
Performance is in our nature.
zemea
bio-based performance

zemea®
bio-based performance

TECHNICAL BULLETIN

Zemea® USP-FCC Propanediol–Making Beverages Better, Cheaper and Faster

Abstract:

Zemea® USP-FCC propanediol is a bio-based polyol that adds a sweet, cool taste to beverages, foods and oral care products, but has the main benefit as a process aid, making other ingredients work better and faster. Zemea® USP-FCC propanediol enables reduced levels of such flavor solubilizers as Polysorbate 80. This bio-based material enables the introduction of gums and thickeners into aqueous-based systems with ease and speed. Zemea® USP-FCC propanediol can carry high-potency sweeteners into water in a fraction of the time, and possibly improve the taste profile.

Background:

Zemea® propanediol is a bio-based glycol (1,3 propanediol) made by an eco-friendly and sustainable process, and has a storied history of use in personal care applications as a humectant, carrier of cosmetic actives, and preservative enhancer. Now it is ready with approvals for use in food, beverage and pharmaceutical applications, carrying the designations FCC and USP. Keys to success in such applications include taste and texture. For flavored aqueous-based products, often insoluble materials are used and need to be solubilized to create a clear-looking product. Most surfactant solubilizers have a poor taste profile, so a minimization program needs to be initiated to mitigate the negative taste effects. Further, these solubilizers generally exhibit localized gelling behavior upon introduction to water. The additional mixing required to smooth out a solubilized system can cause the generation of unwanted foam.

Gums, thickeners and other hydrocolloids are used for building viscosity and texture, suspension and emulsification in a host of formulation platforms. Adding these water-soluble polymers into an aqueous phase generally requires high shear and a time commitment, and initially results in the creation of “gel-balls” and “fish eyes” that need to be eliminated with additional mixing energy. The use of such high-potency sweeteners as Stevia is quite in fashion. Unfortunately, many of these, though water soluble, take an inordinate amount of time to dissolve in water, often longer than the consumer or processor of food and beverage products is willing to spend. Many of these sweeteners have an excellent initial sweet taste, but leave a somewhat unpleasant after-taste.

Materials and Methods:

The formulation and testing was completed by ACT Solutions Corp. located in Newark, Delaware.

Materials

For the flavor oil solubilization in water evaluations, the following materials were used:

Humectants (10%)	Flavor Oils (0.5%)	Solubilizer (1%, 2%, 3%)
Zemea® USP-FCC Propanediol	**Spearmint oil**	**Tween 80™ (Polysorbate 80)–Croda**
Propylene Glycol	**Clove oil**	
Glycerin	**Lemon oil**	
PEG 300	**Tangerine oil**	

For the aqueous polymer dissolution evaluations, the following materials were used:

Humectants (5%)	Polymers (1%)
Zemea® USP-FCC Propanediol	**Keltrol® CG (Xanthan Gum)–CPKelco**
Propylene Glycol	**Cekol® 2000 (Cellulose Gum)–CPKelco**
Glycerin	
PEG 300	

For the sweetener carrier evaluations, the following materials were used:

Sweetener (concentration tested in water)
Domino Sugar Premium Pure Cane Granulated (2%)
Pure Stevia Sweetener Powder—90% Stevosides (0.88%)
Splenda® Sucralose Micronized Powder—Tate & Lyle (0.1%)
Purefruit™ Select Monk Fruit Extract (0.88%)

Methods (all percentages are in wt. %)

Flavor Solubilization

Best practice for effective flavor solubilization was employed. This entails creating a pre-mix, blending humectant, insoluble flavor and solubilizer together, then adding this mixture to water. Humectant was fixed at 10%, flavor set at 0.5% and solubilizer evaluated at 1%, 2% and 3%. Three evaluations were performed in sequence. First, fluidity of the pre-mix was noted. Second, incidence of localized gelling upon initial addition of pre-mix to water, and upon further agitation. Third, clarity of the solubilizations was observed.

Aqueous Polymer Dissolution

Water-soluble polymers Xanthan Gum and Cellulose Gum were added at 1% concentration to water and pre-mixed with humectants (5% total formulation) before adding to room temperature water. Observations were made after hand stirring and after propeller mixing.

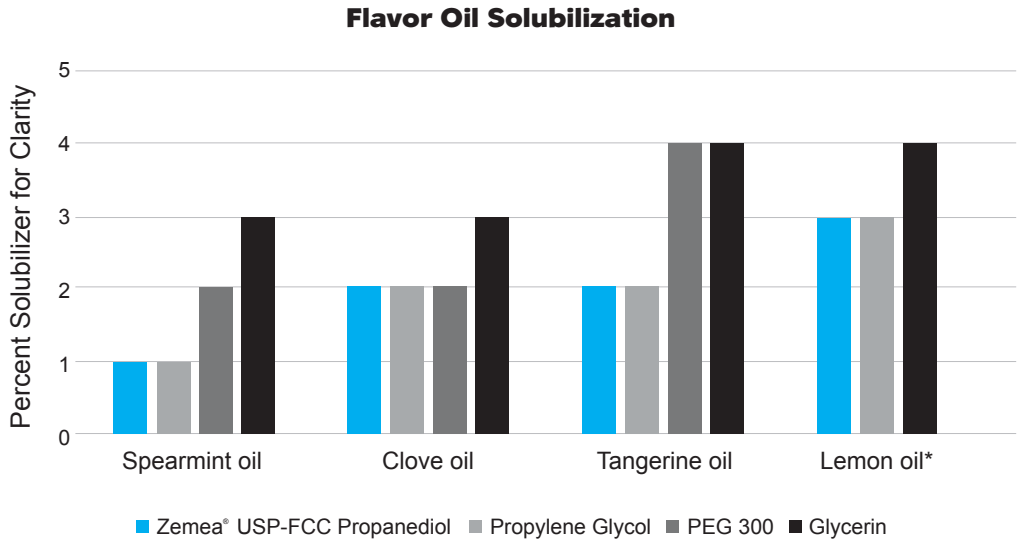
Sweetener Carrier

A baseline concentration of 2% sugar in water was set and the other sweeteners adjusted to equivalent levels of sweetness—Stevia (0.88%), Sucralose (0.1%), Monk Fruit (0.88%). Each sweetener was added to room temperature water and propeller mixed at 250 rpm. Each was timed until full dissolution. Each sweetener was pre-mixed with Zemea® USP-FCC propanediol first, then added to water with equivalent level of agitation.

Results and Discussion:

Flavor Oil Solubilization

In the flavor oil solubilization pre-mix evaluation, all the humectant, solubilizer and flavor combinations were reasonably fluid and uniform except for those using Glycerin and Tangerine oil. This pre-mix was quite viscous and inhibited the entire solubilization process, helping to explain why final results using Glycerin tended to be erratic. All humectants eliminated localized gelling of the solubilizer and flavor. For the flavor solubilization evaluation, Glycerin was the poorest performer. PEG 300 was a bit better, but Propylene Glycol and Zemea® USP-FCC Propanediol were clearly superior. If no humectant is used, it would be expected that more than double the level of solubilizer will be needed to create a clear system. The negative impact on taste and unwanted foaming and additional cost make this option untenable. Below are the minimum percentage of solubilizer needed for clarity for each of the flavors with the individual humectant (chart scores of “4” mean clarity was not attained at the 3% maximum):



*PEG300 was not tested with Lemon oil

Aqueous Polymer Dissolution

It is nearly impossible to make a uniform hand-stirred aqueous polymer dissolution of Xanthan Gum or Cellulose Gum without pre-mixing with a humectant. The question then is which humectant to use. Zemea® USP-FCC propanediol is clearly superior for both Xanthan Gum and Cellulose Gum.

XANTHAN GUM

Zemea® USP-FCC Propanediol

Hand stirring–immediately smooth and uniform

Propeller mixing–immediately smooth and uniform

Glycerin

Hand stirring–thick and stringy, difficult to mix

Propeller mixing–small, dry 'fish eye' clumps

Propylene Glycol

Hand stirring–initial clumping, smooth with continued stirring

Propeller mixing–smooth after continued stirring

PEG 300

Hand stirring–settles in water initially, smooth with continued stirring

Propeller mixing–smooth but with occasional gel clumps

Xanthan Gum Dissolution ratings (***** best to * worst)

	Zemea® USP-FCC Propanediol	Propylene Glycol	Glycerin	PEG 300
Hand Stirring	****	***	*	**
Propeller Mixing	*****	****	**	***

CELLULOSE GUM

Zemea® USP-FCC Propanediol

Hand stirring–initial clumping, smooth with continued stirring

Propeller mixing–immediately smooth and uniform

Propylene Glycol

Hand stirring–settles in water initially, followed by large clumps and gel layer at bottom

Propeller mixing–smooth except for few large clumps

Glycerin

Hand stirring–stringy upon addition, then thick gel layer at bottom

Propeller mixing–difficult to mix due to viscosity of pre-mix, then some small clumps

PEG 300

Hand stirring–small gel clumps with dry center initially, then smooth gel

Propeller mixing–smooth but with very small gel clumps dispersed throughout

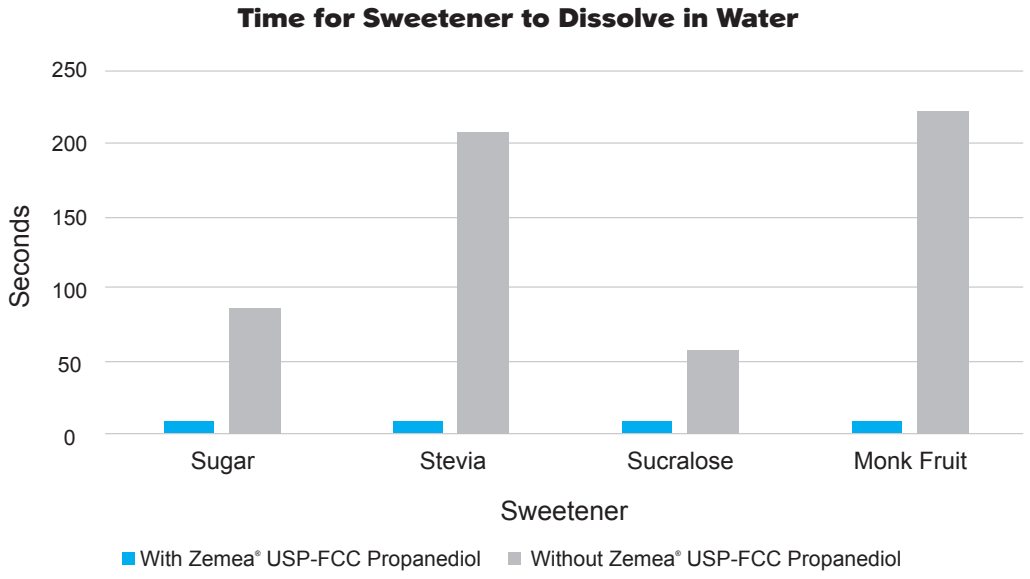
Cellulose Gum Dissolution ratings (***** best to * worst)

	Zemea® USP-FCC Propanediol	Propylene Glycol	Glycerin	PEG 300
Hand Stirring	***	**	*	***
Propeller Mixing	*****	***	**	***

Sweetener Carrier

Zemea® USP-FCC propanediol functions extremely well as a sweetener carrier. When a sweetener is pre-mixed with Zemea® USP-FCC propanediol, creating a clear solution in room temperature water with minimal mixing energy takes approximately 10 seconds. The following times were required for full dissolution of the sweeteners in water:

Sugar	1 minute, 28 seconds
Stevia	3 minutes, 27 seconds
Sucralose	58 seconds
Monk Fruit	3 minutes, 43 seconds



Preliminary work indicates that Zemea® USP-FCC propanediol can reduce the bitter after-taste of Stevia in a reduced-sugar drink mix formulation.

Conclusions:

- Flavor solubilization should always be accomplished by pre-mixing a solubilizer and flavor with a humectant prior to introduction to water.
- Bio-based Zemea® USP-FCC propanediol is superior to Glycerin and PEG 300 for aiding flavor solubilizing, and comparable to Propylene Glycol.
- Aqueous polymer dissolution is best accomplished by first pre-mixing a polymer into a humectant prior to introduction to water.
- Bio-based Zemea® USP-FCC propanediol is superior to Propylene Glycol, Glycerin and PEG 300 for aqueous polymer dissolution, and allows for even hand stirring of polymers into room temperature water.
- Sweeteners are brought into solution much more rapidly when a sweetener carrier is used.
- Bio-based Zemea® USP-FCC propanediol can reduce sweetener dissolution rate from minutes to seconds.

Summary:

Zemea® USP-FCC propanediol has the potential to make beverage and other food products have greater appeal to the consumer and easier processing for the manufacturer.

zemea-performs.com

About DuPont Tate & Lyle Bio Products

DuPont Tate & Lyle Bio Products is a joint venture between DuPont, a global science innovator, and Tate & Lyle, a world-leading renewable food and industrial ingredients company. DuPont Tate & Lyle Bio Products provides natural and renewably sourced ingredients that enhance product performance. We offer solutions for a variety of markets and applications through our bio-based performance brands, Susterra® and Zemea®. For more information, visit www.duponttateandlyle.com

DuPont Tate & Lyle BioProducts™