National Starch
FOOD INNOVATION

Novel Ingredient Solutions for Formulating Clear-Type Beverages

Ricardo Rodriguez
Technical Service Senior Chemist
National Starch Food Innovation
Bridgewater, New Jersey

Novel ingredient solutions for formulating clear-type beverages

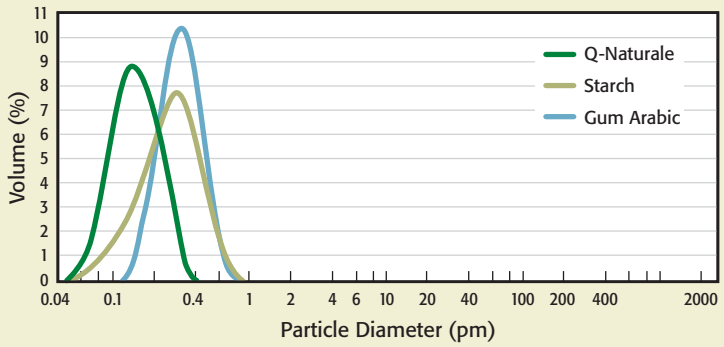
Top trends such as vitamin fortification, "health and wellness" and natural profiles are driving growth in the beverage industry (Leatherhead, 2011). Not surprisingly, beverage manufacturers are continually in product development and reformulating mode to proactively influence and deliver on consumer health benefit and taste preferences. Novel advances in ingredient science are enabling manufacturers to meet these formulation goals.

Historically, in the beverage industry, clear-type beverages like waters and sports drinks have been made using water based colors, flavors and other ingredients instead of oil based. There are three main reasons for this:

1. Oil based flavors/colors require weighting agents, like ester gum and sucrose acetate isobutyrate (SAIB) to stabilize them in the emulsion. These weighting agents contribute opacity in the finished beverage.
2. Often, more emulsion may need to be added to the finished beverage to assure delivery of the desired taste/flavor. More emulsion translates in higher opacity, making it difficult to maintain clarity.
3. Typical emulsifiers used in the beverage industry can only achieve a minimum particle size (when using standard processing techniques) when stabilizing an emulsion – this particle size is usually above 0.250 microns on average. The higher the particle size, the more opacity is contributed to the final beverage. So, it would be beneficial when formulating clear beverages to have a *finer* particle size in the emulsion.

Aside from weighting agents, emulsifiers or stabilizers are needed to make a stable emulsion. The most widely used

FIGURE 1: Differential volume



Q-Naturale produces ~0.15µ emulsion particles for excellent emulsion and beverage stability.

Source: National Starch Food Innovation, 2011

emulsifiers in the beverage industry are gum acacia/arabic and modified starch. There are various products in the industry based on gum acacia/arabic with some differences, they but essentially function the same way. Both work well enough and are functional, but they do have limitations.

A main limitation of both of these emulsifiers is in stabilizing higher oil loads in emulsions. The limitation is due to the fact that higher oil loads require higher ratios of emulsifiers, and these types of emulsifiers become too viscous and cannot be processed.

For this reason, high oil load emulsions have not been utilized in the beverage industry – typical oil loads are below 15% (See Table 1).

A Novel ingredient solution

Clearly, there is a gap in the market that needs to be filled in order to produce clear beverages with high oil load emulsions. Quillaja high-efficiency emulsifier was developed to fill that gap. Quillaja high-efficiency emulsifier is a naturally-derived extract from the quillaja tree endemic to the country Chile. It is grown with sustainable agricultural practices certified by the Forest Stewardship Council and is non-GMO.

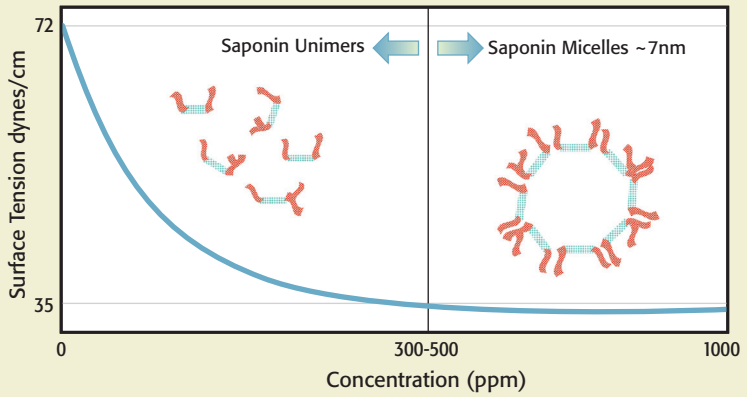
Quillaja emulsifier functions differently than standard emulsifiers used in the beverage industry in that it forms micelles to stabilize emulsions. The active component in quillaja

TABLE 1: Emulsifier comparison

Emulsifier	Usage level	Oil level	Dissolution or hydration time	Mean particle size (micron)	Beverage and emulsion stability
Quillaja	**2%–3%**	**8%–12%**	**none**	**0.154**	**1 year**
Gum arabic	16%–18%	8%–12%	1 day	0.354	1 year
OSA-starch	12%	8%–12%	1 day	0.278	1 year

Source: National Starch Food Innovation, 2011

FIGURE 2: Quillaja saponin micellization



Source: Mitra S. Dungan S., J. Agric Food Chem, 1997, 45, 1587

emulsifier (saponin) allows it to act as a surfactant. Quillaja is very surface active, and the micelles form rapidly around the oil droplets once they are mixed together, creating a stable emulsion. This gives quillaja based emulsions the ability to emulsify higher oil loads without increasing the overall viscosity of the emulsion, which is critical in processing and for overall stability.

Quillaja high-efficiency emulsifier has a very low molecular weight, around 1800-2000 kDa, when compared to gum arabic and modified starches. It also has an HLB value around 13.5 making it ideal for high oil load emulsions. Another key benefit of quillaja emulsifier is that it is sold as a liquid and does not require hydration. Quillaja high-efficiency emulsifier has a similar viscosity to water, which is very low, and it forms very fine emulsions when made using typical processing equipment (e.g. a homogenizer).

Successfully formulating clear beverages

For all of the reasons stated above, quillaja high-efficiency emulsifier is the ideal emulsifier to utilize in making emulsions for clear beverages. Because of its excellent emulsifying properties, low viscosity and other attributes, quillaja emulsifier has the ability to stabilize high oil loads. Quillaja emulsifier can utilize the RCP method* and stabilize oil loads of up to 50% oil. In addition, these high oil load systems can be made without weighting agents and still produce stable and fine particle sized emulsions. Thus, quillaja emulsifier is a novel solution for utilizing oil based ingredients in clear beverages:

- Quillaja high-efficiency emulsifier emulsions can be made without weighting agents.
- Quillaja emulsifier emulsions can utilize the RCP method to make high oil load emulsions, up to 50%, which would require less amounts of the emulsion to be delivered into the finished beverage.
- Quillaja emulsions on average have a fine particle size below 0.200 microns, typically around 0.150 microns, using a standard homogenizer.

For example, formulations can be made using quillaja high-efficiency emulsifier with up to 50% of a citrus flavor, without a weighting agent. Small amounts of the emulsion can be delivered into a finished clear-type beverage like a flavored water. Omega-3 emulsions can be made using 50% oil, minimizing the amount of emulsion needed in a finished beverage to meet daily requirements. Because of this, the sensory and stability of the beverage would be drastically improved.

Example of success

A beverage manufacturer had a goal to replace gum arabic so they could make a naturally-derived, stable emulsion with added benefits including the removal of weighting agents, improved efficiencies in manufacturing/processing times (because no extended hydration time is necessary with quillaja emulsifier), and the ability to make high oil load emulsions. The customer was able to successfully scale up (at a plant level) highly concentrated emulsions with up to 45% of a flavor using quillaja emulsifier.

*The RCP method basically states that it takes a maximum of 64% by volume fraction of a solid to pack a given space/system randomly. If you are below 64%, you are in a loose pack state, which will destabilize quickly. If you are above 64%, you are in a crystalline state, which is not stable.

Key learnings:

Quillaja high-efficiency emulsifier is a novel, naturally-derived and sustainable product that provides innumerous beverage formulation opportunities due to its unique attributes. It is now possible to deliver a wide range of actives, nutrients, vitamins and other ingredients, including oil based, in clear-type beverage formulations and applications.

The differentiating beverage emulsification properties of quillaja emulsifier include:

- High-load emulsions
- Excellent long-term cold temperature stability
- Functionality in a wide range of pH levels
- Solution-ready liquid to speed manufacturing

Quillaja high-efficiency emulsifier helps beverage manufacturers formulate a complete range of products, from juice and energy drinks to carbonated beverages, and to clear and alcoholic beverages. Emulsion and beverage producers can enjoy greater efficiencies, superior performance, cost competitiveness and a sustainable supply chain.

For more information, please contact National Starch Food Innovation at 10 Finderne Avenue, Bridgewater, New Jersey 08807-3300, Phone: 866-961-NATL (6285), E-mail: food.enquiries@nstarch.com, or visit: www.foodinnovation.com.

National Starch Food Innovation (US)
10 Finderne Avenue
Bridgewater, New Jersey 08807-3300

Directory Assistance
Tel: 1-866-961-NATL (6285)
Fax: 1-609-655-4402
Internet: www.foodinnovation.com

National Starch Food Innovation (Canada)
106 Summerlea Road
Brampton, Ontario L6T 4X3
Toll free: 1-866-414-1263
Tel: 1-905-799-2009
Fax: 1-905-454-2526

Unleashing the power of starchology™

National Starch
FOOD INNOVATION

11-0061