhance gelation.
- Acidify products.

AT ICL PERFORMANCE PRODUCTS, WE HAVE THE APPROPRIATE PHOSPHATE FOR VIRTUALLY ANY DAIRY APPLICATION – AND THE RESOURCES TO WORK WITH YOUR SPECIFIC APPLICATION TO DETERMINE THE OPTIMUM PHOSPHATE TO MEET YOUR NEED.



ICL food phosphates are key ingredients in producing desired final product characteristics such as appearance, functionality and shelf life.

Process Cheese Products

Phosphates are used in process cheese products primarily to help maintain the emulsion of fat in the protein-water matrix. Through interaction with milk proteins and minerals associated with protein, phosphates allow the proteins to improve emulsification at the oil-water interface. Therefore, the product is uniform in flavor, and fat does not separate from the cheese when melted. In addition to helping stabilize the protein-water-fat emulsion, phosphates also buffer the product at an optimum pH and give the product appropriate firmness and melting characteristics. Phosphates provide this same functionality in “filled cheese” products, imitation cheese and pasteurized cream cheese products.

Federal regulations govern the use of emulsifying agents in the manufacturing of pasteurized process cheese (21 CFR 133.169), cheese food (21 CFR 133.173) and cheese spread (21 CFR 133.179). Under these regulations, the solids weight of the emulsifying agents may not exceed 3% of the weight of the finished product.

Typically DSP, alone or with TSP, is used at a total level less than the maximum allowed (3%). Pyrophosphates will increase the resistance to melt. In higher water content, process cheese products such as dips, SHMP can be used to minimize syneresis.

Natural Cheese

Phosphates can be used during the production of cultures for natural cheese. Bacteriophages typically require free calcium to multiply in starter cultures. Through precipitation of calcium by DSP, these cultures can be protected

from phages. Potassium phosphates can be used to supply valuable nutrients to the starter culture media.

During cheese manufacturing, milk can be directly acidified by MCP or phosphoric acid to decrease processing time, increase yield and increase calcium levels in cheese, especially cottage cheese. The use of TSPP will also shorten processing time. It is added with the culture, rennet and phosphoric acid to produce a curd that can be molded and allowed to start the aging process immediately.

Other Dairy Products

Incorporating DSP into skim milk before drying yields a nonfat dry milk that will dissolve more smoothly in water. The phosphate keeps milk proteins dispersed by protecting them from heat coagulation during spray drying.

Powdered TSPP helps disperse and suspend cocoa and malted milk powder in milk, thus minimizing sediment. In addition, incorporating TSPP at the appropriate level promotes formation of a thin gel layer around the milk proteins. The gel enriches both the flavor and the color and contributes to the smooth mouthfeel of the final beverage.

The use of phosphates in instant pudding and “no-bake” cheesecake mixes depends on the reaction between TSPP and calcium in the milk protein, which induces gelation. The addition of DSP will accelerate the setting of the gel. In some cases, calcium is added to instant pudding or no-bake cheesecakes in the form of MCP to strengthen the gel.

DSP and SHMP are commonly used during the production of spray-dried cheese. These phosphates protect milk proteins from heat denaturation. In addition, they act to disperse milk proteins upon spray drying to assist in solubility of cheese powder upon reconstitution with water. They also stabilize the protein-water-fat emulsion to enhance flavor, body and appearance of the reconstituted product.

Fluid Milk Products

To prevent heat coagulation in condensed and evaporated milk or cream, DSP is added to stabilize casein in the milk.

Sterilized milk, including ultra-high temperature (UHT) treated products, gains added storage life when stabilized with DSP or SHMP to prevent age gelation during storage. Buttermilk produced by direct acidification via the addition of phosphoric acid has a reduced processing time and a longer refrigerated shelf life than cultured buttermilk. Adding TSPP prior to acidification acts as a dispersing agent for the curd that would normally be formed in the acidic medium. TSPP enhances the flavor, viscosity, body, stability to whey-off and appearance of buttermilk.

The thickening of milk products is just the reverse of the dispersing action described for buttermilk. In chocolate milk, calcium reacts with the pyrophosphate to form a

weak calcium pyrophosphate gel. This gel interacts with milk protein to give it more body. Often milk is consumed through a straw and the thickness can be limited by adding only about 0.1% TSPP. Chocolate milk thickened with TSPP has a richer color and a superior flavor.

Cream Products

Phosphates are used in sterilized cream as a stabilizer to prevent agglomeration. SHMP is used at a level of about 0.15% along with an anti-oxidant such as ascorbic acid. Half-and-half products, sterilized for sale in small containers for restaurant use, may contain a phosphate stabilizer.

To maintain fat dispersion in ice cream mix, DSP, TSPP or SHMP may be added so “churning” will not form lumps of butter during the freezing operation. In chocolate ice cream, DSP, TSPP and SHMP also function to maintain a stable chocolate suspension. These phosphate ingredients can also serve the same purpose in other frozen desserts.

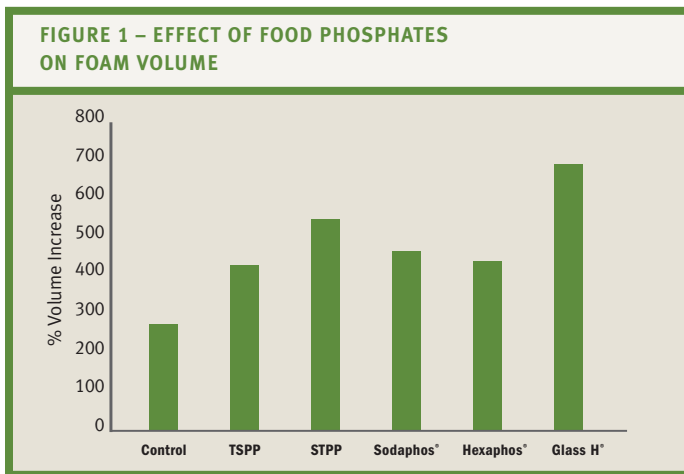
DSP is used in canned cream and cheese soups which are subjected to high sterilization temperatures. The phosphate functions as a stabilizer to prevent proteins from flocculation and to maintain a smooth appearance and taste.

The addition of STPP in imitation sour cream and chip dips controls syneresis. STPP interacts with proteins to promote swelling of the molecules.

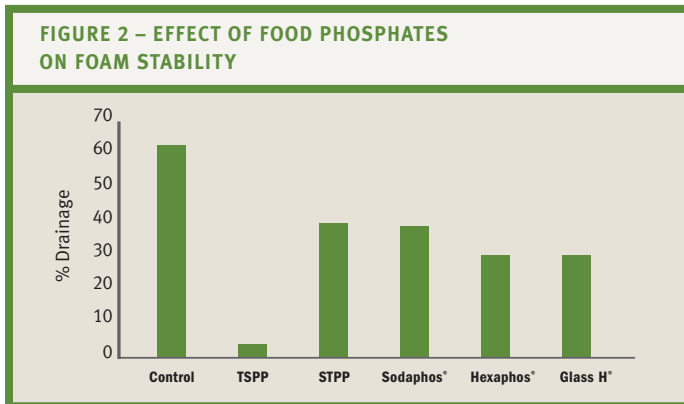


Whipped Toppings, Non-dairy Coffee Whiteners and Whey Processing

Whipped toppings of various compositions obtain increased whipping efficiency and foam stability from the addition of TSPP. By stabilizing the protein films, SHMP inhibits weeping in milk-based toppings, while DSP functions similarly in products based on other protein sources such as soybean.



Increase over unwhipped NFDM and water mixture. Foams generated with 10g NFDM, 50mL water and 0.2g phosphate.



Drainage measured after two hours of standing. Foams generated with 10g NFDM, 50mL water and 0.2g phosphate.

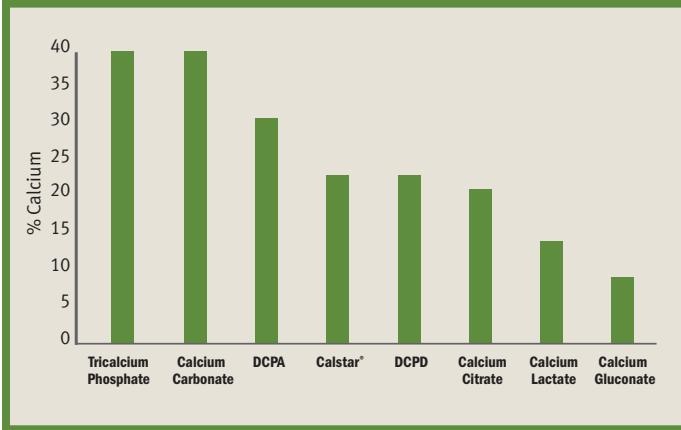
ICL phosphates are effective at low levels to improve foam characteristics (see Figure 1). More air can be incorporated into foams made with dry milk; Glass H® can double foam size, relative to the control. Phosphates also make the foams more stable. Significantly less drainage, or weeping, occurs with all the phosphates and especially with TSPP (see Figure 2).

In **non-dairy coffee whiteners**, a phosphate buffering system consisting of DSP, DKP, SAPP and/or STPP contributes to stability of the protein layer around the fat droplets, thus preventing syneresis. This buffer system also prevents feathering and fat separation when the coffee whitener is added to the hot acidic coffee medium. TSPP has also been used as a stabilizing agent to help disperse soy protein-based coffee whiteners.

Whey contains valuable protein and lactose, in dilute form. When whey is concentrated and lactose is crystallized, some protein is denatured and coagulates. This occurs again when the mother liquor is reconcentrated. Protein denaturation interferes with lactose production, either by contaminating the product or by slowing down or preventing crystallization. Higher yields can be obtained by the use of phosphates. After most of the protein is coagulated by heat and filtered off, a polyphosphate is added to the liquor. This prevents further protein precipitation and interference, and the lactose is readily crystallized.

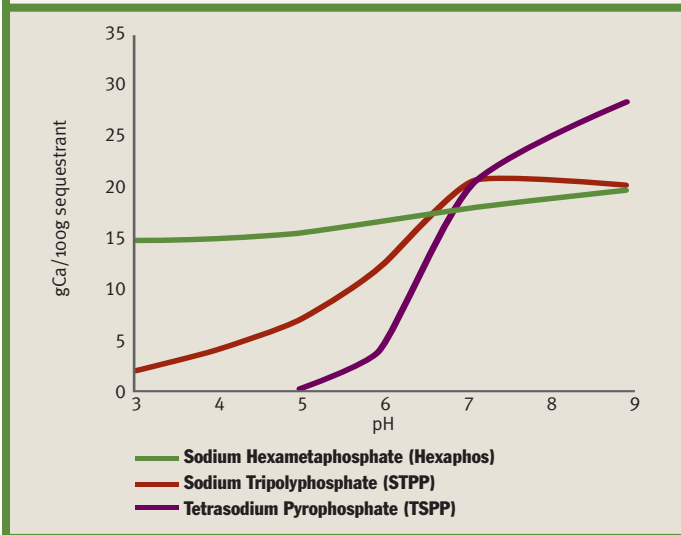
In a similar situation, where the emphasis is on recovering proteins in an easily digested form, a protein-phosphate complex is precipitated from the whey. The phosphate can be removed by lime treatment afterwards. It can also be left in the complex and the product dries and is used as a protein source in food.

FIGURE 3 – PERCENT CALCIUM IN VARIOUS CALCIUM SALTS



Calcium phosphates are broadly utilized in nutritional supplementation and fortification. They are a quality source of both calcium and phosphorus. Calcium is the most abundant mineral in the human body and is critical to the proper development of bone and teeth. Additionally, calcium is important in the prevention of osteoporosis, the promotion of normal growth and development of children, and participation in metabolic functions necessary for normal activity of nervous, muscular and skeletal systems. TCP and other calcium phosphates have a high level of calcium, when compared to other calcium products, make them an efficient supplement (see Figure 3).

FIGURE 4 – SEQUESTRATION OF CALCIUM



Phosphorus is the second most abundant mineral in the human body. Like calcium, phosphorus is also required for bone growth, maintenance and repair. Additionally, the body utilizes phosphorus in protein synthesis, carbohydrate metabolism and activation of enzymes and B vitamins.

Magnesium is an essential mineral for physical health and well-being. Magnesium supports the formation of bone and teeth by assisting with the absorption of calcium and phosphorus. Mag-nificent® is an ideal source of magnesium and phosphorus in one package. It is compatible for use with calcium phosphates to balance the essential minerals.

Potassium phosphates have been recognized as key ingredients for supplementing products with potassium to achieve a “heart healthy” product claim.

NUTRITIONAL ENHANCEMENT

Dairy products are one of the primary food products used to deliver fortification of essential minerals. Phosphates are an excellent source of that fortification in cheese, yogurt, smoothies, beverages and other dairy-based products.

METAL COMPLEXING

ICL polyphosphates can be used in dairy products to complex calcium ions. This can be done in order to allow proteins to have greater functionality, to prevent precipitate formation or to stabilize calcium. Sequestration curves at 25°C are illustrated in Figure 4. Polyphosphates can also complex Mg^{2+} , Fe^{2+} and Fe^{3+} .

Dairy Applications of ICL Food Phosphates

APPLICATION	PHOSPHATE(S)	FUNCTION	USAGE LEVEL
CHEESE			
Cheese sauce	DKP, DSP, SHMP, TKP, TSP, Benephos™	Emulsification	0.5-3.0%
Direct-set cottage cheese	MCP, Phosphoric Acid	pH modification	3.0%
Grated cheese	TCP	Flow aid	0.5-2.0%
Pasteurized process cheese, cheese food and cheese spread	DKP, DSP, MKP, MSP, SAPP, Benephos, SHMP, STPP, TKP, TKPP, TSP, TSPP, KTPP	pH modification, protein stabilization, Ca complexation	0.5-3.0%
Spray-dried cheese	DKP, DSP, SHMP, Benephos	Protein stabilization	1-3% of cheese
MILK			
Buttermilk	Phosphoric Acid, TKPP, TSPP	pH modification coagulant	0.01-1.0%
Chocolate milk	TKPP, TSPP	Protein stabilization	0.1%
Dried milk-drink products	DKP, DSP	Dispersant	2.0% of milk solids
Evaporated, condensed milk or cream	DKP, DSP, TKPP, TSPP	Protein stabilization	0.02-0.1%
Flavored milk powders	DKP, DSP, TKPP, TSPP	Protein stabilization	0.1-0.3%
Sterile concentrated milk or cream	SHMP, Benephos	Protein stabilization	0.1-1.0%
UHT milk	DKP, DSP, SHMP, Benephos	Protein stabilization	0.1-0.5%
OTHER			
Canned cream or cheese soups	DKP, DSP	Protein stabilization	0.2%
Ice cream, frozen desserts	DKP, DSP, SHMP, TKPP, TSPP, Benephos	Protein stabilization	0.1-0.2%
Imitation sour cream, dips	STPP, KTPP	Protein stabilization	0.05-0.2% of oil
Instant pudding, no-bake cheesecake	DKP, DSP, MCP, TKPP, TSPP	Protein coagulant	2.5-3.0%
Milk foams	SHMP, STPP, TKPP, TSPP, Benephos, KTPP	Protein stabilization	0.02-4.0% of milk solids
Non-dairy coffee whiteners	DKP, DSP, TKPP, TSPP	Dispersant, protein stabilization	1-2% of powder 0.1-1.0 % of liquid
Nutritional	MCP, DCPD, DCPA, TCP, Levona™, DMP, DKP, MKP, TKP, TKPP, KTPP	Calcium, magnesium and potassium fortification	To desired level
Whipped toppings	DKP, DSP, TKPP, TSPP	Protein stabilization	0.02-1.0% of liquid
Whey processing	SHMP, Benephos	Ca complexation, dispersant	0.1-0.5%

This chart will help you match a phosphate to a particular application, function and usage level.

Contact the ICL technical team at (800) 244-6169.



**For order assistance or technical service,
please call toll free: (800) 244-6169 or
(314) 983-7500.**

www.icl-perfproductslp.com

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