Hydrocolloids for Suspension & Stabilization in Beverages

These ingredients can help suspend cocoa particles in high-protein beverages and functional oils in water bases.

by Nesha Zalesny

The beverage industry is one of the most innovative and fast-paced sectors within F&B. Despite COVID-19 measures, which had most product developers working from home, beverage industry launches grew 6.2% (Global, CAGR 2019–2021). Beverage marketing tactics such as product placement in coolers at the front of the store and large eye-catching labeling enable companies to capture consumer interest with new and diverse products.

The portable nature of beverages lends itself to innovation. Beverages with new flavors, new functional ingredients, or new packaging seem to be introduced on a weekly basis. Three of the biggest trends in beverages right now are protein beverages, functional ingredients added for energy/relaxation, and sugar reduction. Hydrocolloids are tools that help formulators bring these innovations to life.

Protein Beverages

Who didn't have a New Year's resolution to lose a little weight and become more fit? Many consumers choose to support their health goals with meal replacement shakes or high-protein beverages. Walk into any big box store in January and chances are there will be a large display of high-protein meal replacement shakes. Offerings will run from simple chocolate or vanilla varieties formulated with milk proteins to fully organic plant-based protein beverages.

Newer protein shake trends include keto-friendly, balanced carbs, or new flavors such as salted caramel, birthday cake, or cookies and cream. The protein content may be derived from milk or plant sources, but they are all neutral pH beverages.

Carrageenan-Casein Synergy

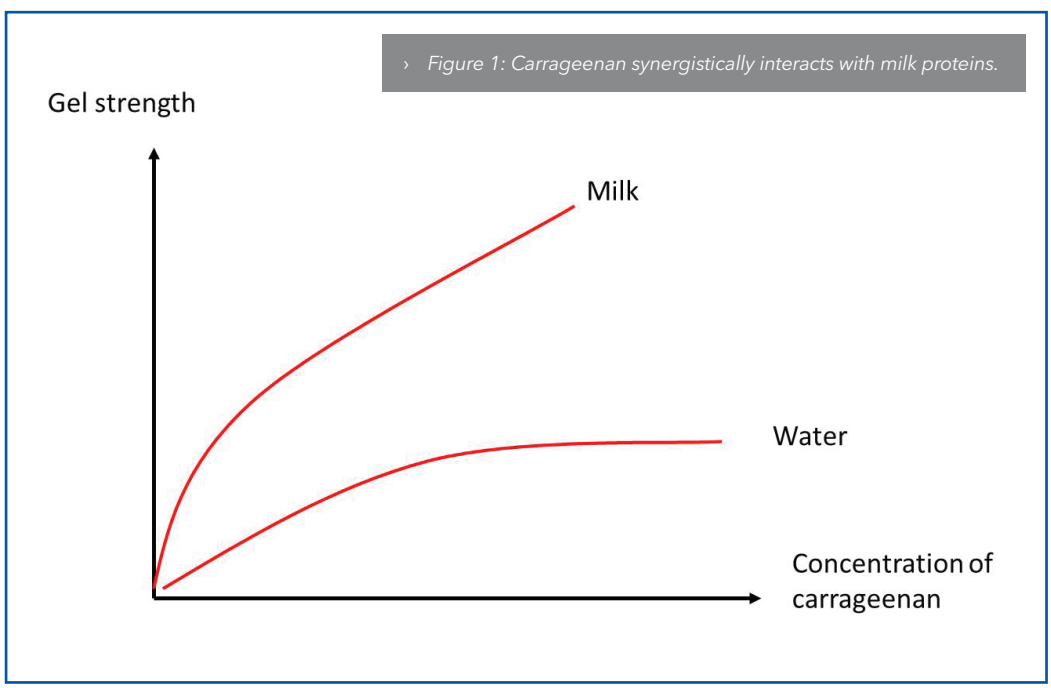
For neutral pH milk protein-based beverages, it is hard to beat carrageenan. Carrageenan is derived from red seaweed, which can be found wild or cultivated in seaweed farms. These farms are located throughout the globe. The seaweed itself needs little to no fertilizer or other inputs to grow and can be raised using eco-friendly methods. Market research conducted by IMR International estimates that well over 250,000 earn a living from seaweed cultivation, making this a high employment industry.

One of the biggest advantages of carrageenan is that it interacts with casein protein to form a three-dimensional network that suspends protein or cocoa particles. Because of this, use levels can be very low, in the 0.018%–0.025% range. Use levels will need to be adjusted to account for different fat levels and different types of cocoa. Highly alkaline cocoa can interfere slightly with the synergistic binding between carrageenan and casein proteins and may require higher use levels. Figure 1 indicates just how synergistic carrageenan is with milk proteins.

Neutral pH milk protein-based beverages stabilized with carrageenan are highly thixotropic. These beverages are essentially gelled while sitting still, but the gel network is easily disrupted when the consumer begins to drink them. The viscosity of the beverage all but disappears as it is shaken or consumed. The carrageenan-casein network recovers when the beverage sits still and becomes gel-like once again. It takes a little time for it to recover completely.

One key aspect to working with carrageenan is that it has a relatively low gelation temperature. Beverages made with carrageenan should be deposited below 25°C for the best texture. If the beverage is deposited above this temperature, the carrageenan is likely to form localized gel regions, which can result in a gloppy flow.

Along with carrageenan, many high-protein meal replacement beverages also contain microcrystalline cellulose (MCC) and carboxymethylcellulose (CMC). The insoluble MCC is a rod-like chain of cellulose that is co-processed with CMC, which is soluble. This co-processed blend is added to a beverage and activated by homogenization. When it is properly activated, it forms a colloidal network with itself. A good

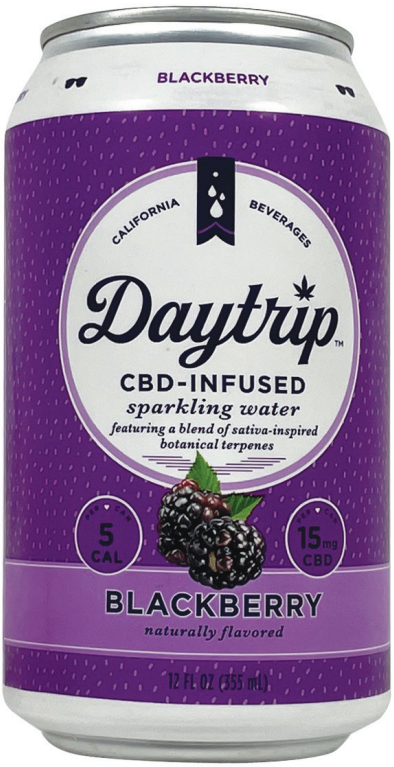


› *Figure 1: Carrageenan synergistically interacts with milk proteins.*

DAYTRIP CBD-INFUSED SPARKLING WATER WITH BLACKBERRY FLAVOR (US)

Water, less than 2% medium-chain triglycerides, gum acacia, cannabidiol from hemp, citric acid, terpenes, natural flavor.

Acacia gum delivers oil-based CBD in a water beverage.



way to visualize this is to picture a cotton ball that is pulled apart piece by piece. A single cotton ball can fill a 200 mL beaker. Add 200 mL of water to these fibers in the beaker and you have a conceptual picture of what the colloidal MCC and CMC do in a beverage.

Like carrageenan, the MCC network is highly thixotropic. A small amount of shear pulls the tendrils apart, but they re-tangle after sitting. This networked colloidal suspension will stabilize cocoa and added calcium. The high surface area of this network also helps stabilize emulsions. This is especially useful if a small amount of functional fat is added to the beverage.

Gellan Gum for Non-Dairy

For neutral pH plant-based beverages, high acyl gellan gum is especially useful. Unlike carrageenan, gellan gum is not dependent on protein synergism to form a stable network. Gellan gum is a fermentation-derived hydrocolloid. It is a very long-chained polysaccharide that forms a stable, double-helical stranded network with itself. The long strands interact with themselves and other strands, forming a net that suspends particles such as protein, cocoa, or added minerals. Use levels for gellan gum are also low, between 0.028%–0.035%.

Gellan gum does not interact with fat. Several hydrocolloid specialists have created gellan gum blends that contain an emulsifying grade of gum acacia. Blenders also add a bit of mouthfeel by adding a viscosifying hydrocolloid such as locust bean gum, tara gum, xanthan gum, or CMC. The addition of these ingredients will be less than 0.1%, depending on the grade. One gellan manufacturer has a grade of high acyl gellan gum that does not need added mouthfeel enhancement. Gellan gum has a high gel set temperature. It can be deposited above 25°C and 70°C and still form a stable network.

Protein in Fruit Beverages

For a food science experiment at home, mix orange juice and milk and watch as protein flocculates and drops out of the solution. Adding heat to this mix speeds the process up immensely. Many proteins have an isoelectric point of pH 4.5–5.0. Protein-fortified fruit beverages fall well below this range. To prevent flocculation and precipitation of protein, beverage manufacturers have three good options: pectin, CMC, or soy fiber. These hydrocolloids protect the protein found in these drinks, while maintaining a drinkable texture.

In its native state, above the isoelectric point (>4.5–5.0), protein is negatively charged. Below the isoelectric point, the protein becomes positively charged. At a lower pH, pectin, CMC, and soy fiber are negatively charged in some of the molecules' regions.

The prevailing theory is that these negatively charged regions interact with the positively charged region of the protein. The rest of the long-chain polysaccharide that does not interact directly with the protein forms a protective layer around the protein. This protective layer physically and electrostatically repulses other hydrocolloid encased proteins, preventing flocculation. These protected protein micelles will stay suspended for much longer than unstabilized proteins.

The creation of this stable system is very temperature-dependent. It is important to completely hydrate the hydrocolloid and then blend this solution with the hydrated protein. These two solutions should be blended while at room temperature. The pH can then be adjusted to 3.8–4.2 and the beverage processed like a juice. Pectin and soy fiber will create stable beverages with a refreshing light viscosity. Formulators may have more texture options with CMC, from low to high viscosity.

VLY COCOA DRINK (GERMANY)

Water, pea protein (5.6%), dates (4.1%), rapeseed oil, cocoa powder (1.3%), natural flavors, citrus fibers, sea salt.

A plant-based protein beverage stabilized with citrus fiber.

Collagen Waters

One of the latest and biggest protein trends is collagen waters. These highly drinkable, lightly flavored beverages feature collagen peptides, which are derived from gelatin. Collagen peptides have been shown to be beneficial for not just hair and skin, but also for bone and joint health. Collagen peptides are water-soluble themselves and do not generally require additional stabilization. These have been increasingly popular and are only bound to grow with an aging population.

Functional Ingredients

Energy beverages have been popular for many years. These usually contain water-soluble B complex vitamins, herbal extracts, such as guarana—which is a natural source of caffeine—in addition to caffeine. Some also contain amino acids and other ingredients. Many of these ingredients are bitter or have other off-notes. On the opposite end of the market, relaxation ingredients often have similar issues.

Oil Emulsions

In the US, one of the most popular new ingredients for beverages is CBD oil. The flavors used to make these ingredients are crucial for consumer acceptability.

Oil and water do not mix on their own. Add a few drops of vegetable, CBD, or orange oil to water and shake to mix them together. Initially, the water will be cloudy and homogenous. Within a few minutes, the oil droplets will be visible on the surface of the water, and the water will be clear again. To stabilize the oil in the water, an emulsifier or hydrocolloid that interacts with both water and oil needs to be used. Formulators have a few choices. The primary hydrocolloid choice is acacia gum, but beet pectin or citrus fiber can also be used.

Acacia gum has two grades, seyal and senegal. The senegal type is the emulsifying grade used to create stable flavors and functional oil emulsions. The creation of a stable emulsion with hydrocolloids uses similar a mechanism to the one used for protein in low pH systems.

Acacia gum, beet pectin, and citrus fiber have hydrophilic portions that interact with water as well as hydrophobic portions that interact with oil on the same molecule. The hydrophobic portion interacts with oil and will coat the surface of an oil droplet. The hydrophilic portion will interact with the surrounding water. The hydrophilic layer repulses other hydrocolloid coated oil droplets, preventing them from agglomerating and floating to the surface of the water. This technology can be used to deliver a wide variety of functional oils as well as oils used for flavor.

Acacia gum has an advantage in this system in that it does not impart a lot of viscosity even at high concentrations, so emulsions made with it are easily dispersed.

Sugar Reduction

Reducing the amount of sugar consumed is a primary concern for many consumers. So much so that many countries have implemented government policies designed to push both manufacturers and consumers to reduce their sugar intake. Sugar-sweetened beverages may contain anywhere from 8%–15% sugar. This number goes up to 20%–25% for slushie-type frozen beverages. High-intensity sweeteners such as stevia or monk fruit can be used to replace sugar.

Removing 8%–15% of sugar removes calories, but also removes a lot of mouthfeel and body. There are some great hydrocolloid options for adding body back. Pectin, xanthan gum, CMC, and guar gum are all good options at low concentrations. Pectin is especially good in reduced-sugar fruit juices or fruit-flavored beverages.

Other hydrocolloids like acacia gum (seyal type) can also be added to give a fiber boost as well as a small amount of body. Acacia gum has recently been added back to the US Food and Drug Administration (FDA) fiber list after being removed in 2016.

There are a lot of great innovations in the beverage market. Manufacturers are using hydrocolloid systems to create great-tasting high-protein beverages, deliver a variety of functional ingredients, and create healthier low sugar options. The texture options available from hydrocolloid use have barely begun to be discovered. ▼

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WELCH'S DIET CRANBERRY GRAPE FLAVORED JUICE DRINK (US)

Filtered water, concord grape juice concentrate, citric acid (for tartness), cranberry juice concentrate, natural flavor, vegetable juice (for color), stevia leaf extract, sodium citrate, pectin, ascorbic acid (vitamin C), fruit juice (for color).

Pectin adds body to this sugar-reduced fruit juice.