

Gums That Improve on Nature

By Donna Berry, Contributing Editor

Natural, native gums are highly functional ingredients that contribute to the texture, stability and other physical attributes of processed foods. However, sometimes, they need physical or chemical modifications to extend functionality, or enable them to overcome various processing and shelf-life challenges. For example, a few gums naturally have a small affinity for fat; however, modification improves this attribute, enabling them to function as emulsifiers by dispersing fat in aqueous solutions.

Gum basics

All gums must be hydrated to function in a food system, so they are characterized as hydrocolloids, with “hydro” meaning water and “colloid” referring to the dispersion of small particles in another medium. Gums can structure water, thereby allowing other ingredients in a food system to be dispersed and suspended in an aqueous medium.

“The food-ingredient category called gums refers to high-molecular-weight, long-chain, carbohydrate-based polymers that are capable of modifying aqueous solutions by creating viscosity, as well as sometimes gelling,” says Allen Freed, CEO, Gum Technology, Tucson, AZ. “They can create a wide range of rheologies, depending on the choice of single gum or the synergistic blend of more than one gum.”

Mar Nieto, senior principal scientist, TIC Gums, Belcamp, MD, further explains, “Gum polymers are either linear polysaccharides consisting of one sugar monomer, or linear and consisting of a repeating dimer; linear with another sugar substitution or side chain on the linear backbone; or branched consisting of a mixture of different sugars.

“In addition, they can exhibit either a neutral charge (e.g., acetate esters, methyl ethers, other neutral sugars), negative charge (e.g., carboxylate, sulfate groups), or positive charge (e.g., amino groups) due to the presence of various chemical groups attached to individual monosaccharide units,” continues Nieto. “All of these structural features of gums contribute to their differences in solubility; synergy or incompatibility with each other or with other ingredients (e.g., proteins, minerals, acids and lipids); thickening, gelling and emulsifying properties; and their film-forming properties.”

Freed says: “Plant-based gums include those derived from seeds, such as guar and locust bean. Cellulose gum is derived from the fibrous material in plants.

“Tree exudates are a fancy name for sap, like maple syrup,” continues Freed. “The difference between maple syrup and gums like gum arabic (acacia gum) and gum tragacanth is that these saps harden as they ooze from the tree. The hardened sap is picked off the tree and ground down to a fine flour. Each has its own unique attributes.”

There are also marine and microbial food-gum sources. “You will see names like carrageenan, alginate and agar. These are marine gums,” says Freed. “Xanthan gum is produced by microorganisms and is considered to be just as natural as those gums that come from plants and the earth’s waters.”

While many gums are used in a natural, albeit refined state, others need a helping hand to improve on nature.

From the lab

As mentioned, physical or chemical modifications can extend hydrocolloid functionality. A few gums have “more-mysterious names, products that are the creation of a person in a white coat,” says Freed. “The most common of these is probably carboxymethyl cellulose (CMC), which starts out as cellulose but is chemically modified to enhance functionality.”

Nieto explains: “Gums are modified or derivatized to improve their functionality. One good example is modified gum arabic, which is produced by adding a lipophilic group to the gum arabic molecule to improve its emulsification property. The raw gum is a poor emulsifier, and the modified gum arabic is a very good emulsifier.”

Generally, a modified gum is mainly called on to provide a specific functionality that can't be achieved with a natural gum. “A formulator making table syrup might opt to use CMC, because this gum provides thickening without changing the clarity of the syrup,” continues Nieto. “A salad-dressing manufacturer may opt to use propylene glycol alginate (PGA) in French dressing in conjunction with xanthan gum in order to emulsify the oil and improve stability of the finished dressing. Or, he or she could use modified gum arabic in place of PGA to provide emulsification without the additional thickening.”

PGA is an ester of alginic acid in which some of the carboxyl groups are esterified with propylene glycol; some are neutralized with an appropriate alkali and some remain free. “The addition of propylene glycol groups to the alginate molecule imparts emulsifying and whipping properties to this gum, properties that are not shown by the parent material,” says Nieto.

These products can provide economic advantages, too. Many salad-dressings rely on PGA; however, its price and short supply present challenges. A new stabilizing system based on modified gum acacia serves as a 1:1 replacement for PGA, offering comparable emulsion stability, viscosity and sensory attributes, and making reformulation unnecessary. It prevents oil separation, provides creamy texture, emulsifies at low concentrations and is stable in harsh environments, such as high acid, high salt and high temperature. This agglomerated gum system allows easy dispersion and rapid hydration, resulting in more batches per shift and increased yields from existing production equipment. It is versatile on its own and when used in combination with other ingredients.

“In beverage emulsions, a formulator would opt to use modified gum acacia for hard-to-emulsify oils or for high-oil-load emulsions,” says Nieto. “Otherwise, the emulsion could cream or break down.”

Sold on cellulosics

Modification greatly improves the functionality of cellulose, an abundant polysaccharide found in all plants. The food-ingredients marketplace has numerous cellulose derivatives. “Examples include hydroxypropyl methyl cellulose (HPMC) and methylcellulose (MC),” says Nieto. “These ingredients are derived from their insoluble parent material: cellulose. The parent material has no functional properties in foods, except as a bulking agent or source of insoluble fiber. Modified celluloses are very good thickeners, film formers, water binders, and texturizing or aerating agents.”

Unique to MC and HPMC is the ability to form gels at elevated temperature. These cellulose ethers function in reverse of gelatin. They are firm when warm and soft when cool, with actual temperature varying by the ingredient, as there are a range of MC and HPMC ingredients based on degree of substitution and polymer

backbone length. This feature is ideal for foods that need stability at cooking temperatures, such as preventing a sauce from thinning out or a filling to boil out. Both MC and HPMC can improve a food that undergoes heating during processing or preparation and needs stability at cooking or processing temperature. Such modified cellulose ingredients also function as binders in products such as veggie burgers and batter-coated fried foods due to their cohesive nature at low temperatures and the structural integrity of the gel at higher temperatures.

The Dow Chemical Co., Midland, MI, developed a food emulsion system that allows meat formulators to develop healthier products by reducing the overall fat content based on a mixture of MC, HPMC and oils such as canola or olive. It allows makers of frankfurters, burgers and sausages to replace partially hydrogenated oils.

Introducing the emulsion system at the Food Ingredients Europe Expo last year, Stephanie Lynch, global market manager, food and nutrition, Dow Wolff Cellulosics, a subsidiary of Dow Chemical located in Bomlitz, Germany, explained to attendees: "Both the general public and food manufacturers are highly attuned to the issue of trans and saturated fats and their impact on health. On the other hand, a label boasting healthy fat choices will not be enough to convince consumers to buy the product again if it fails to deliver on taste or appearance. Our emulsion technology helps food formulators to incorporate healthier oils while mimicking the texture of other saturated fats."

The Aug. 2008 issue of *Food Hydrocolloids* (22; 6:1,062-1,067) includes a study showing that MC can be added to batters to reduce fat absorption during frying. The researchers also investigated if pre-frying impacts the foods' fat and moisture content, and the sensory acceptability.

Sensory evaluation showed that the battered foods (with or without pre-frying) made with MC were equally as acceptable as conventional products. The researchers found that the lowest oil contents were obtained without pre-frying in all products.

"This means the process without pre-frying is a suitable alternative to producing a wide variety of good-quality, healthier battered food with good sensory acceptability," wrote lead author Ana Salvador from Instituto de Agroquímica y Tecnología de Alimentos, Valencia, Spain.

In the May 2008 issue of the same journal (22; 3:387-402), researchers investigated HPMC in batter-coated fish nuggets. The mackerel nuggets were coated with HPMC prior to battering or coated with batter containing HPMC. Both additions of HPMC improved crust crispness through the formation of a thermal gel barrier, which prevented the diffusion of water from the fish nugget into the crust during microwave reheating.

These are the major products currently on the U.S. market, but expect more to come if their cost-benefit ratio makes sense. For example, Chinese scientists have altered xanthan gum to make it easier to dissolve by reducing its intermolecular interactions and crystallinity. (*Carbohydrate Polymers*, 2003; 53(4):497-499). Other techniques, such as enzymatic alteration of the structure of guar to change its gelling characteristics are under investigation (*Carbohydrate Polymers*, 2005; 62(3):267-273).

While modified gums can provide advantages, product designers need to remember "modification impacts the way gums are labeled," concludes Nieto. "Gum arabic, when modified, must say 'modified gum arabic' on the label." The cellulose and alginate derivatives are also labeled by their chemical name. For all such modified gums, their use is restricted to products without a natural claim.

Donna Berry, president of Chicago-based Dairy & Food Communications, Inc., a network of professionals in business-to-business technical and trade communications, has been writing about product development and marketing for 13 years. Prior to that, she worked for Kraft Foods in the natural-cheese division. She has a B.S. in food science from the University of Illinois in Urbana-Champaign. She can be reached at donnaberry@dairy-food.com.