Indispensible Hydrocolloids in Plant-Based Ready Meals

Hydrocolloid systems can enable sophisticated prepared meals for today's consumers who demand clean label and sustainable products.

by Nesha Zalesny

If you ask people of a certain age what they think of when they hear "prepared meals," most will remember a frozen divided aluminum tray with a piece of meat covered in a thick gravy in the center, a section with a serving of mashed potatoes, another section with a veggie medley of some sort, and finally, another section with dessert.

If that person is old enough, they'll even say that they cooked it for 45 minutes to an hour in the oven—not in the microwave. These salty but bland prepared meals were a treat for many kids who grew up in the 60s and 70s.

Fast forward to 2021 and prepared meals are seen by many as a large part of the diet. Meal options cater to a variety of lifestyles such as plant-based or keto-friendly and can come from the freezer, the refrigerator, and even off the shelf (ambient).

Many consumers expect these products to be healthy, organic, or clean label and are looking for sustainable options.

Here we explore some of the most common hydrocolloid applications in plant-forward ready meals, although the list is by no means exhaustive.

Frozen Meals

Those divided trays with a meat, starch, vegetable, and dessert still exist in many markets, but tastes have evolved. Today's consumers are more likely to purchase Asian-inspired beef tips in a spicy soy sauce with rice than a Salisbury steak with mashed potatoes.

Plant-forward or flexitarian consumers are opting for vegetarian "beefless" tips in spicy sauce. The rice would not need additional texturing. However, to deliver the proper texture, the meat and sauce could have a few texturizing options.

Fried Plant-Based Meat Replacements

Most parents have had a period in their child-rearing when their child will only eat chicken nuggets, french fries, and maybe an apple (if they're lucky).

Having plant-based options may ease the guilt for many consumers. Consequently, one of the fastest-growing market segments is plant-based meat such as chickenless chicken tenders or nuggets.

The primary challenge for these products is maintaining the texture through par frying, freezing, and then the finished cook step completed by the consumer.

Hydrocolloids assist with binding water which helps slow ice crystal formation which increases freeze and thaw stability for these products.

There are actually two matrixes to be concerned with for the nugget. The spongy meat-like matrix comes primarily from a combination of texturized vegetable proteins that are bound with a starch.

The more difficult challenge is the batter texture. It should cling to the protein/starch matrix during the battering process, should not explode in the fryer during the par fry process, and finally, it should impart a crisp texture after the consumer fries or bakes it.

Perfecting the Batter

Xanthan gum, guar gum, or cellulosics such as carboxymethyl cellulose (CMC) or hydroxypropyl methylcellulose (HPMC) can improve the cling of the raw batter. Some of these hydrocolloids also form a film that slows or prevents excessive fat uptake of the fried food.

These are at low use levels, generally 0.25% or less. The batter itself is comprised primarily of starches. Whether wheat-based or gluten-free, a higher amylose starch—usually corn—helps bind the batter together and give a crisp texture. Starch can be included anywhere from 2%–4% in a batter system.

It functions by swelling as it hydrates, then gelatinizing as it is heated in the oil during frying. As water is driven off, a scaffold network of set starch granules remains. High frying temperatures also drive amylose and amylopectin to cross link, further setting the scaffold.

Once frying is done, the starch scaffold sets, imparting a crispy texture. The best starch blend not only gives the right bite for a fried food, it also avoids starch retrogradation which can lead to a soggy and stale texture after freezing and reheating.

Methylcellulose's Unique Property

Rather than the spongy soft chicken-like texture of nuggets, beefless

Marie Callender's Meatless Be'f Pot Pie

This beef-less pot pie contains a wide variety of plant-based protein sources along with vital wheat gluten and soy protein.
The "Be'f" utilizes methylcellulose (MC) for binding and freeze-thaw stability. The filling contains modified corn starch and additional MC for the gravy.
MC gels when it is heated, and liquefies when it cools. It is included to keep the meat substitute and veggies from migrating (floating or sinking) too far during baking.

beef tends to have a firmer bite. To achieve this, many manufacturers are turning to methylcellulose (MC). MC is unique among hydrocolloids in that it forms a firm gel when hot, and melts and provides viscosity when it cools.

It provides an ideal texture for many plant-based meat products because it mimics protein hydrolyzing as it cooks. To conceptualize the functionality of MC, imagine the texture of a boiled egg.

Then, imagine the boiled egg going back to the texture of a raw egg once it is cooled. The firm gel of the hot methylcellulose along with the plant-based protein gives a bite very similar to cooked meat, and imparts juiciness as it cools.

It is included at 1%–2% depending on the texture that the formulator wants and the grade of MC. Frozen products may not need the super gelling type products that the refrigerated products use. This may be a way to reduce the formulation cost.

MC Alternatives

Formulators have options when considering how best to meet consumer expectations. There are other hydrocolloid systems such as blends of xanthan and konjac, locust bean gum and carrageenan, or konjac and carrageenan.

These synergistic blends form a firm thermo-irreversible gel to mimic the bite of beef. Oftentimes, manufacturers add a small amount of a viscosifier, such as guar or CMC, to impart the succulence of tender-cooked beef. Gum acacia (Senegal type) or citrus fiber can be used to emulsify the fat added to this system.

It is interesting to note that consumers of plant-based products don't seem to be as fazed by the length of the ingredient declaration as one would expect.

Saucing it Up

Sauces or gravies make a great addition to plant-based meat alternatives that might be a little plain on their own. A simple mushroom gravy or a sweet and sour sauce may need only the addition of 2%–4% starch to thicken the sauce.

However, many starches retrograde and give up water under freezing conditions. This can yield a curdled looking or watery sauce. Traditionally, a modified starch was used to slow retrogradation. But with many consumers demanding more label-friendly ingredients, native or physically modified starches may be the better option.

Several starch producers have launched "functional native starches" which claim to have the performance of modified starches without the need to label them as such. These will appear as simply waxy maize, corn, potato, or rice starch on the label.

Tapioca or cassava is another option that is becoming increasingly popular with plant-based audiences. It has a wide range of pH stability and can be labeled as either a starch or a flour.

One of the primary challenges for the industry is delivering reduced sugar, carbohydrate, or salt options. If starch is not an option, a combination of a functional fiber such as citrus fiber and a viscosifying hydrocolloid such as guar, xanthan, or CMC may be good choices.

Cauliflower is Everywhere

Some trendier options for frozen foods include pizza crusts made with cauliflower as the main ingredient. These products are usually lower-carb, gluten-free, and many support a keto-friendly diet.

Gluten-free products often use

a combination of brown rice flour, tapioca starch, and xanthan gum to give a similar chew to a pizza crust made with high-gluten wheat flour.

Keto-friendly products usually contain cheese, egg white, and xanthan gum as binders for the crust. These products may benefit from the addition of MC or HPMC for similar reasons as plant-based meats.

The MC or HPMC, used at around 2%, would form a gel as the crust is baking and bind the ingredients firmly while the product is hot.

Sodium Alginate to Prevent Food Waste

One of the hottest topics within the food industry is the prevention or mitigation of food waste.

The US Department of Agriculture (USDA) estimates that as much as 30%–40% of the global food supply is wasted.

This is incredibly expensive in terms of natural resources, and also tremendously expensive in terms of the cost to humanity.

There are many issues to tackle in food waste. One small part of the solution may be to use a hydrocolloid such as sodium alginate to make "ugly" fruits and vegetables into useable products.

There are a few examples already on the market. The pimentos in stuffed olives are usually made with sodium alginate. Many onion rings are made by creating a slurry of onions, water, spices, and 0.8%–0.9% sodium alginate.

This slurry is then extruded into a water bath that contains calcium (usually calcium lactate as it is less bitter than $CaCl_2$).

The gelled onion is then breaded and fried, and becomes an onion ring. Carrot pieces for canned soup or olive slices for frozen pizzas can be made with similar technology (minus the breading and frying step).

Because sodium alginate does not require heat for hydration, blueberries, cherries, peaches, or other fruits can also be created for fruit fillings, muffins, and desserts, utilizing fruit that may not be able to be sold in grocery stores.

These binding properties can also be used in restructured meat products from pieces that might otherwise go to waste.

Refrigerated Prepared Foods

A new trend in grocery stores in the US is meal "crates."

These crates mimic the concept of a home delivery meal-prep service such as Blue Apron, where all the raw ingredients come in the meal kit and the consumer prepares the finished dish.

But whereas there is a subscription for Blue Apron kits delivered directly to the home, similar kits can be found in the grocery store with no subscription required.

These are short shelf life products that contain raw meat or plant-based meat, vegetables, and sauces.

What generally sets these products apart is that they are curated with specialty ingredients.

They often contain organic, high-quality meat options, fresh spices or sauces, and organic fresh vegetables.

The sauces are usually made with high-quality, organic starches, which sets them apart from other products. These high-performance starches also add a bit of process tolerance for home cooks.

The world has felt as if it has been set on pause for over a year. If there are any positives in the situation, it is that many consumers have rediscovered a love of cooking and preparing meals at home.

Whether it is with new plant-based meat analogs, interesting sauces, alternative pizza crusts, or an entire meal expertly put together and then (inexpertly) cooked at home, hydrocolloids can enhance textures and flavors, while meeting in-demand label claims. ▼

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

Rebellyous Foods Plant-Based Nuggets

These plant-based nuggets have wheat gluten and soy protein concentrate and isolate as their protein source. The protein is bound together with modified corn starch and methylcellulose. The texture of the breading is achieved with rice starch.

Amy's Meatless Pepperoni Pizza

This plant-forward pizza contains tapioca starch which has many properties that make it suitable for frozen meals.
Tapioca starch has found a nice niche within the plant-based product market especially among clean label producers.
This pizza is meatless—not plant-based—as it contains real cheese.