ICL Performance Products LP

APPLICATIONS AND PRODUCTS

FOR THE FOOD INDUSTRY

Beverage

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APPLICATIONS OF FOOD PHOSPHATES

THE BEVERAGE INDUSTRY RELIES ON THE FUNCTIONALITY PROVIDED BY PHOSPHATES TO IMPROVE AND ENHANCE SOFT DRINKS, JUICES, DAIRY BEVERAGES AND SPARKLING WINE.

Today's beverage industry continues to grow and expand, offering consumers new product choices – and phosphates are key to the success of many new and rapidly growing beverage categories:

- Isotonic drinks and sports beverages, high in cations such as sodium and potassium, are designed specifically for consumption after exercise.
- Meal replacement drinks are nutritionally fortified beverages designed to serve as a complete meal.
- Soy beverages require phosphates to support dispersion of the soy protein and fortify the beverage with calcium minerals.
- Fruit-based beverages and teas benefit from phosphate ingredients.

ICL PERFORMANCE PRODUCTS CONTINUES TO PROVIDE INNOVATION FOR NEW PRODUCT DEVELOPMENT IN BEVERAGES. OUR LINE OF INGREDIENTS INCLUDES SUPPLEMENTS AND PROCESSING AIDS TO IMPROVE THE QUALITY OF THE BEVERAGE SYSTEM.

Today's beverage industry continues to grow, and ICL food phosphates are key to the success of many new and rapidly growing beverage categories.

Soft Drinks

Phosphoric acid is used as an acidulant for cola and root beverages. Colas contain about 0.05% phosphoric acid and have a pH of about 2.3. Root beer has a higher pH of about 5.0 and contains 0.01% phosphoric acid. Despite the low use level, phosphoric acid is of extreme importance to beverage manufacturers. On a price performance basis, phosphoric acid is less expensive than organic acid alternatives. Phosphoric acid provides many advantages in the formulation by providing:

- Sparkling bite and astringency counteract the heaviness of root and cola flavors.
- Low pH improves flavor and storage stability.
- Chelation of troublesome metal ions helps establish a stable carbonation.

Isotonic and Sports Drinks

These beverages are specifically formulated to replace fluids that are lost during exertion and to balance cations that will maintain or improve performance of the athlete. Carbohydrates and water are the key ingredients in these drinks to replace energy and fluids. The other components are also important for their contribution to the osmolality, which is at a level similar to plasma. Orthophosphates are included in formulations for their contribution to the osmolality by their dissociation into ions. The Na^+ and K^+ ions are also important electrolytes in the body's metabolism. MSP and MKP are most often the phosphates of choice in isotonic beverages. The solubility and pH of these salts make them appropriate choices.

Juices

Beverages that contain fruit juice are common, popular drinks. They are gaining popularity in all segments of the population. Potassium, sodium, magnesium and calcium phosphates are added to fortify these drinks and utilize health claims as they are approved by the FDA.

Tricalcium phosphate (TCP) can be added to low pH beverages such as fruit juices (which are opaque) as a source of calcium. The lack of interaction with other components minimizes impact on the flavor of the juice.

Monopotassium phosphate (MKP), dipotassium phosphate (DKP), tripotassium phosphate (TKP), and **tetrapotassium pyrophosphate (TKPP)** are highly soluble phosphate salts that can be added to juice as a source of potassium.

Glass H® sodium hexametaphosphate (SHMP) is valuable to beverage manufacturers to increase shelf life. Cold-filled beverages with a low level of fruit juice can reduce the potassium sorbate and/or sodium benzoate levels by 50% (from 1000 to 500 ppm) with the addition of 0.1 to 0.15% (1000 to 1500 ppm) SHMP. This change in formulation results in reduced ingredient costs and improved flavor profile. SHMP also aids in color stabilization of fruit juice beverages or beverages containing fruit juice components.

Dairy Beverages

Dairy proteins and dairy components such as whey are frequently used in beverage products such as yogurt smoothies, milk-based sodas and whey-enhanced sports or protein drinks, as well as fluid milk itself. Proteins require protection, stabilization and dispersion in these systems. ICL phosphates are excellent tools to provide stable dairy-based beverages.



FLUID MILK PRODUCTS

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.

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

Whey contains valuable protein and lactose, in dilute form. It is often used as a protein and energy source in beverages designed to enhance muscle development. Phosphates aid in whey processing as well as in stabilization, suspension and dispersion of whey protein in high performance beverages.

Soy Beverages

TSPP, SHMP, DSP and **potassium phosphates** can be used as stabilizing agents to help disperse soy proteins. Compared to cow's milk, soy milk contains only one-third the amount of calcium. TCP can be a good source of calcium fortification for soy milk and other soy products.

Mag-nificent® is an ideal source of magnesium in soy-based beverages. It does not interact with the soy protein, minimizing undesirable odors and flavors.

Meal Replacement Drinks

Monocalcium phosphate (MCP), dicalcium phosphate (DCP) and **tricalcium phosphate (TCP)** can be used as a source of calcium and phosphorus in beverages designed to be a complete meal. Mag-nificent is a source of magnesium and phosphorus. SHMP may also be used to aid in stabilizing the protein and solubilizing the mineral salts.

In nutritionally fortified beverages, the metal complexing properties of polyphosphates (SHMP, STPP, TSPP) afford protection for vitamin C, which is readily oxidized in the presence of some metal ions. (See figure 3 on page 4 for phosphate metal complexing.)

Coffee Systems

In coffee systems phosphates act to stabilize dairy-based foams and non-dairy coffee whiteners.

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

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.

Dry Mixes

H.T.® Monocalcium phosphate monohydrate (MCP) can be used in the formulation of beverage powders. MCP has many benefits:

- Economical pH buffer to control tartness.
- Nonhygroscopic acidulant replaces up to 50% of citric acid.
- Calcium and phosphorus contribute to the products' nutrient profile.

Tricalcium phosphate (TCP) is also commonly used for dry powder formulations where it contributes several useful properties:

- Flow conditioning.
- Clouding agent after reconstitution.

Benefits of Phosphates in Beverages

FLOW CONDITIONING

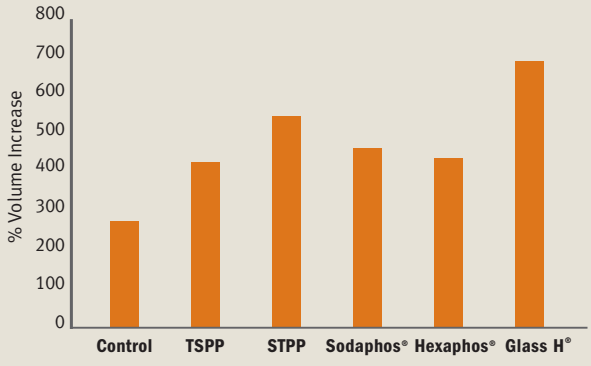
TCP is generally utilized as a flow conditioner for powdered and fine granular products due to its small particle size, low electrical conductivity and ability to absorb water without becoming sticky. TCP is effective at levels of 0.5% to 3% as shown in Figure 2. When used in sugar, TCP has much better anti-caking effects than cornstarch. TCP also contributes nutritional value.

METAL COMPLEXING

Metal complexing or sequestration is important in many beverage applications, see figure 3 for calcium sequestration. It is the interaction with calcium ions that lends itself to preservative enhancement. In nutritionally fortified beverages, the ability to complex calcium, magnesium and other minerals, and to stabilize them in a formulation, is key to delivering an acceptable product. In dairy-based beverages, stabilization of proteins is often related to metal ion interaction. In carbonated beverages, chelation of troublesome metal ions helps establish a stable carbonation.

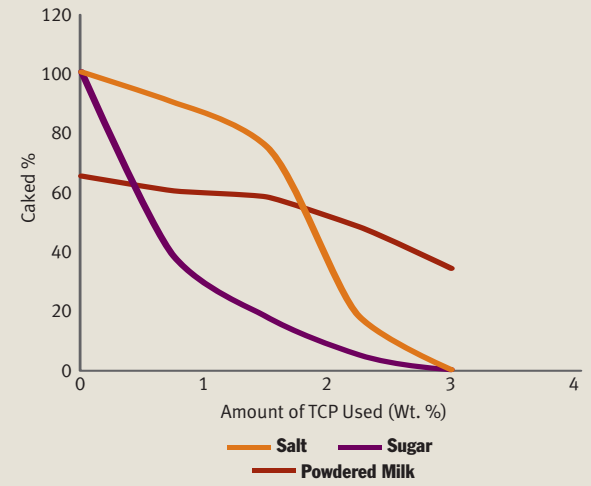
The polyphosphates including Nutrifos® 088 STPP,

FIGURE 1 – EFFECT OF FOOD PHOSPHATES ON FOAM VOLUME



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

FIGURE 2 – EFFECT OF TCP ON CAKING



Hexaphos® SHMP and TSPP sequester metal cations, such as Ca^{2+}, Mg^{2+}, Fe^{2+} and Fe^{3+}. Subsequently, this binding prevents the formation of undesirable precipitates or interactions.

Sequestration of Ca^{2+} and Mg^{2+}, present in water, sweeteners and other ingredients, helps to maintain beverage clarity and uniformity.

PRESERVATIVE ENHANCEMENT

Long-chain polyphosphates, such as Glass H, can work synergistically with some preservatives in beverage systems. The mechanisms include: the chelation of metal ions in cell membranes; pH effect; increase in ionic strength; interactions with cell walls and

FIGURE 3 – SEQUESTRATION OF CALCIUM

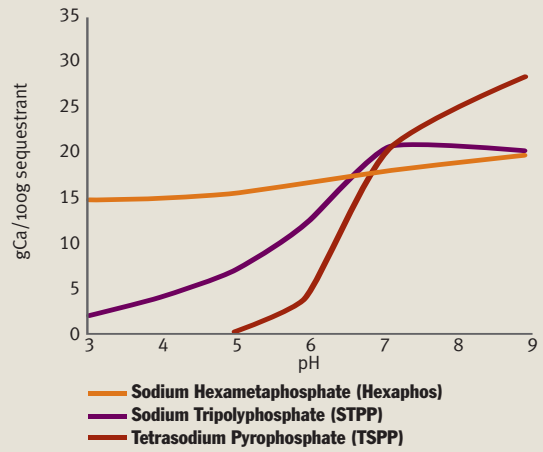


FIGURE 4 – PERCENT CALCIUM IN VARIOUS CALCIUM SALTS

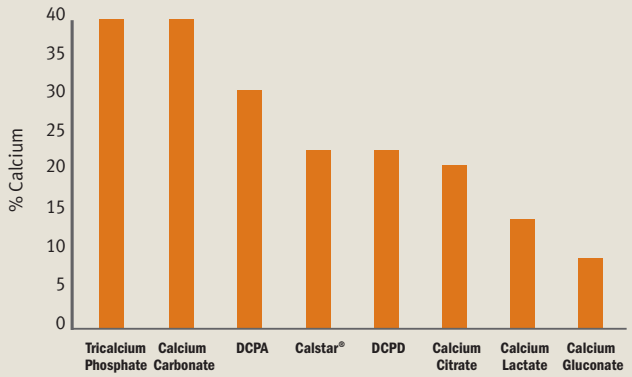
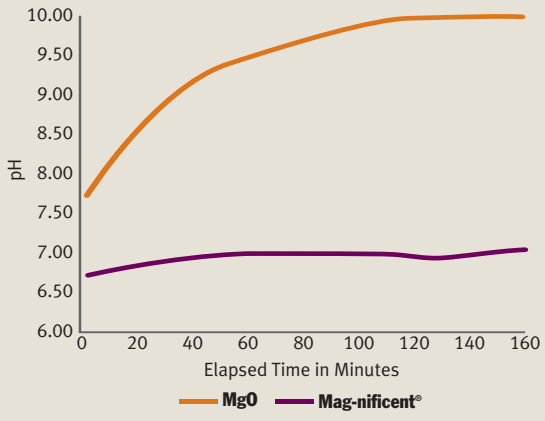


FIGURE 5 – pH DRIFT: MgO VS MAG-NIFICENT



membranes; and interference with various transport functions. The use of polyphosphates may lower the use level of preservatives.

NUTRITIONAL ENHANCEMENT

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.

The fine particle size of both DCP and TCP make them particularly useful in beverage applications, including some clear beverages. TCP and other calcium phosphates have a high level of calcium, when compared to other calcium products, which make them an efficient supplement (see Figure 4).

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 food ingredient for a number of beverage applications. It is compatible for use with calcium phosphates to balance the essential minerals. Additionally, because Mag-nificent does not have a dramatic change in pH over time, it is compatible with other formulation components, including proteins and heat-sensitive vitamins. Figure 5 compares pH drift for Mag-nificent vs. magnesium oxide, another source of magnesium that is used in beverage applications. Mag-nificent can be used in dairy-based beverages, meal replacement beverages, juices, waters and sports drinks to deliver magnesium, which is critical to cardiovascular health.

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

Beverage Applications of ICL Food Ingredients

APPLICATION	INGREDIENT(S)	FUNCTION	USAGE LEVEL (%)
Buttermilk	Phosphoric Acid, TKPP, TSPP	pH modification coagulant	0.01-1.0%
Chocolate milk	TKPP, TSPP	Protein stabilization	0.1%
Cold-filled beverages	Glass H® SHMP, Hexaphos® SHMP, Benephos™	Sequestrant	0.1-0.15
Dairy beverages	DCP, DKP, Glass H SHMP, Benephos, MCP, MKP, TCP	Sequestrant, calcium and mineral fortification	To desired level
Distilled spirits	Phosphoric Acid	Nutrient for yeast	<1.2 g/l
Dried milk-drink products	DKP, DSP, TSPP	Dispersant	2.0% of milk solids
Dry mixes	Adipic Acid, MCP, TCP, TSPP	Acidulant, calcium fortification, flow conditioning	0.5-3.0
Flavored milk powders	DKP, DSP, TKPP, TSPP	Protein stabilization	0.1-0.3%
Fruit juice	DKP, MKP, SHMP, Benephos, TCP, TKP, TKPP	Color stabilization, calcium fortification, potassium fortification	To desired level
Isotonic/sports drinks	MKP, MSP, STPP, KTPP, DKP, TKP	Sequestrant, acidulant	To desired level
Low juice containing drinks	Glass H SHMP, KTPP, Benephos, STMP, STPP	Sequestrant	0.1-0.5
Meal replacements	DCP, Mag-nificent®, MCP, TCP	Calcium fortification, magnesium fortification	To desired level
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
Nutritional	MCP, DCPD, DCPA, TCP, Levona™, DMP, DKP, MKP, TKP, TKPP, KTPP	Calcium, magnesium and potassium fortification	To desired level
Preservative enhancement	Glass H, Hexaphos, Benephos	Anti-microbial	0.1-0.15 in beverage
Soft drink – cola flavored	Phosphoric Acid	Flavor, acidulant	0.05
Soft drink – root beer	Phosphoric Acid	Flavor, acidulant	0.01
Soy beverage	TSPP, DSP, DKP, STPP, KTPP, SHMP, Benephos, DCP, TCP, Mag-nificent	Stabilize protein, mineral fortification	0.02-0.5 to desired level
Tea	SHMP, Benephos, STPP, KTPP	Clarification, sequestrant	0.1-0.2
UHT milk	DKP, DSP, SHMP, Benephos	Protein stabilization	0.1-0.5%
Wine	SHMP, Benephos, STPP, KTPP	Yeast nutrient, sequestrant	<0.96 g/l Depends on level of heavy metals

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.

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

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