Author: Matt S. Faber, PPG Research Manager
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PPG's FLO-GARD™ precipitated silica products in bulk food/feed and dry powders increase efficiencies in production and transportation

Introduction

In the food and animal nutrition manufacturing industry, liquid ingredients and additives require careful handling that can create production and transportation challenges. Packaging for liquids must provide durable barrier and seal performance to preserve freshness and avoid leaks, which have the potential to ruin large quantities of product.

Dry liquid concentrates (DLC), which use carrier agents to convert liquids into dry powders, offer many benefits to food service companies and manufacturers. They enable highly accurate measuring and dosing, particularly in applications utilizing sticky and high viscosity liquids. Powders also provide greater flexibility for storage and transportation conditions.

There are multiple types of carrier agents available, such as gums, salt, tricalcium phosphate, maltodextrins, and precipitated silicas (amorphous silicon dioxide; SiO_2). These agents are used to add liquid flavors, extracts, nutrients, vitamins, and minerals to food products and animal feed premixes.

Each carrier agent has its own unique characteristics, with some providing anti-caking properties, extended shelf life, or other processing benefits.

Precipitated silicas are effective carriers due to their high loading capacity, or the ability to absorb high volumes of liquid. They are an important part of many powdered and granulated food and animal nutrition products, such as drink mixes, instant soups, choline powder, and protein powders.

The rise of convenient food mixes, powders and instant meals that deliver fast, easy solutions to consumers has contributed to the growth of silica applications. Silica products also support brand owners' sustainability goals. Delivering food products as concentrates and powders enables reduced packaging and can lower emissions associated with transportation.

Maltodextrin and precipitated silica have been used in the food industry for many years, and they are both porous carriers that absorb liquids to create free-flowing powders and DLCs. PPG has conducted new research to compare the carrying capacity and performance of these two materials to help manufacturers choose the right product for their application.

The data shows that precipitated silica has a higher carrying capacity than maltodextrin. This increased capacity offers performance advantages including increased throughput and efficiency for manufacturers, creating cost saving opportunities throughout the food and feed production process.

Properties of Carrying Agents

When selecting a carrying agent, manufacturers must consider several important factors. The properties of the carrier and the liquid can affect the finished product's taste and consistency.

First, the liquid's viscosity can make the blending process more difficult. The carrier agent must have a suitable particle size and carrying capacity to absorb the liquid and maintain it as a free-flowing powder. Additionally, if the powder is prone to caking, it can clog screens, hoppers, and other machinery, as well as form clumps in the final packaging that impact the end user experience.

Silicas have been used in the food industry for more than 40 years. They are chemically and nutritionally inert, and impart no taste, odor, or calories to food. They absorb moisture and oils from food particles, contributing to improved flowability.

Maltodextrin was developed in the 1960s and 1970s[1] and is widely used as a bulking filler and carrier agent in food products today. Unlike silica, maltodextrin has a calorie value and can alter the taste profile of food, potentially requiring adjustments to the recipe during the manufacturing process.

Precipitated silicas and maltodextrin are both available in a variety of particle sizes for different applications. Particle size affects the product's mouthfeel; powdered beverages require fine particles to prevent a grainy texture, while sauces and cake mixes can tolerate larger particles.

While maltodextrin is commonly used in a wide variety of food products, the use of precipitated silicas as a carrying agent is expanding as manufacturers realize its value.

1 J. Agric. Food Chem. 2009, 57, 18, 8125–8129

Silica Performance

To demonstrate the absorbent capabilities of precipitated silica, researchers at PPG performed a side-by-side comparison of silica and maltodextrin. In lab conditions, sunflower oil was added to each agent to turn the liquid into a dry, free-flowing powder.

The maltodextrin had a large particle size of 160 microns. It displayed a carrying capacity of 3.75% by weight, meaning that for every 100 grams of powder, 96.25 grams were maltodextrin and 3.75 grams were oil.

Four grades of PPG's FLO-GARD™ precipitated silicas of various particle sizes were tested, and all showed maximum carrying capacities above 66%. In this experiment, it would take more than 40 times the amount of maltodextrin to absorb the same 66 grams of sunflower oil – over 1,500 grams compared to 34 grams of silica.

These results demonstrate that precipitated silicas offer exceptional carrying capacity compared to maltodextrin. Significantly lower amounts of silica are needed to convert liquids to dry powers and DLCs compared to maltodextrin.

Silica	Particle size (µm)	Maximum carrying capacity – sunflower oil
Flo-Gard AB/AB-D	40	67.5
Flo-Gard 255-CD	45	66.0
Flo-Gard SP	45	67.0
Flo-Gard LPC	140	66.0
Maltodextrin	44 - 149	3.75

Table 1. Maximum carrying capacity of various silica products compared to maltodextrin.

Production Benefits

The characteristics of silica as a carrying agent leads to processing efficiencies for manufacturers and producers. Due to its excellent absorbency, the use of silica leads to shorter mixing times and smoother blending. It has a wide workability window, and accidental overloads are easy to recover with the addition of more silica. Its large loading capacity also allows for the creation of concentrated products.

These highly efficient concentrates that pack more product into smaller volumes lead to space and packaging savings. They require less facility space for storage and they can be packaged in smaller units, helping companies reduce their packaging and contribute to sustainability goals.

In addition to its carrying capacity for food and feed additives, silica also optimizes flow conditions for powders by preventing caking and agglomeration, making the packaging process easier and improving the consumer experience. Because silica is inert, it contributes to longer shelf life than maltodextrin additives which can be more prone to grow mold and bacteria.

Dry powders provide transportation flexibility as well. They require less temperature and climate control than liquids. Smaller, concentrated products can reduce shipping costs and lessen the overall carbon footprint of the manufacturer.

Converting to Silica

For blenders and manufacturers who are using maltodextrin and want to convert to precipitated silica, the transition is straightforward. Silicas can be used in standard commercial hoppers, conveyors, ribbon blenders, mixers, spray dryers and machinery. No new equipment or additional investment is needed to incorporate silica into existing operations.

The cost-in-use for silica is significantly lower than maltodextrin due to its greater carrying capacity. Less silica is needed to carry the same amount of liquid.

Conclusion

Precipitated silica and maltodextrin are two food and feed additives that improve flow and convert liquids into dry powders. For applications where carrying capacity is important, the research shows that silica can carry large amounts of liquid at various particle sizes.

Precipitated silicas have a well-established track record as an anti-caking and carrier agent in food products, but their effectiveness and versatility open the door to even more applications. Silicas work with a wide range of liquids, creating broad possibilities for food and feed manufacturing.

Companies will be able to explore new product line opportunities as the world seeks to move to a more efficient and sustainable model of production and consumption. For example, a juice concentrate company had historically offered their products as liquids. After exploring the options provided by silicas for DLCs, they were able to diversify their product selection with a powdered version of their concentrates and reduce carbon footprint achieved through product shipping efficiencies.

For food service companies, contract blenders and manufacturers, silicas provide a technical solution to save time, process costs, and storage space. Their high porosity and excellent absorption make them an efficient carrying agent that supports streamlined production and transportation operations.

For more information about PPG's portfolio of *Flo-Gard* precipitated silica products and use as an anticaking agent for DLCs, visit https://www.ppgsilica.com/Applications/Carrier-and-Free-Flow/Food.aspx.

USA
PPG Monroeville Business and Technical Center
440 College Park Drive
Monroeville, PA 15146 USA
1-800-243-6745

www.ppgsilica.com

EUROPE
PPG Delfzijl Plant
P.O. Box 18
9930 AD Delfzijl, The Netherlands
Customer Service: +31-596-676710

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