Texturizing Beverages for Stability and Mouthfeel

A short guide to hydrocolloid formulation in protein drinks, lattes, soft drinks, and alcoholic offerings.

by Nesha Zalesny

The beverage industry is a world unto itself within the food industry. It is highly fragmented with multiple categories, an incredible number of producers and consumers. Beverages come in a wide variety of textures, flavors, and functionalities. Shoppers can choose products that fit within their preferences and lifestyles. Whether keto-friendly, vegan, paleo, or other—there's a drink for that.

Of course, each of these categories has its own technological challenges for stabilizing ingredients and providing the desired texture. This article will focus on tips and tricks for stabilizing and texturizing beverages. When considering what hydrocolloid to use for stabilization, it is helpful to classify beverages by alcohol content, pH, and protein content. Other major factors are processing conditions and shelf life. A large part of the nonalcoholic market is water, which is not stabilized, and therefore outside the scope of this article.

Neutral pH Beverages with Protein

Dairy and plant-based milk alternatives fall within this category. These beverages have a neutral pH and contain varying amounts of protein. Generally, dairy milk is not stabilized. Milk proteins and fat globules are generally less than 1 micron, which means they will remain in suspension for the shelf life of the milk. Cream and chocolate milk contain either milk fat that will agglomerate and float to the top over time or cocoa particles that are larger than 1 micron, which will settle to the bottom of the beverage. Both cream and chocolate milk benefit from the addition of a stabilizer. The hydrocolloid of choice for both is carrageenan.

Stabilizing Cream with Carrageenan

Carrageenan works synergistically with casein to form a three-dimensional network that physically separates fat globules, thereby stabilizing high products high in milk fat. By the same token, the casein-carrageenan network keeps cocoa particles in suspension by slowing settling. The use level of carrageenan in dairy milk beverages is very low, it will be in the 0.018%–0.025% range. For thicker chocolate milk or milkshakes, microcrystalline cellulose, guar, tara, or locust bean gum (carob) are often added to provide a more decadent mouthfeel.

Gellan Gum for Non-Dairy

Plant-based milk alternatives do not contain casein, so carrageenan is not the first choice for these beverages. Carrageenan can be used, but without the synergistic effect of casein, the use level is higher at 0.03-0.05%. A better choice may be high acyl gellan gum. Gellan gum provides the suspension properties necessary to suspend plant-based protein or cocoa particles throughout the product's shelf life. Gellan gum on its own has an extremely clean mouthfeel so many manufacturers are choosing to add a small amount of a galactomannan, such as locust bean gum (carob bean gum), guar gum, or tara gum, to modify the mouthfeel of the beverage. The use level for gellan gum is 0.028%–0.032% and for the galactomannans is 0.1% or less. The senegal type of gum acacia can be used to emulsify added fat in these systems.

Latte Perfection

Latte-type products can contain either dairy or a plant-based alternative plus coffee and flavor. They can be produced using high-temperature/short-time pasteurization (HTST), ultra high-temperature processing (UHT), or retort processing. Lattes should have a light creamy texture regardless of the "milk" coming from dairy or plants.

To achieve this, UHT processors have turned to high acyl gellan gum for suspension, with a galactomannan such as locust bean, tara, or guar gum to add some mouthfeel. UHT processing of latte-type products can be problematic. Coffee itself is acidic, and UHT temperatures are harsh. Protein protection by buffering the pH is crucial. A pH range of 6.7–7.0 is recommended. For retort-processed lattes, switch to HM pectin for its protein-protective properties.

Texturizing High-Protein Sports Drinks

Gyms have been closed for many months during the pandemic. However, protein-fortified beverages used by bodybuilders remain popular as convenient meal replacements. The diet industry has wisely repositioned meal replacement shakes as protein-fortified beverages, choosing to accentuate the positive (protein content and low carb) rather than focus on the negative (meal replacement and diet). These beverages benefit from a systems approach.

If casein is present, a suspending hydrocolloid such as carrageenan is used. High acyl gellan gum is the ingredient of choice for plant-based proteins. Microcrystalline cellulose and carboxymethylcellulose (MCC/CMC) are often also used.

The colloidal cellulose modifies

Starbucks Non-Dairy Almond & Oat Milk Caramel Macchiato

A neutral pH protein beverage, this Starbucks product is stabilized with gellan gum for protein suspension and guar gum. Notice the addition of potassium citrate and baking soda for buffering the pH. Buffering is essential for UHT processed coffee products.

Ingredients:
Almond milk (water, almonds), oat milk (water, oat flour), sugar, coconut oil, pea protein, natural flavor, potassium citrate, baking soda, gellan gum, guar gum (from the guar plant).

Nestlé Coffee Mate Oatmeal Crème Pie Creamer

This creamer is a neutral pH protein beverage. It is stabilized with carrageenan for protein suspension and colloidal microcrystalline cellulose (cellulose gel, cellulose gum), which assists with process tolerance and mouthfeel.

Ingredients:
Water, sugar, vegetable oil (high oleic soybean and/or high oleic canola), and less than 2% of micellar sodium caseinate (a milk derivative), mono-and diglycerides, dipotassium phosphate, natural and artificial flavor, cellulose gel, cellulose gum, carrageenan, salt.

mouthfeel and stabilizes the suspension over time. It is especially useful in low-fat or non-fat beverages, as it mimics the feel of cream in the mouth. These high-protein products are most often UHT-processed and are shelf-stable. Use levels for carrageenan will be similar to chocolate milk (0.018%–0.025%) if milk proteins are used. Gellan gum will also be the same at 0.028%–0.035%. MCC will be approximately 0.3%. Again, protein protection for UHT processing in these beverages is crucial.

High-Protein Mixes

Dry mix instant cocoa or protein shakes are designed to be consumed quickly. These products simply need some added viscosity to aid in temporary protein suspension and mouthfeel. Gum acacia (senegal type) is often used to deliver any added fats in these systems. Senegal type acacia is the emulsifying grade that is used for the delivery of liquid fats in dry form. In many cases, these dry mixes contain a small amount of carrageenan for protein stabilization during spray drying, and CMC, guar, or xanthan gum for mouthfeel. The selected hydrocolloid needs to be a rapidly hydrating type, either a very fine mesh product or an agglomerated product depending on the concentration of the other ingredients.

A good rule of thumb is a 10 to 1 ratio. There should be 10 parts of the other ingredients to 1 part gum for the best chance of hydration of the hydrocolloid. Most protein powders do contain a sufficient amount of other ingredients to meet this requirement.

Low pH Beverages with Protein

One of the hottest growing trends within the food industry is probiotics or fermented foods. Fermented beverages such as drinkable yogurts and kefir are considered low pH, protein-containing beverages. These can be made with dairy or plant bases. The struggle most plant-based products face is offering products with a similar protein content as dairy-based products. Plant-based proteins such as pea have very distinct flavor profiles that are not enhanced by fermentation. A possible solution may be a blend of several different plant-based proteins such pea, lupin, and soy to improve flavor. Whatever the protein source, is dairy or plant-based, it can be stabilized with HM pectin or MCC and/or CMC. Another great option is citrus fiber, which contains HM pectin native to the citrus peel.

Protein-Fortified Juice

Hybrid fruit juice products such as protein-fortified juice appeal to consumers seeking to support their health. These directly acidified protein beverages are also stabilized with HM pectin, MCC, and/or CMC or

› *UHT processing of latte-type products can be problematic due to acidity. Protein protection by buffering the pH is crucial.*

soy fiber.

There are a few tips for producing these beverages successfully. The first tip is to start with a small uniform protein particle. This will help with stability and is especially relevant for plant-based protein juice beverages. To do this, hydrate plant-based proteins by homogenizing them. This step makes the protein particles small and uniform and also roughs up the surface of the protein particle, allowing for better contact with the stabilizing hydrocolloid. The next tip is to blend the hydrocolloid into the hydrated protein as close to room temperature as possible. Finally, add the juice and adjust the pH to 3.0–3.5 with a citric acid solution, again, at room temperature. The product can then be homogenized, pasteurized, and packed following USDA guidelines for low pH juices.

Non-Protein Low pH Beverages

The beverages in this category include carbonated soft drinks, fruit juices, and fruit-flavored drinks (belly washes). Concerns over the expanding waistlines of consumers have led to global efforts to reduce sugar consumption. In beverages, sugar not only sweetens, it also provides some mouthfeel. When sugar is removed from carbonated soft drinks, the beverage becomes watery. Small amounts of hydrocolloids work well to improve the lack of mouthfeel. There are several that work well; xanthan gum, CMC, and MCC at very low use levels (0.03%–0.06% wt/vol) will add a subtle amount of viscosity to sugar-free soft drinks. Sugar reduction is also an opportunity to fortify with fiber. There are many soluble fiber options to incorporate, some of which have a naturalness.

Reducing Sugar in Juice

To reduce sugar in fruit juice-based beverages, it is necessary to reduce the amount of actual fruit juice used. Pectin can replace the body lost when removing some juice content to reduce sugar and total calories in RTD juices. Dry mix fruit beverages are more popular outside the US. They are available in a wide variety of flavors and many contain gum acacia (senegal type) as a flavor carrier. Gum acacia (seyal type), by contrast, is a good choice for fiber fortification, in the EU, and a natural mouthfeel.

Gum Acacia Regulation

At the moment, gum acacia is considered a fiber in the EU, but it is not yet on the FDA-approved fiber list. Small amounts of xanthan gum or CMC are good choices to create a light mouthfeel in the reduced-sugar dry mix. The agglomerated form of these hydrocolloids are recommended as these often do not contain enough other ingredients for the 10:1 ratio recommended for good hydration.

Stabilizing Cocktails

With bars and pubs closed in many parts of the world, consumers are creating and enjoying cocktails from home. The presence of alcohol presents a challenge to many hydrocolloids. Biogums such as xanthan or gellan gum, carrageenan, and many others are insoluble in concentrated alcohol. They are processed by precipitation with isopropyl alcohol. However, most cocktails have low enough concentrations that many hydrocolloids will function. A simple rule of thumb is the alcohol content should be 30% or lower.

Beer & Liqueurs

While not commonly used in the US, globally, propylene glycol alginate (PGA) is used as a foam stabilizer in beer. PGA reduces interfacial tension of the beer, which helps with air incorporation while pouring. Bailey's Irish Cream is stabilized with gum acacia. The senegal type, which is the emulsifying grade, keeps the fat in the "cream" from agglomerating and floating to the surface of the bottle. Gum acacia is one of the few hydrocolloids that does not have solubility issues with alcohol.

Minute Maid Soft Frozen Orangeade

This frozen product contains pectin and guar gum to give the product the slushy mouthfeel when frozen. This slushy product would be a great cocktail base as well.

Ingredients:
Micron filtered water, sweeteners (sugar, corn syrup), concentrated orange juice, maltodextrin, less than 1% of: natural flavors, pectin, guar gum, citric acid (provides tartness), annatto and turmeric (for color).

Future Products that Pop

There are so many nutritional and functional ingredients that can be offered in a variety of textured beverages. The only constraints are processing challenges and stability. Tastes are also changing. Millennials and Gen Z are popularizing "mocktails," mixed drinks that do not contain alcohol but have exotic flavors and textures typically found in cocktails.

Boba or bubble milk teas are also becoming more popular as Asian flavors and textures become more mainstream in the West. Traditionally, boba beads are made with tapioca starch. But, different textures can be achieved with different hydrocolloids. The exploding boba is made with sodium alginate. A softly gelled multicolored boba can be made with gellan gum. Jelly pieces created with agar can also offer other textures to beverages.

The biggest challenge to these becoming a reality is processing. Multi-colored boba balls need to use oil-soluble colors that won't bleed into the surrounding beverage. Turmeric, beta carotene and annatto work fairly well.

Finally, hydrocolloids are being looked at as a possible solution to packaging waste. Sodium alginate can be used to create a film around water for a novel bottle-free delivery system. The film, made by setting sodium alginate in calcium is edible and biodegradable. Hydrocolloids can provide a world of textures and even packaging to beverages. They are limited only by the imagination and consumer acceptance.▼

Nesha Zalesny is co-author of ***The Quarterly Review of Food Hydrocolloids***, an in-depth analysis on hydrocolloids, produced by IMR International since 1991.