Novel Ingredient Solutions for Removing Weighting Agents

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Weighting agents are often used in flavored soft drinks providing stability and turbidity to beverages. Although there has been a high demand to remove weighting agents due to potential concerns relating to their chemical compositions and process inconvenience, recently developed Q-NATURAL® and PURITY GUM™ Ultra emulsifiers are known to stabilize non-weighted emulsions and beverages.

Typically, beverages such as soft drinks start off as emulsions: containing water, oil, weighting agents and beverage emulsifiers. Because water and oil are not naturally miscible, emulsions are used to deliver oils to make uniform and stable beverages. Citrus oils and other oils are important for beverage emulsions, but they also present a major problem for the emulsions because of their low density.

Citrus oils, a popular flavor, have a specific gravity of 0.845 to 0.890 g/cm3. The specific gravity of a 10–12% sugar solution of soft drink is about 1.038–1.046 g/cm3. Such high specific gravity difference between the discrete phase (oil) and the continuous phase (aqueous) makes a flavor emulsion/flavored beverage extremely difficult to stabilize. Under Stoke's law,* the oil droplets turn to cream (the migration of the dispersed phase of an emulsion over time), and that causes phase separation in the emulsion or ringing in beverages. The creaming speed is proportional to the difference of specific gravity and the square of the droplet size. As a remedy, weighting agents, such as brominated vegetable oil (BVO), sucrose acetate isbutyrate (SAIB), and glycerol ester of wood rosin (ester gum) are mixed with flavors to increase the specific viscosity of the oil phase.

Weighting agents, key ingredients that enable delivery of oil soluble flavors and actives into beverages, have several potential significant disadvantages to consumers and beverage marketers:

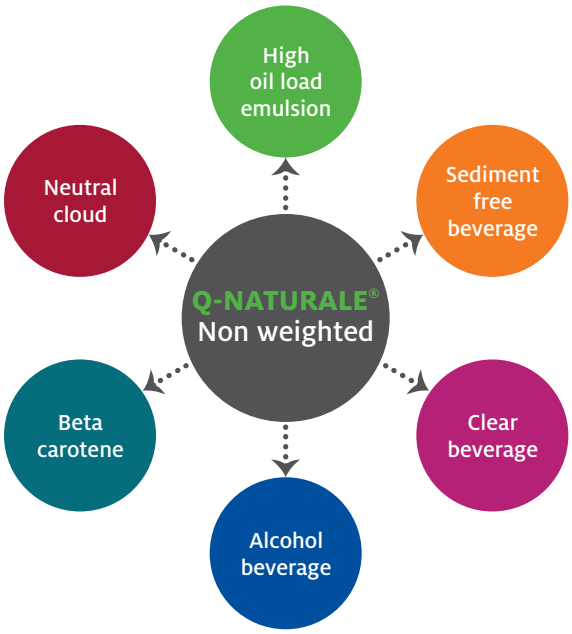
- **Weighting agents may be viewed as a health concern by consumers:**
  - BVO no longer has GRAS (generally recognized as safe) status in the U.S. It was removed from GRAS status list by the Food and Drug Administration (FDA) in the mid 70's. Currently, the FDA limits the use of BVO to 15 ppm but the substance is still listed on the agency's food additives list that has interim approval pending.
- **Regulatory limits on weighting agent usage level:**
  - Glycerol ester of wood rosin (Ester Gum): 100ppm
  - Sucrose Acetate Isobutyrate (SAIB): 300ppm
  - Brominated Vegetable Oil (BVO): 15ppm
- **Weighting agents are expensive and contribute as much as 50% to the formulation cost of the emulsion**
- **Time consuming process in dissolving weighting agent**
- **Weighting agents cause sedimentation in beverages, especially in alcoholic beverages**

Ingredion offers two recently introduced novel ingredient solutions, Q-NATURALE and PURITY GUM Ultra high efficiency emulsifiers, to deliver both flavor (or color) and turbidity effectively without the use of weighting agents. In addition, these novel ingredients allow beverage manufacturers to maximize oil load and minimize water usage in emulsion concentrates for significant savings.

Q-NATURALE®

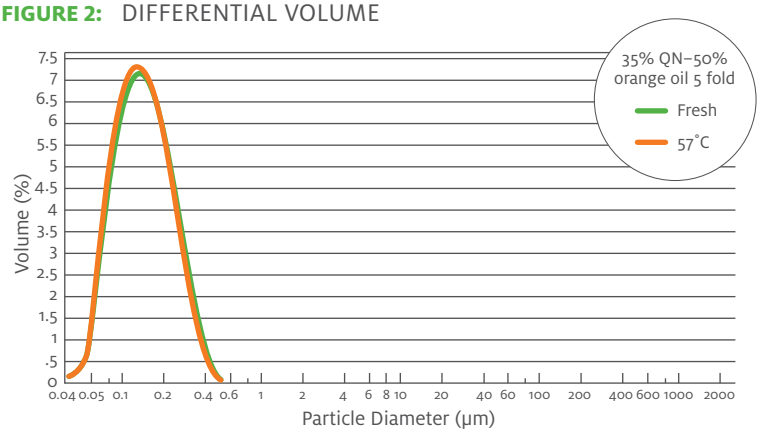
Q-NATURALE emulsifier is derived from Quillaja Saponaria Molina tree (native to Chile). Extracted by a natural process, Q-NATURALE is a highly efficient emulsifier that can emulsify non-weighted oil systems — a solution for a wide range of beverage applications (Figure 1).

FIGURE 1: BENEFITS OF Q-NATURALE®



*Batchelor, G.K. *An Introduction to Fluid Dynamics*. Cambridge University Press. 1967;223.

FIGURE 2: DIFFERENTIAL VOLUME

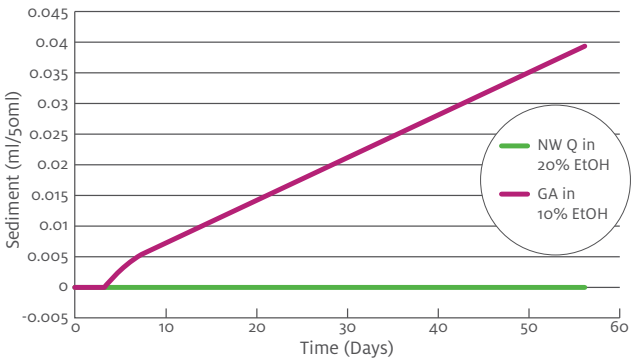


Q-NATURALE® emulsifier in non-weighted systems is ideal for clear beverages and waters.

Q-NATURALE can produce very stable emulsions without the use of any weighting agents, through achieving an emulsion droplet size of less than 0.15 micron. Fine emulsions are critical to stabilized non-weighted emulsions, and they can also enable clear beverages. It was discovered and patented that such stable emulsions can only be achieved at around random close pack (RCP) volume fraction. RCP is a parameter used to characterize the maximum volume fraction of solid spheres can randomly pack into. Figure 2 demonstrates the ability of Q-NATURALE emulsifier to form small particle size emulsions that allow for high oil load of flavors and actives. This ability to carry high levels of oil allows for clear beverages because lower doses can be used.

- **Q-NATURALE emulsifier in 20% alcoholic beverage** Q-NATURALE non-weighted emulsions minimize the sediment in beverages containing 20% alcohol because it reduces the density difference between 2 phases (oil and water) and also produces a very fine stable emulsion for clear alcoholic beverage (Figure 3).
- **Q-NATURALE emulsifier can deliver challenging natural colors such as beta carotene into beverages without the need of weighting agents!**

FIGURE 3: NON-WEIGHTED EMULSIONS MINIMIZE SEDIMENT IN 20% ALCOHOLIC BEVERAGES



Natural equivalent colorants, such as beta-carotene, are highly crystalline. They typically require a high amount of non-active oil in order to be dissolved, and the resulting emulsions are very difficult to stabilize. Typically, beta-carotene is less than 14% when dissolved in the non-active oil phase.

The formulation in Table 1 features a stable, high oil load, non-weighted emulsion, and clear beverage, based for which, the recommended Q-NATURALE/carotenoid ratio is 10/1 for clear beverages, and 5/1 for turbid non-weighted beverages.

TABLE 1: BETA CAROTENE EMULSION FORMULA

INGREDIENTS FOR CLEAR BEVERAGE	%	INGREDIENTS FOR TURBID BEVERAGE	%
30% beta carotene suspension in canola oil	19.04	30% beta carotene suspension in canola oil	10.5
Non-weighted D-Limonene	23.56	Non-weighted D-Limonene	24
Q-NATURALE	57.14	Q-NATURALE	15
Sodium Benzoate	0.25	Sodium Benzoate	0.25
Water	up to 100	Water	up to 100

Results

Q-NATURALE/ ACTIVE RATIO	% Q-NATURALE IN EMULSION	EMULSION PARTICLE SIZE (µ)
10/1	57.14	0.09
5/1	15	0.3

PURITY GUM® Ultra emulsifier

Another option for removing weighting agents is PURITY GUM® Ultra — a cost-effective beverage emulsifier that stabilizes high oil load. Its unique oil stabilizing properties optimize oil droplet size distribution, which contributes

to beverage turbidity. PURITY GUM® Ultra emulsifier also reduces costs and energy use by enabling high oil load emulsions and eliminating the need for weighting agents.

- **PURITY GUM Ultra emulsifier in Neutral cloud emulsion (high oil load)**
  PURITY GUM Ultra emulsifier provides excellent particle size distribution of less than one micron in non-weighted neutral cloud emulsions. Therefore, it is the only OSA-starch choice for non-weighted applications.
- **PURITY GUM Ultra emulsifier in non-weighted flavored — (20%flavor : 80%MCT), 6% starch to deliver opaque beverage PURITY GUM Ultra at 6% usage level can emulsify up to 24% non-weighted oil load and deliver the same flavor and turbidity as a weighted system with traditional starch at their typical usage level of 12% starch. This results in a simpler label, reduced cost and doubled productivity.**

TABLE 2: FORMULA 1 – FLAVOR OIL

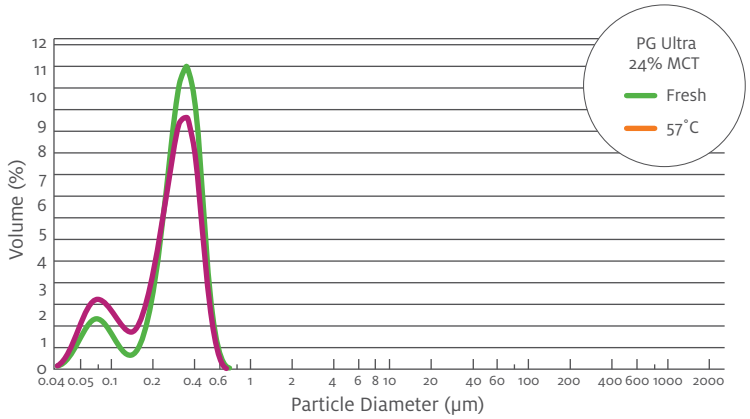
INGREDIENTS	NON-WEIGHTED (%)	WEIGHTED (%)
Orange oil (1x)	0	48
Orange oil (5x)	20	12
MCT	80	0
Ester gum	0	40
Total	100	100

TABLE 3: FORMULA 2 – ORANGE OIL EMULSION

INGREDIENTS	PURITY GUM ULTRA (%)	TRADITIONAL STARCH (%)
Flavor oil	24	12
Stabilizer	6	12
Sodium benzoate	0.2	0.2
Citric acid	0.30	0.30
Water	Up to 100	Up to 100

PURITY GUM Ultra emulsifier in non-weighted flavored emulsion

FIGURE 4: PURITY GUM ULTRA EMULSIFIER IN A NON-WEIGHTED CLOUD EMULSION (24% MCT)



**Stress test @ 57°C 1 day corresponds to 6 months at ambient temperature*

Performance Summary

Manufacturers can now remove weighting agents from their beverages, addressing potential consumer concerns about these types of ingredients, while reducing their emulsion costs. Q-NATURALE and PURITY GUM Ultra emulsifiers have demonstrated that they can create highly stable emulsions and sufficiently small emulsion droplet size to eliminate the need for costly weighting agents, such as BVO, SAIB and ester gum.

Beverage manufacturers can also create clear and alcoholic beverages without worrying about sediment and ringing, offering consumers better products with simpler labels.

Corn Products and National Starch
are now Ingredion.

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