

# Chapter 1

## Hydrocolloids: Fifteen Practical Tips

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### **Tip One: Dissolving Hydrocolloids—The Influence of Mesh Size**

Achieving maximum hydrocolloid functionality in most food products begins with fully dissolving the hydrocolloid. Particle size or mesh size is a fundamental issue influencing solubility. The basic principle is that larger particles, corresponding to a coarser mesh size, such as 40–80 mesh, take longer to dissolve because the water takes longer to penetrate the dry hydrocolloid particle. A finer mesh particle, such as those that pass through 120, 150, or 200 mesh screens, takes less time for water to penetrate and become fully soluble.

However, the converse of this situation is that a coarser size particle is less subject to lumping, while a finer mesh particle lumps more easily. Once lumps are formed, achieving full solubility becomes more difficult and also takes much more mixing to do so.

There are two ways to overcome the potential for lumping for small particle size hydrocolloids. One is to use high agitation mixing. The other is to preblend the hydrocolloid with another dry ingredient such as sugar. By preblending, the hydrocolloid particles are separated from each other before entering the liquid, thereby minimizing lumping.

In summary, if high agitation is used in dispersing the hydrocolloid or if it can be preblended with a dry ingredient then fine mesh grades will allow the most rapid solubility. If mixing is not as vigorous and

the hydrocolloid is not preblended then it is safer to use a coarser mesh product to avoid lumping, even though this will require more mixing time to achieve full solubility.

### **Tip Two: Dissolving Hydrocolloids—The Influence of Temperature**

Some hydrocolloids require heat to dissolve. In these cases, it is important to know exactly how much temperature is required for the exact grade being used. There can be a substantial difference in the required temperature based on other ingredients, especially ions. Thus, it is important to heat the food product to different temperatures and determine the minimum temperature to achieve full functionality, in terms of maximum viscosity, gel strength, or stability of the food product.

Temperature should be measured carefully. First, the thermometer or thermal probe being used must be precise and accurate. Mechanical thermometers are especially notorious for requiring frequent calibration to ensure accuracy. Another issue can be that the product mixing is not sufficiently vigorous during heating, allowing pockets of higher or lower temperature. This must be ascertained by moving the thermometer or thermal probe around to different locations in the mix to determine if temperature gradients exist. The minimum temperature achieved in any part of the mix should be the benchmark used to determine if the temperature is adequate.

One contrary thought is important to add. Although it is important to achieve full functionality of a hydrocolloid, it is also true that some hydrocolloids can be partially degraded by excessive heat, for example, guar gum. Some other hydrocolloids may be degraded if there is a combination of heat and acid, for example, carrageenan. Therefore, the heating should be adequate to fully dissolve all the hydrocolloids and thus gain full viscosity, but not high enough that the viscosity is decreased due to partial hydrolysis of the hydrocolloid.

### **Tip Three: Dissolving Hydrocolloids—The Influence of Cations**

Some hydrocolloids are not highly influenced by ions (except at very high ion concentrations), for example, agar, xanthan gum, guar gum, and locust bean gum. Several others are influenced in their solubilization by

ions. These include sodium alginate, carrageenan, pectin, gellan gum, and sodium carboxymethyl cellulose (CMC). In these cases divalent cations and in some cases monovalent cations can influence the ability of the hydrocolloid to dissolve.

Calcium is the major issue for sodium alginate, ι-carrageenan, low-methoxy pectin, and gellan gum. Potassium is the major issue for κ-carrageenan, and sodium chloride can inhibit full viscosity development for CMC for certain grades. Options to circumvent reduced solubility include the following procedures.

First, the ions can be added to the food product after the hydrocolloid has been dissolved. Second, for gums such as carrageenan, where the ions are present with the gum powder, solubility can be achieved by heating to a higher temperature.

Third, for calcium, sequestrants can be added to bind these ions, at least temporarily, to allow the gum to dissolve. If water used in the processing plants is naturally quite high in calcium, this approach may be necessary if the water is not pretreated to remove these ions. Sequestrants include phosphate compounds such as sodium hexametaphosphate, tetrasodium pyrophosphate, and dipotassium phosphate and also citrates.

Fourth, also for calcium, it is possible to add in very low solubility forms, thus largely delaying the calcium going into solution until after the gum has dissolved. Tricalcium phosphate is a very slow-dissolving calcium source, and dicalcium phosphate is also quite slow, the anhydrous form being slower than the dihydrate form.

#### **Tip Four: Gelling Hydrocolloids—The Effect of Temperature**

Some hydrocolloids gel by simply cooling a hot solution. Agar and gelatin are the prime examples. Others gel after cooling, but also require ions to be present. These include κ- and ι-carrageenan, low-methoxy pectin, and gellan gum. High-methoxy pectin gels after cooling in a low-pH or high-sugar environment. Methyl cellulose forms and maintains a gel only while it is being heated.

The first significant aspect is to make sure the gum has been given enough heat to fully dissolve, as discussed in Tip two. Whatever amount of gum is left undissolved will not contribute to the final gel properties. Only fully dissolved gum will gel when cooled. The exact gelling

temperature will vary by the product and grade in a similar fashion as the solubility temperature varies. But this is generally less significant since eventually the product will generally be cooled to at least room temperature and fully gel.

The key item to remember when gel formation is occurring during cooling is whether the gel will be broken apart during gel formation or left intact. ι-Carrageenan has some gel “healing” properties, but most gums will not reform a gel well when the gel is broken up by agitation or motion during gelling. For most products, it is imperative that the gelled product is placed into a quiescent situation when the critical gelling temperature is near to being reached. For products where a disrupted gel is sought, it is still important to make sure that disruption occurs in a way to facilitate the exact product texture desired. This may require some experimentation.

There are cases where a semi-gelled structure is sought and in those cases mixing during cooling is often acceptable. One interesting example is the use of κ-carrageenan to suspend cocoa powder and also provide some mouthfeel in chocolate milk. If there is no mixing during the gel formation stage, the cocoa powder will completely settle out. If the product is mixed during cooling, the κ-carrageenan will be able to begin to suspend the cocoa as its weak gel begins to form. In this case the disruption of the gel by mixing is not a negative since the texture and stabilizing functionality that is desired is achieved.

#### **Tip Five: Gelling Hydrocolloids—The Influence of Cations**

Cations are needed for gelation of many hydrocolloids. Those requiring heating and cooling simply need adequate amounts of the appropriate cation to fully gel. Some cations may be present in the hydrocolloid powder, some in the other ingredients used to make the food, and some may be added to ensure that an adequate amount is present. Generally, enough should be added to get maximum gel strength, especially if it is a gelled product. If the gel is too strong then it is more economical to reduce the amount of the hydrocolloid used than to have the hydrocolloid starved for gelling ions.

An exception to this principle is when a semi-gelled-type product is sought. This type of product would generally be not seen as a fully gelled product but as something pourable, such as a sauce. However, some

linkages used in gelling are allowed to occur to take advantage of the thickening and stabilizing properties of the semi-gelled hydrocolloid.

In the case of sodium alginate, calcium is needed, but no heat, to form a gel. However, calcium also inhibits solubility, and therefore either the calcium must be added after the alginate has solubilized or the calcium must be bound using a sequesterant to allow the alginate to first dissolve, or the calcium can be added in a low solubility form where it slowly releases, mostly after the alginate is dissolved. Once the alginate is dissolved, the calcium may be added in a quickly available form or a slowly available form. The former includes calcium chloride and calcium acetate. The latter includes tri- and dicalcium phosphates. Intermediate is monocalcium phosphate and calcium lactate. If a quick reaction is desired then the product must already be in some mold (such as onion rings) or there must be no worry about a broken gel (such as imitation fruit pieces). If enough time is needed for the food product to be mixed and pumped then a slow-release calcium is used, such as for fruit fillings.

#### **Tip Six: Hydrocolloid Functionality—Texture**

Hydrocolloids have an impact, whether desirable or undesirable, on stability, texture, color or appearance, and flavor of the foods in which they are utilized. Hydrocolloids are generally added to a food to have a decisive role in one or both of the first two parameters. The goal should be to have a positive or neutral impact on all four parameters. In terms of the range of texture, hydrocolloids may be used to impart the characteristic texture of the food or be added for stability with the desire to have no noticeable impact on texture.

If the goal is to impart a specific texture then this texture should first be defined, and second measured in some way. Now, of course, food comes in a wide range of textures from thin liquids, to thicker but pourable liquids, to solid foods of many different types. Hydrocolloids are often used to make liquids thicker and even to give fairly thin liquids, such as chocolate milk or eggnog, a noticeable mouthfeel. Solid gelled foods are also frequently given their characteristic texture using hydrocolloids.

A characteristic texture may be the texture of a good prototype or a competitor's product that is being matched. The first step is to establish what will be the "gold standard" to be matched. The second step requires

that by taste testing and/or instrumental testing this gold standard's texture must be measured in ways that are reproducible. This allows newly developed sample prototypes to be accurately compared to the gold standard. The third step is to figure out what hydrocolloid or blend of gums will allow this texture to be achieved.

### **Tip Seven: Hydrocolloid Functionality—Stabilization**

Stabilization, with or without contributing to important textural parameters, is a prime reason why hydrocolloids are used in foods. Stability can often be defined best by a lack of negative effect: the food product does not fall apart. Loss of stability can be seen in a number of common dilemmas. These include separation of the product into phases, including something dropping to the bottom or separating to the top of the food. Separating components can be gaseous (foams), liquid (oil or aqueous layers), or solid (particulates or even a solid lump). Sometimes there is one main source of separation, and other cases involve multiple problems.

To best understand stability, it is necessary to fully understand instability. The food scientist will comprehend what makes the product stable by pushing at the edges of stability to see when and how an unstable product could occur. The advantage of this is that if problems should occur in the future in plant production, the scientist will have a list of common unstable prototypes and how these were made using deviations of the hydrocolloid levels. It is always good, for example, when 0.5% of a gum is used in a food to know how the product would look at 0.4%, 0.3%, etc., especially testing to see when the product would not hold together, and how it would separate. It could even be the source of new product ideas. What about a drinkable pudding?

Another potential problem with hydrocolloids being used to stabilize foods is overstabilization. This condition is caused by using too high a level of gums in a product, causing it to become too gummy, too firm, or in some other way too strong in texture. There are two approaches that can be taken to gain a more equitable texture while retaining full stability. The first is to lower the gum level or levels until the texture is appropriate and determine if the stability is still adequate. In many cases much of the gum used is not even necessary to achieve stability.

If this does not work then the use of a new stabilizer system may work to bring about full stability while not causing an overstabilized texture.

Too high a gum level can also cause the product to fall apart and separate because some bonds become too strong and therefore disrupt the overall equilibrium of forces holding the product together. A typical example of this concept is an increase of aqueous syneresis, where water is squeezed out of a gelled matrix.

Again, when this type of instability is present, it is useful to consider lowering the level of the stabilizer system to determine if improvement is possible while also avoiding introduction of new stability concerns. It can be a balancing act but is often not that difficult once the overall philosophy is adopted that both too little and too much of these powerful hydrocolloids can cause problems in the food, and therefore the optimum middle level should be sought.

### **Tip Eight: Hydrocolloid Functionality—Color or Appearance**

Hydrocolloids are most often used to provide intentional effects on texture and stability. But hydrocolloids can have noticeable effects on the color and appearance of foods, either intentionally or nonintentionally. These effects can be perceived as both positive and negative depending on the desired food parameters and which hydrocolloids are utilized. Let us review some major color or appearance effects caused by gums.

One major effect is the increase in opacity in foods that can be caused by hydrocolloids. In some cases this is due to insoluble particles found in the gum powder. Microcrystalline cellulose is completely insoluble and has the greatest effect in increasing opacity. If the desired product is a clear beverage, the opacity will be a negative, but in many products opacity is sought, especially if the product is a low-fat version of an established product. Removal of fat can reduce the opacity of foods, for example, in coffee whitener.

If the food product is considered of best quality when it is transparent, then transparent versions of several gums are available, including sodium alginate, xanthan gum, and carrageenan. For these gums the insoluble components are removed during processing. If a gum is not fully dissolved then this can be an additional source of insoluble particulates in the food product and therefore achieving full solubility is important from an appearance as well as textural point of view.

Opacity can also be caused by increased air incorporation, which gums can also contribute to. This can be either desirable or undesirable. If the latter, then the mixing procedure can be altered to minimize air incorporation. Gums can contribute glossiness and sheen to foods, which can be a strong benefit. The natural brightness of the foods can be accentuated this way. This is true of various sauces, fruit fillings and glazes, and many gelled products. Gums can provide an inherently positive benefit, and when compared to alternative texture providers such as modified starches, the contrast in quality can be staggering. The hydrocolloid-stabilized products are often seen to be much more bright, glossy, and full of rich, natural color than pure starch alternatives.

#### **Tip Nine: Hydrocolloid Functionality—Effects on Flavor**

Flavor effects are somewhat parallel to effects on color and appearance. Most of the time, the gums are added for reasons other than flavor, but flavor can be impacted. In most cases, flavor will be somewhat suppressed by the use of gums. This can be a negative effect when flavors are added or are naturally present in a food. Some of that flavor will be suppressed, requiring the use of additional flavor. It can be a positive effect when flavors are desired to have less impact, such as acid flavor in salad dressings. In this case, flavor suppression is helpful to allow the product to be less harsh.

Since a thick product requires something to make it thick, the question is not whether flavor suppression occurs but how much is acceptable and to use appropriate choices among hydrocolloids to achieve the best product. As with color, starch tends to have the most flavor-suppressing effect, and therefore substitution by the much lower levels of gums needed tends to cause a large increase in flavor perception. In many cases this is a big positive effect, but in some cases the starch suppresses undesirable flavors. Also, among hydrocolloids there is a wide range of flavor suppression. These are best explored experimentally since it is not simply a matter of more or less flavor, but flavor nuances as well. Certain components of a flavor profile may be suppressed more or less than other components. A comparison of four or five gums in a food system will quickly indicate the differences in flavor release caused by the various gums.



**Tip Ten: Using Hydrocolloids—Basic Tests**

Hydrocolloids can be complicated to completely understand and use most effectively. One danger is that one or two gums, the easiest to use, will be used again and again in all applications. Product quality and cost savings may both be sacrificed by this approach. It is prudent to take steps to learn about all the major hydrocolloids, at least those that are used in the specific food where product development efforts are focused.

Learning about hydrocolloids can occur on many levels including observing the effects on functional properties and stabilities of foods with various hydrocolloid types and levels. But it is a simple process and well worth the investment of research time to make up pure solutions and/or gels of various hydrocolloids. Simply making up 1% solutions or gels of a number of hydrocolloids in water, or in some cases milk, can be very instructive. Observe the appearance and color of the solutions or gels. Then compare the textures and flavors of the hydrocolloids. Is the texture long or short; that is, is it like jam (long textured) or does the liquid break from itself quickly and cleanly (short)? What kind of mouthfeel does each of the gums provide? Is this the texture desired in the food product itself?

It is also interesting to check stability properties such as suspending ability by adding some spices or other particulates and determining the ability of the gums to stabilize emulsions by adding oil and mixing the oil into the aqueous phase to generate an emulsion.

A day spent in the laboratory with the above-mentioned assignment would add immensely to the practical understanding of the world of hydrocolloids. It is true that within a food system there are a myriad of sometimes complex interactions. At the root of it all, however, are the hydrocolloids and their immense effect on the water within the food.

**Tip Eleven: Using Hydrocolloids—Single Gum versus Multiple Gums**

Although it may be a challenge to fully understand one hydrocolloid in a food system, it is often desirable to use a combination of gums in a food product. Before discussing how to approach research and

product development with two or more gums in a food product, let us quickly review some of the primary reasons for using multiple gums in a formulation. Four of the most common reasons are cost, synergy, serendipity, and quality.

For cost a common rationale involves using a highly effective gum at a low use level to give some needed stabilization to a food and then adding onto that a less expensive gum to fill out the requirement for viscosity and texture. Several gums are synergistic with other gums, meaning that the net viscosity or gel strength, when the two gums are used together, is greater than would be expected from the additive combinations of each gum. The gums form an interaction that creates a more effective three-dimensional network to structure water. Xanthan gum is synergistic with guar gum and locust bean gum. Konjac is synergistic with carrageenan, xanthan gum, and putatively alginate. These are some of the most common examples. Often synergistic gums are most synergistic at a one-to-one ratio with each other.

Serendipity is used to explain that in the real world many prototype formulations are tested with various combinations of gums and one seems to work better than all the others. So this combination is used in the final product. In one case a product development manager tried two complex, but totally disparate, approaches to develop a specialized type of frozen pancake batter and neither was totally acceptable. Finally, he mixed the two different batters together and found that to be a good final product. This blended formulation had 30 different ingredients including several hydrocolloids. It was probably not an optimized formulation, but it worked, and time constraints dictated that the research and development time was ended and this became the final formulation.

Quality approaches with multiple gums are generally more sophisticated and are practiced by those who understand the nuances of gums more proficiently. Costs, synergies, desired textures, and stabilities are all considered during product development to come up with what is hoped to approach an ideal formulation. Costs are minimized, synergies are maximized, and stability is very good but not at the expense of desirable texture being sacrificed. A common theme in many of these sophisticated formulations is that a gum, which might be an excellent stabilizer, but not ideal for textural parameters, such as xanthan gum, is kept at a set low level where stability is assured but texture is not compromised.

To begin to approach this area of research, the following ideas may be helpful. To understand synergies, and indeed any gum combination, make up simple model systems in water to better observe the differences in viscosities, textures, gels, and stabilities.

From a cost point of view, get current and accurate pricing of all the major hydrocolloids and make cost in use comparisons. Molecular weight and viscosity are often correlated for a specific hydrocolloid. Very low-viscosity grades may be more expensive to buy due to extra processing costs to degrade the hydrocolloid to a much lower molecular weight. Very high-viscosity grades may be more expensive because only a portion of the raw material used for that gum may yield a very high viscosity and also it is more difficult to gently process it in such a way as to maintain absolute maximum molecular weight.

The low- to middle or high-viscosity grades for a specific hydrocolloid are often priced about the same since the raw material costs and processing costs are similar for these grade ranges. The issue is not cost per kilogram however, but cost to make a say 300 cP viscosity solution. Since the middle or high grade requires a lower amount to make a 300 cP solution than the lower viscosity grade, it tends to be more cost-effective to use in the actual food product than the lower viscosity grades.

Rather than using pure serendipity to find the best prototype, it is best to use a systematic approach in product development. If it is decided to use two or three gums in a series of prototypes, vary the ratios of the gums in a systematic way to determine the whole panorama of textures and stabilities that are possible. This is better than a typical approach often used where some guess is made of what good use levels may be for the gums in a formulation and then these are tweaked up or down as prototypes are made and found defective in various ways.

The quality approach can also be done in a systematic way. For example, the minimum level of a good stabilizing but poor texturizing gum can be ascertained in tests. Once the minimum level needed for stability is determined then that gum is set at that level and the other gums are altered to get the best texture. Of course, for this minimum-level test to be accurate, the other gums must be present in sufficient quantity to give a texture or viscosity similar to the final desired product. Similarly, the maximum level of a low-cost gum can be determined before textural and other product quality considerations dictate that its level has gone too high.

### **Tip Twelve: Using Hydrocolloids—Substitution of Gums for Starch**

Modified starch is generally of low cost on a cost per kilogram of product basis, but the use levels of starch are much higher than of gums. In addition, starch will generally cause a gummy mouthfeel, be found to be flavor suppressing, and often affect the color or appearance in a negative way. Often it is best to think of starch as a low-cost hydrocolloid, which it is, that can be useful to provide some base viscosity or gel strength but whose use level must not be allowed to go too high to avoid adversely affecting product quality.

Fortunately, although gums are more expensive on a per kilogram basis, the cost in use is much more comparable to starch and sometimes lower. This is because gums can often substitute for starch on a one-for-ten weight basis. For example, in the fruit pie filling formulations in Table 1.1, it is seen that the pure starch formulation uses 5–6% starch to provide adequate gel strength and some boil-out stability during baking. But the sodium alginate-containing formulation drops the starch content

**Table 1.1.** Alginate versus starch in pie fillings.

Fruit Pie Filling: Starch	Weight (%)
IQF fruit	65.0
Corn syrup	19.0–20.0
Sucrose	10.0
Cornstarch	5.0–6.0
<i>Total</i>	<i>100.0</i>
Fruit Pie Filling: Alginate and Starch	Weight (%)
IQF fruit	65.0
Corn syrup	22.4–22.5
Sucrose	10.0
Cornstarch	2.0
Sodium alginate (800 cP)	0.3–0.4
Tetrasodium pyrophosphate	0.1
Dicalcium phosphate, anhydrous	0.1
<i>Total</i>	<i>100.0</i>

*Source:* Guaranteed Gums (2007).  
IQF, individually quick frozen.

down to 2% while only using 0.3–0.4% sodium alginate to produce the same gel strength and far superior boil-out protection. Also, the alginate product has much better flavor release (due to its lower use level), is not gummy, is clearer, and has excellent sheen.

Briefly, we can therefore summarize the major concepts when substituting gums for starches. First, there is an order of magnitude difference in use level. Second, costs therefore tend to be similar on a use level basis and perhaps somewhat less for the gum. Third, stability is often better for the same texture or gel strength. Fourth, the overall appearance and desirability of the product is often improved due to better texture, less pastiness, combined with greater clarity, sheen, and improved flavor release. This can allow the use of more cost savings by some reduction in added flavors and flavor-providing ingredients.

### **Tip Thirteen: Using Hydrocolloids—Benchtop Product Development**

Although benchtop product development is not usually done in the way that is recommended here, this method ensures that the full functionality of hydrocolloids will be understood and appropriated in the food system where the gums are being utilized. The first step is to guarantee the gums can be fully functional by making sure they are fully dissolved and have all the other key conditions such as sufficient heat and/or specific cations for maximum functionality. The goal should be to guarantee the gums are fully functional and not worry about making the food product in the most efficient manner. That will come later.

Mixing, heating or cooling, and cations are the three areas that must be focused on. Mixing may require premixing the gum by itself to ensure that the gum is completely dissolved. Also, it may require using much higher shear that is normally used, but be sure not to allow air to be whipped in unless this is desired for the food product being made. In addition, it may be a good idea to allow a much longer mixing time to ensure full dissolution. Care should be taken to evaluate the mix after mixing to see if there are any signs of incomplete solubilization. That is one advantage to predissolving the gum in only water—it is easier to detect any lumping.

For heating and cooling, be sure the temperature probe or thermometer is completely accurate. This has often not been the case with

laboratory instruments that have been in use for a long time and not calibrated recently. Especially this is true for older or cheaper instruments. Next, be certain all the mass of product reaches the desired temperature and if possible goes a little above that temperature or holds for a slightly longer period at the temperature if that can be done without sacrificing product quality.

Cations use and control is the final key area to ensure complete gum functionality. The first issue is to control cations that may inhibit full solubility of a gum. It is often a good idea to use distilled water to make sure there is no chance of interfering ions in these idealized first tests. After the gum is fully dissolved, for a number of gums, cations are added to allow full gel strength or viscosity. It is important to be sure these added cations are dissolved enough to be available for the hydrocolloid to utilize. In these preliminary tests, it is a good idea to add more than the theoretically required amount of cation to ensure a sufficient amount.

Once this idealized prototype is made where the gum's functionality is fully maximized, it is necessary to thoroughly evaluate the prototype, especially for textural parameters, both by instrumental methods and by taste testing. If more or less gum is indicated by these testing methods then the next prototypes can be made in the same careful way. Once the prototype is close to what may be required from a textural and stability point of view, the next steps of finding the most efficient formulation and processing procedure can be undertaken.

At this point it is useful to consider the plant processing procedures and think about limitations in the plant operations, especially in the area of mixing. Then it is useful to plan a benchtop procedure that will best mimic the plant operations. The good thing is that it is known what the product will look like if the gum is allowed to become fully functional. The rest of the product development is to take the idealized procedure developed to allow maximum gum functionality and gradually adjust it to allow a simpler operation for the plant while maintaining full functionality. This should be done step by step. For example, cations can be reduced to the point where the gum starts to lose some functionality. At this point add back enough ions to allow full functionality. The mixing time and intensity can be reduced, and each time the product made can be compared to the gold standard to determine the minimum mixing time and intensity required.

**Tip Fourteen: Using Hydrocolloids—Scale-Up to Plant Production**

Scale-up to pilot plant and then to plant production can be tricky for any food product, and where hydrocolloids are used as ingredients, it should be done carefully. There do not have to be any difficulties, but certain precautions are important. It is best to plan and proceed systematically. Among the steps that may be critical involving hydrocolloids include incorporation of the gums, mixing, any ion addition step, heating, cooling, holding, and packaging. The thing to remember is that at the benchtop scale several of these steps are easily controlled and some are hardly even thought about. One benefit of the benchtop is that often everything that is happening is easy to monitor and adjust, but not so in the plant. For example, unwanted air incorporation can be easy to see and adjust on the bench but may not even be observed in the mixing tanks used in the plant.

Incorporation of the gum is what first should be considered. When and how to do this is important as well as what should be done before and what should be done after concerning other ingredients. Avoiding lumping by premixing with another dry ingredient or high shear is important. Also, sufficient time must be allowed for the gum to fully dissolve. In some cases the mixing time must be increased in the plant compared to benchtop tests because the mixing may not be as intense or efficient. If sequestrants, such as phosphates, are added to help the gum dissolve, these should be added before the gum or at least with the gum. For the heating and cooling steps, it is important to ensure that the entire mass of product reaches the maximum heating temperature and also the final cooling temperature.

The holding and packaging steps are very critical to plan for and monitor during plant production. During benchtop tests, these steps are often done with no delay, but in the plant, emptying out a large mixing tank and packaging the product may take many minutes. If the product begins to gel or set up during or shortly after cooling, or after adding some cations, then it must be ensured that the entire product is packaged before this occurs. Otherwise, the gelling product will be chopped up and may permanently ruin the texture and stability.

If the product gels with calcium, such as with sodium alginate, then adding a less soluble calcium salt will allow the extra time needed for

the product to be fully packed before gelation becomes an issue. If the product gels by cooling, then packaging the product before fully cooled may alleviate premature gelation.

### **Tip Fifteen: Using Hydrocolloids—Plant Troubleshooting**

This tip deals with the situation where everything has been going well in plant production for quite some time and suddenly a problem or problems appear. What is to be done in these cases? The most important step is to collect all relevant information for both the ingredients used in the problem batch and all the data recorded and information available from each unit processing step. From the processing point of view, it should be determined if any new employees operated any equipment, if processing times and temperatures were altered for that lot, and if any equipment showed any signs of malfunction. Instruments that record temperatures and other parameters should be carefully checked to determine if any anomalies occurred.

On the ingredient side, even though texture or stability may be affected, it should not be automatic to assume that the prime textural and stability components, hydrocolloids, are always the culprit. Still, the first step when texture or stability problems occur is to check all the ingredients, including the hydrocolloids, and determine if any of them had a new lot that was first used in the problem production run. If the problem in the plant coincides exactly with a new lot of hydrocolloid being used in that batch, the hydrocolloid should be investigated.

The first step is to look at the quality assurance (QA) data for that lot, both that provided by the manufacturer and any that was generated by the customer's QA department. At the same time when this sheet of data is evaluated, also pull out the data from several of the previous lots for comparison. It is unusual for a manufacturer of gums to ship out a lot that is out of spec. Therefore, it is helpful to determine first of all if anything is atypical about the lot, even if it is still within specifications.

For example, one of the oldest and largest alginate manufacturers sent a lot of sodium alginate to their largest customer a few years ago. The sauce being made was too thin even though the viscosity of the alginate was in spec. But someone noted that the moisture content was extremely low, about 6%. The specification specified less than 15% moisture, and most previous lots had 12–15% moisture. It turns out



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that the viscosity of the lot was low, and the production people in the alginate plant decided to overdry the product to squeeze it into the right viscosity. But this caused extreme dusting problems and damaged the hydration ability of the alginate when used in the sauce. The main point is to look for unusual data, even data that look too low, as in this case. Incidentally, one-way specifications should be avoided, as this case typifies. Instead of less than 15% moisture, it is better to specify between 10 and 15% moisture, for example.

What if the hydrocolloids were all used in previously acceptable production batches? In that case, look at any other ingredient that may have been from a new lot. Also, check the water source and water purification system for potential problems. It is not uncommon for carbon filtration systems to become overloaded at times in water purification systems, and thus improperly treated water may have been used in the production batch. The water may have then been the source of higher ion contents being added to the mix, which could have inhibited some hydrocolloids from hydrating. Was the clean in place (CIP) system not used correctly allowing some iodine or chlorine to enter the batch? These types of strong oxidizing agents can damage macromolecules in the food system and cause unstable final products. Good troubleshooting will almost always determine where the problem occurred so that the situation can be remedied to avoid future problems.

### **Reference**

Guaranteed Gums. 2007. *Newsletter*, August 2007 Issue, p. 2.

