

# Achieving fine particle, free flow fructose: Myth or Reality?



## If you're looking for a free flow, time-saving and low energy fructose solution, read on...

For many decades fructose's solubility and improved taste and sweetening qualities have been harnessed throughout the food and beverage industry. Now, for quick dissolving or powder-based applications, fine particle fructose is making free flow a new reality.

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### Introduction

This white paper discusses the challenges in integrating fine particle crystalline fructose in the food and beverage manufacturing process. The need to sustain quality ingredients, while achieving energy savings drives the demand for faster crystalline fructose dissolving rates. Galam experts have found a clear ratio between various crystalline fructose particle sizes and time to dissolve during the manufacturing process. From the perspective of crystalline fructose powder-based applications, homogeneity is crucial. Whilst fine particle fructose powders offer more streamlined manufacturing solutions, sustaining consistency and extended free flow prove challenging.

Inherent to this is the problem of caking, with the presence of naturally occurring humidity in fructose molecules, compounded by humidity absorbed from the environment during shipment and storage. These concerns raise the question – is fine particle, free flow crystalline fructose an achievable reality for today's liquid and powder-based manufacturers?



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## Chapter 1: Particle Size and Dissolving Rate

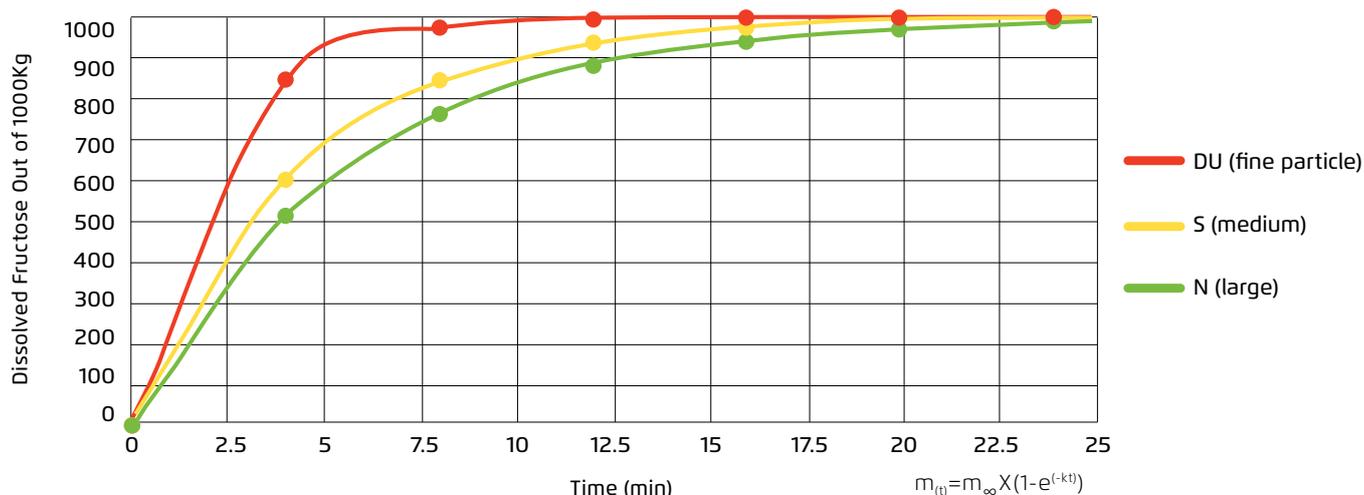
Reducing dissolving time for crystalline fructose is of critical importance to streamlining food and beverage production processes. Likewise, reaching higher concentrations and volumes of concentrated syrups ensures more efficient dissolving at later points in food and beverage production. In each case, the ability of fructose to quickly and easily dissolve enables rapid reconstitution at room temperature, significantly reducing heating expenses and energy output.

Fructose's varying particle sizes play an important role in a faster dissolving rate. Smaller particles mean a larger external area to internal volume ratio. In other words, there is more surface area exposed to water, with less internal volume containing water.

With the intention of verifying the hypothesis that smaller fructose particles dissolve faster, Galam created a series of controlled experiments in the company's laboratories. The results of these experiments were then tested in Galam's own production facilities.

*The following diagram demonstrates the results of extended testing. The water absorption rate of fructose at room temperature and according to particle size is shown, with the time to dissolve one ton of fructose in small, medium and large particle sizes.*

### Time to dissolve 1000 kilograms of crystalline fructose



Based on the experiment results, Galam created an index demonstrating the amount of time different fructose particle sizes, in varying volumes, take to dissolve in water during the manufacturing process. Energy and time efficiencies achieved when using smaller particle fructose can be clearly correlated to substantial cost savings for manufacturers.

### Fructose particle size dissolving rates

Grade	Size (mm)	2r (mm)	r (cm)	Surface Area (cm <sup>2</sup> )	Volume (ml)	Surface area/volume
N	600-1200	900	0.045	0.0254469	6.90229E-05	0.0027124 cm
S	200-600	400	0.02	0.005026548	5.31984E-07	0.0001058 cm
DU	<250	100	0.005	0.000314159	1.29879E-10	0.0000004 cm

Sphere surface area  $A=4\pi r^2$  Sphere volume  $V=4\pi r^3/3$   $\pi=3.141593$

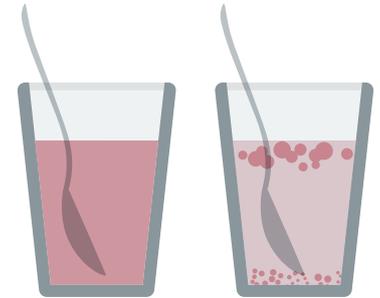


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## Chapter 2: Homogeneity in Powdered Formulations

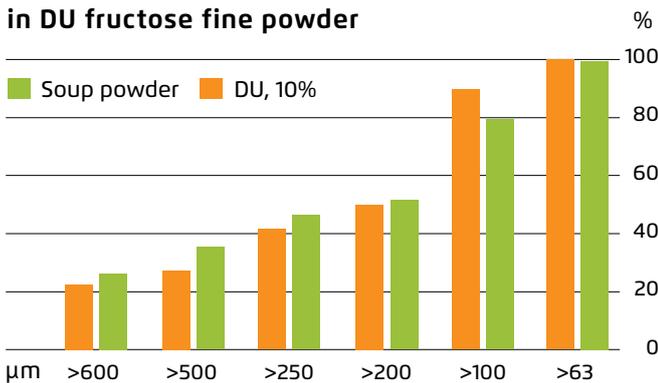
For manufacturers using multiple powdered ingredients, fructose offers a number of new opportunities in broadening product range, formats and shelf life. Since most powdered food and beverage products contain multiple ingredients, the challenge to achieve a homogenous finished product is two-fold. Firstly, despite differing particle sizes and free flow rates of individual ingredients, a powdered mix must be uniform and cohesive throughout transport, storage and production. Secondly, to preserve the quality and functionality of individual ingredients the water content of the powdered mix must be reduced until the wet formulation stage.



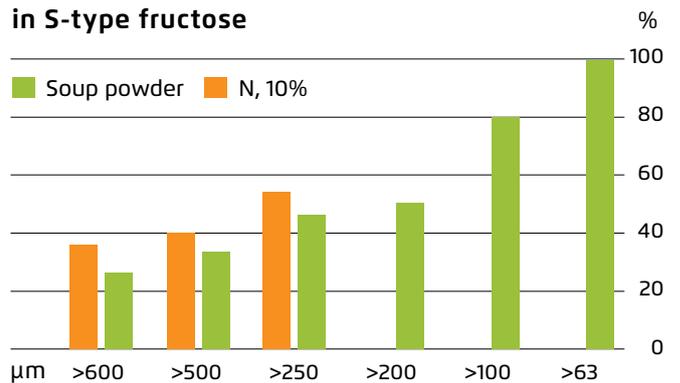
In the image on the right, the segregating and layering effect can be seen to inevitably occur with a powder mix of different particle sizes.

Galam resolved the problem of mixtures, where different sized particles separate, with a fine particle fructose offering. Galam's one-bag-mix is a consistent powder with extended free flow. It offers an ideal solution for secondary mixing with powers or other pre-mixes.

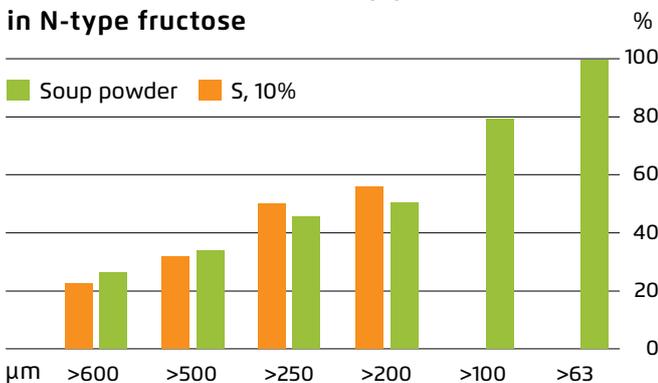
**Particle division of 10% soup powder in DU fructose fine powder**



**Particle division of 10% soup powder in S-type fructose**



**Particle division of 10% soup powder in N-type fructose**



*In this experiment Galam's fine particle DU powder is tested, along with a control, medium and large sized fructose particles. The experiment demonstrates that adding DU to the existing soup powder produces a homogenous mix. The DU results are closest to the control since its particles are most similar in size to the soup powder.*

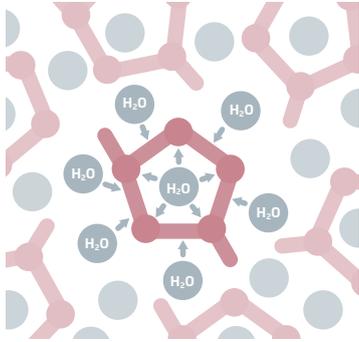


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## Chapter 3: The Caking Challenge

While smaller particles ensure a more homogeneous solution, fructose's hygroscopic nature introduces a further complication for manufacturers. Every fructose molecule holds naturally occurring humidity.



The tendency to absorb moisture results in "caking": Internal molecular moisture comes to the surface of the crystals, as well as moisture entering through packaging. The caking process occurs throughout the product lifecycle - from packing, to storage and transport.

Until now, producers of food and beverages using fructose in powder or liquid form have been faced with only two alternatives: Either purchase and store fructose in small amounts, or procure a larger granular size which consumes more energy and time and will not achieve homogeneity when combined with other products.

## Chapter 4: Galam's Unique Solution

Galam scientists pursued a solution to resolve this dilemma for manufacturers. The aim was now to not only maintain the fine particle form, but to use packaging that could ensure free-flow for at least one year.

A solution had to be found that would address the remaining water inside the mass of crystals, as well as any humidity that could be absorbed via the packaging during shipping and storage.

The purity and homogenous nature of Galam's fine particle fructose created strict parameters for a free-flow solution to meet. It would have to maintain the small particle size, as well as the purity of the company's high quality fructose. This ruled out adding any non-caking ingredients or other foreign materials.

Galam specialists developed a technologically advanced packing solution that not only achieves small particle-delivery but also prevent the common problems of caking. The unique packaging technology delivers hygroscopic fructose in fine particles and protects the product purity, all while ensuring the fructose free flow for at least a year.

The technology introduces a method that absorbs the water that exists inside the mass of crystals as well as through the packaging. Galam's packaging system and pure ingredients ensure full humidity absorbance to prevent the common fructose challenge of caking and lumping during storage and transport. For manufacturers this means significant time and energy savings when dealing with fine particle fructose in both large volume liquid and light powder formats.

