Chapter 2

Hydrocolloids in Salad Dressings

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This chapter covers the various types of salad dressings used in the United States and Canada, including typical ingredients, manufacturing equipment, and how to assemble the different products. The common functions of dressing stabilizers are addressed, along with a discussion of the major stabilizers used, usage levels, and benefits versus liabilities for each stabilizer. Tips are presented on determining the proper hydrocolloid level, how to achieve the desired shelf life, and rheological properties for dressings, as well as some pitfalls to avoid.

To begin with, let us consider the *various types of salad dressings* that are marketed in the United States and Canada. They include *spoonable dressings* such as mayonnaise and salad dressing, *pourable dressings* with shelf-stable emulsions and also temporarily stable emulsions or separating dressings, and *dry mix dressings* for home or restaurant preparation. There are two types of pourable, shelf-stable dressings, “fine” and “coarse” emulsions. Examples of “fine” emulsions are regular French dressing and ranch dressing. Examples of “coarse” emulsions are Catalina French and Golden Italian. Italian dressings are made in four different forms: creamy (a “fine” emulsion), golden (“coarse” emulsion), separating, and dry mix, which may be either of the separating or stable emulsion type. Obviously there is a plethora of dressings available, and to add another order of complexity, all of these dressings are made in low-oil or no-oil forms as well.

Hydrocolloids in Food Processing, Thomas R. Laaman

Real mayonnaise is a standardized product that requires at least 65% oil and does not allow any hydrocolloid stabilizers. (See the following web site: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?fr=169.140.) However, lower oil dressings of this type (i.e., spoonable), including "salad dressing," will contain hydrocolloid stabilizers and oil levels from 0–55%. The only hydrocolloid allowed in "standardized salad dressing" is starch, and it must have at least 30% oil. (See the following web site: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?fr=169.150.)

French dressing is another standardized product (i.e., pourable dressing) which must contain at least 35% oil and may contain various hydrocolloids. (See the following web site: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?fr=169.115.) Of the regular (i.e., full oil) pourable salad dressings, the top 12 most popular flavors are listed below.

Top 12 Popular Flavors (Regular Varieties)

1.	Ranch
2.	Blue cheese
3.	Italian (separating)
4.	French
5.	Thousand Island
6.	Caesar
7.	Honey Dijon
8.	Poppy seed
9.	Balsamic vinaigrette
10.	Olive oil vinaigrette
11.	Red wine vinaigrette
12.	Italian (creamy)

Flavor Trends—Association for Dressings and Sauces, November 2004.

Typical Salad Dressing Ingredients

Water, oil, and vinegar are the major ingredients of "regular" salad dressings. Additional important ingredients include salt, spices, hydrocolloid stabilizers, emulsifiers, chelators, flavorings, and colors. The oil component is normally a vegetable oil, such as corn, soy, or canola.

Vinegars may be of various types like white (essentially acetic acid), wine, cider, etc. Often vinegar used in commercial production will be of 100 grain strength (i.e., 10% acetic acid). Emulsifiers may be "natural" or "chemical." Examples of "natural" emulsifiers would be lecithin and cholesterol (in egg yolks) and mustard powder (dressing grade). Examples of "chemical" emulsifiers would be polysorbates 60 and 80—usually of hydrophilic/lipophilic balance (HLB) 12 or higher for pourable dressings. Chelators such as ethylenediaminetetraacetic acid (EDTA) are used to extend the oil shelf life by chelating heavy metal ions, which promote oil rancidity.

Typical Equipment for Making Salad Dressings

While assembling pourable dressings, one should guard against forming vortices in mixing tanks since they tend to incorporate air, which is anathema to dressings. Air incorporation leads to many negative consequences including emulsion separation, unsightly striations, slack fills, and oil rancidity. A horizontal, variable speed, squirrel cage-type mixer in the bottom of the mixing (premix) tank provides a rolling action with no vortex and little if any air incorporation.

Dixie agitated premix tank, 100 gallon, 29″ dia × 41″ deep w/6″ deep cone bottom. 316 SS triple squirrel cage agitation.

Another important point is the need for all stainless steel equipment. The use of any brass surfaces that contact the dressing will result in copper ion introduction and very rapid development of oil rancidity.

Most stable emulsion, pourable dressings, as well as spoonable dressings, are passed through colloid mills to make the oil droplets as small as possible and thus contribute to increased shelf life, viscosity, and homogeneity. Colloid mills allow for much faster throughput than homogenizers and thereby increase production rate and require much less space than comparable capacity homogenizers.

How to Assemble Dressings

Stable, *pourable emulsions* will be considered first.

The "minor" ingredients (i.e., low percentage ingredients such as emulsifiers, spices (except for salt), color, flavors, chelators) should be added to the water first. Then any stabilizers (e.g., a 3:1 oil to stabilizer slurry, or dry mixed with 5–10 parts of sugar) should be dispersed and the dispersion should be added to well-agitated water in order to hydrate the stabilizer. Mixing under high shear conditions should be continued (for 3–5 minutes) to hydrate the stabilizers before addition of remaining ingredients.

It is very important to completely hydrate the hydrocolloid stabilizers *before* addition of water competitors like vinegar, salt, sugar, etc. since these competitors may prevent further hydration of incompletely hydrated hydrocolloids! An additional minute or 2 of high shear mixing at this initial stage will accomplish far more than 10–20 minutes of mixing in the presence of competitor ingredients!

Add the ingredients that compete for water, such as vinegar, sugars, and salt, *once the gum is completely hydrated*.

The oil is normally added last, under high shear mixing. It should be added slowly at first, then more rapidly as it becomes incorporated into the emulsion (but not so rapidly as to allow "pooling") to form stable, "fine" emulsions. Note: *"coarse" emulsion dressings* require relatively low shear mixing under carefully controlled conditions and the absence of o/w emulsifiers.

Once the formation of the emulsion in the premix tank is complete, it is normally passed through a colloid mill, with the exception of most low oil/fat-free and "coarse emulsion" products. The last step before packaging would be the addition of any particulates that should not go through the colloid mill (e.g., chunks of blue cheese, bell peppers), mixing just enough to insure uniform dispersion throughout the dressing.

Separating dressings—The aqueous phase of separating dressings is assembled similarly to that of stable emulsion dressings, but the oil is held aside and added as the second stage of a two stage filling operation. In other words, the completed aqueous phase is filled into bottles first, followed by the oil phase that is filled on top of the aqueous phase in order to create minimal mixing between the two phases.

Spoonable dressings differ from "fine emulsion," pourable dressings, as in that most of the viscosity comes from starch. A modified starch, designed for salad dressings, should be used. The starch must be cooked (gelatinized) to form a starch paste, which must then be cooled before assembling the rest of the dressing. Any additional hydrocolloids (gums) may be added to the starch slurry before cooking, using typical dispersion techniques, or hydrated in a portion of the formula water and added as a solution to the starch paste after cooling. Remaining ingredients are added much the same as for the "fine emulsion," pourable dressings, with oil again being the last ingredient, followed by milling. Pregelatinized (or instant) starches are also available that do not require cooking and are treated like other cold water soluble hydrocolloids (i.e., require proper dispersion methods to prevent lump formation).

Dry mix dressings may be either of the separating type (standard Italian dressing) or stable emulsion type. In either case, the hydrocolloid particle size (mesh size) is very critical and particle size of other dry mix ingredients is also important. A fine mesh hydrocolloid (e.g., 200 mesh) is normally required to achieve rapid hydration of the gum under minimal shear conditions (such as handshaking in a cruette with vinegar and salt present). The mesh size of other ingredients, such as sugar and salt, are important to provide sufficient surface area to act as good dispersants for the hydrocolloid. This becomes especially important with fine mesh gums, because they tend to form lumps much easier than more coarse mesh gums, so efficient dispersion is required.

Typical Functions of Hydrocolloid Dressing Stabilizers

Viscosity is one of the major functions of dressing stabilizers, which is related to suspension of particulates, emulsion stability, pourability, etc. Just about all hydrocolloids will provide significant initial viscosity, but long-term stability of viscosity is crucial. Often these dressings must maintain a stable viscosity for up to 1 year, or even longer, after manufacture. This means that only those hydrocolloids which have sufficient acid, and sometimes temperature, stability, can be used when such long-term shelf life is needed. The most acid stable of the gums are xanthan gum (XG), gum tragacanth, propylene glycol alginate (PGA) and microcrystalline cellulose (MCC). Generally speaking, neutral gums like guar and locust bean gum produce good viscosity initially but have relatively poor long-term acid stability. Of course, once viscosity drops due to acid degradation, then the dressing looses its ability to suspend, the emulsion may start to separate, the color can change, etc.

The ability of the dressing *to cling* nicely to salad greens is another important function of the stabilizer. This not only depends on viscosity, but more importantly on rheology, or the specific flow properties of the hydrocolloid stabilizer and hence the dressing. If the dressing is Newtonian-like, it will pour nicely (smoothly), but will not cling as well to the greens as a dressing with a more pseudoplastic rheology. The pseudoplastic rheology is characterized by very high viscosity at rest, and much lower viscosity while being subjected to work (shear, like pouring, pumping). Consequently, dressings with pseudoplastic flow properties tend to cling to the salad very well, since the viscosity is very high while sitting on the lettuce. Rheology is also very important during filling operations, and clean cut off during filling (i.e., lack of "tailing") is extremely important when filling portion packs and to prevent splashing during filling of larger containers. Again, a pseudoplastic rheology is best for these functions.

Suspension of particulates and oil droplets is of course very important and related directly to viscosity and rheology. When hydrocolloid stabilizers are degraded, viscosity drops and suspension properties are also degraded. All of the hydrocolloids will suspend particles, but those with pseudoplastic rheology will be considerably more efficient than those with more Newtonian rheology because their effective or apparent viscosity will be much higher at rest than when being mixed, and therefore can be formulated at considerably lower viscosity values (as measured on a Brookfield RVT viscometer at 20 rpm, for example).

Prevent/control separation: This function is also directly or indirectly related to viscosity and suspending power, which is related directly to gum concentration. Once the viscosity drops below some critical value, separation of oil and settling of particles will begin to occur. Of course this phenomenon will be exacerbated at elevated temperatures, and storage of emulsions in ovens (100°F, for example) is often used as an "accelerated emulsion stability" test.

Maintain/impart color: This function relates to loss of viscosity because this can cause emulsions to degrade. The oil droplets then become larger through coalescence, and that usually means colors become darker. For example, a typical creamy French dressing with a light reddish orange color will change to a deeper color, typical of a Catalina-type dressing, due to the change from a fine, creamy emulsion to a coarser one.

Limit calories: Since all hydrocolloid stabilizers, except for starch, are nondigestible, they do not contribute any significant calories, especially at typical use levels of under 1.0%. Even some starches (resistant starches) are now available which are minimally digestible.

Mouthfeel: Each of the hydrocolloid stabilizers contributes different kinds of mouthfeel, and some are actually used for this purpose. For example, MCC is frequently used in low calorie dressings as a fat memetic, and other hydrocolloids are used to modify the mouthfeel characteristics of starch in spoonable dressings.

Major Dressing Stabilizers—Benefits/Liabilities

The hydrocolloid stabilizers that we discuss here are XG, PGA, starches, MCC, and guar gum. Although other hydrocolloids may be used occasionally, these are the major players.

XG: Few will disagree that XG is the most versatile of the hydrocolloid stabilizers for salad dressing, especially of the pourable variety. This benefit flows from its rheological and stability properties. Rheologically speaking, XG is best described as highly pseudoplastic, which gives it the superior suspension, cling, ease of pumping and mixing, and excellent filling characteristics, as mentioned earlier. In addition to rheology, XG's stability toward acid, temperature, and enzymes help to explain why it is the favorite stabilizer for pourable salad dressings. One can prepare emulsions that are stable against separation for 3 years with XG. No other dressing stabilizers possess such long-term acid stability. It also tends to maintain a steady viscosity over a wide range of temperatures, unlike most other hydrocolloids that typically thin with increasing temperatures. The amount of XG needed depends on the type of dressing being produced. Regular oil dressings usually require about 0.25%, separating dressings generally require considerably less, and low- or no-oil dressings need around 0.5%. On the negative side, XG can produce dressings with "gloppy" or "chunky" flow characteristics if used at high concentrations (usually $>0.5\%$). This becomes a problem mainly in low calorie dressings, which require considerably higher hydrocolloid levels due to the increased amount of water that must be stabilized. This brings us to the next hydrocolloid.

PGA: Before food approval of XG, PGA was the hydrocolloid of choice for pourable salad dressings. It has the advantages of being quite acid stable (6–9 months in dressing environs), possessing secondary emulsifying properties, and a smooth, Newtonian-like rheology. Also, PGA is sensitive to high levels of calcium (a potential problem in dressings containing substantial levels of dairy ingredients), and its heat stability is rather poor. At current prices, it is also considerably more expensive than other choices. In today's marketplace, PGA is used mainly to modify the rheology of XG (to make it more smooth), especially in low- or no-oil dressings, which require high hydrocolloid concentrations. There is a convenient relationship between XG and PGA viscosity/use level. Two parts of low viscosity, dressing grade PGA, are roughly equal in viscosity to one part of XG in salad dressing formulas. Generally speaking, PGAs should not be used in "coarse" type emulsions, due to their emulsifying properties, which favor "fine" emulsion formation.

Modified starches are used mainly in spoonable dressings. These starches are modified to have improved acid and shear stability so that they may withstand high acid and shear conditions encountered during processing and storage. Starches have the advantages of giving the typical spoonable texture, not obtainable from other hydrocolloids, being "consumer friendly" (clean label), being permitted in standardized dressings, and possessing low cost per pound. They are usually digestible and used at concentrations approaching 5%, so contribute calories to the formulas. Many of the starches require cooking to gelatinize them before they can be used in the dressing and are susceptible to degradation under high heat and acid conditions. At the highest usage levels, starches can contribute a pasty mouthfeel and tend to mask delicate flavors. A major difference between mayonnaise and spoonable salad dressing is the "heavier" mouthfeel caused by the presence of starch in the salad dressing.

MCC is used extensively as a fat mimetic in low- or no-oil dressings. It contributes opacity (very white) to dressings and can produce starch-like consistency or texture if the levels are high enough ($>2\%$) and so, it is useful in spoonable as well as pourable dressings. MCC possesses good stability to acid, salts, and temperature, so it works well together with other hydrocolloids. MCC also acts as a good suspending agent, due to its thixotropic rheology. Although relatively high shear is needed to develop MCC's full viscosity, this is normally not a problem when using dressing equipment. For coarse emulsion products, MCC could be problematic and its whiteness would likely change the color from the desired hue.

Guar gum is the lowest cost hydrocolloid (on a usage level basis). It is rarely used alone in dressings, and is sometimes combined with XG as a means of lowering the total hydrocolloid cost. Under certain conditions, guar and XG combinations provide synergistic viscosity increases, but this effect is markedly reduced as the pH decreases below 5 and as the salt concentration increases, because the synergism is due to hydrogen bonding between the 2 gums, and that effect is significantly reduced as hydrogen and other ion concentrations increase. Additionally, guar has poor long-term acid stability. When used in combination with XG, after a few weeks the guar will start being hydrolyzed by the acid. When that occurs, not only is guar viscosity lost, but any viscosity from the synergism between XG and guar will also be lost. This may result in a significant viscosity loss and subsequent emulsion separation. Heat exacerbates degradation and will further reduce dressing shelf life. Therefore, manufacturers should be very cautious about using guar in salad dressings.

Typical Dressing Formulae

Typical Pourable French Dressing

Ingredients	Grams (g)	Percent (%)
Vegetable oil, soybean	382.0	38.20
Water	308.0	30.80
Sugar, granular	115.0	11.50
Vinegar, white, 10% (100 grain)	100.0	10.00
Tomato paste (26% T.S.)	60.0	6.00
Spices, color, flavor, etc.	12.5	1.25
Salt	10.0	1.00
Mustard powder	10.0	1.00
Xanthan gum	*2.5*	*0.25*
	1000.0	100.00

Preparation

1. Blend all dry ingredients except for XG and salt, and add to well-agitated water.
2. Slurry XG in 3–5 times its weight of oil.

3. Add oil/gum slurry to #1 aqueous solution, under vigorous agitation, and continue vigorous mixing for 3–5 minutes.
4. Continue mixing and add tomato paste, color (if liquid) and salt. Mix to homogeneity.
5. Add oil slowly, under continued vigorous agitation.
6. Continue mixing and add vinegar. Mix until homogeneous.
7. Pass dressing through a colloid mill set at 0.25 mm (0.01″).
8. Fill containers.

This dressing uses only one stabilizer (XG) and should possess a viscosity of about 3,500 cP (Brookfield LV viscometer, spindle #4, 60 rpm), pH of 3.6, and aqueous phase acidity of 2.26 (as acetic acid). Unless augmented by other preservatives, the aqueous phase of dressings should typically be >2% as acetic acid to inhibit bacterial growth.

Typical Spoonable Salad Dressing

Ingredients	Grams (g)	Percent (%)
Vegetable oil	350.00	3.5
Water	319.00	31.90
Sugar, granular	120.00	12.00
Vinegar, white, 10% (100 grain)	100.00	10.00
Egg yolks, frozen	55.00	5.50
Modified corn starch	*35.00*	*3.50*
Salt	15.00	1.50
Mustard flour	5.00	0.50
Xanthan gum	*1.00*	*0.10*
	1,000.00	100.00

Preparation (laboratory)

1. Preblend all dry ingredients and add to the water while mixing and heating to 180°F (82°C) in a double boiler.
2. Cool to room temperature, while stirring in an ice water bath.
3. Transfer to a Hobart-type mixer with a wire whip.
4. Add thawed egg yolks; mix with a wire whip.
5. Add oil slowly, while continuing mixing.

6. Add vinegar slowly and continue mixing until smooth.
7. Pass through a colloid mill set at 0.01″ (0.25 mm).

This spoonable dressing's main stabilizer is starch, but the level of starch is reduced by the addition of 0.1% XG, thereby improving the texture and stability of the dressing.

Typical Italian Dressing (Separating Type)		
Ingredients	Grams (g)	Percent (%)
Vegetable oil, soybean	560.0	56.00
Cider vinegar, 5% (50 grain)	280.0	28.00
Water	90.0	9.00
Lemon juice, single strength	50.0	5.00
Salt	10.0	1.00
Spices and flavorings to suit	9.8	0.98
Xanthan gum	*0.2*	*0.02*
	1,000.0	100.00

Preparation

1. Dry blend XG with all dry ingredients.
2. Hydrate dry blend in all available water under vigorous agitation for 10 minutes.
3. Add lemon juice and vinegar.
4. Fill aqueous and oil phases in a two-step process by weight or volume.

This should produce a dressing with pH of 4, viscosity of 130 cP* (after shaking at room temperature), and aqueous phase acidity of 4%, as acetic acid. (*Brookfield LVT, spindle #2, 60 rpm).

Note: This separating dressing will only hold together for a few minutes at this low concentration of XG. Higher levels of XG may produce dressings that are stable for considerably longer periods of time but may not separate as cleanly as the low concentrations.

Typical Low-Calorie Italian Dressing		
Ingredients	Grams (g)	Percent (%)
Water	820.30	82.03
Vinegar, white, 10% (100 grain)	150.00	15.00
Salt	10.00	1.00
Spices, flavors, and sweeteners to suit	8.20	0.82
Xanthan gum	*4.50*	*0.45*
Propylene glycol alginate	*3.00*	*0.30*
Sodium benzoate	0.50	0.05
Potassium sorbate	0.50	0.05
	1,000.00	100.00

Preparation

1. Thoroughly blend all dry ingredients, except salt.
2. Add dry blend to available water under vigorous agitation.
3. Mix for 5–7 minutes.
4. Add vinegar and mix until homogeneous.
5. Add salt and mix for 1–2 minutes.
6. Bottle.

This formula should produce a dressing with pH 3.3, viscosity of 720 cP* (room temperature), and aqueous phase acidity of 1.6%, as acetic acid. (*Brookfield LV spindle #3, 60 rpm).

Two gums, XG and PGA, are used. In order to achieve sufficient viscosity with only XG, a dressing with objectionably “chunky” rheology would result. PGA produces more Newtonian flow properties than XG and is used to give the added viscosity needed after the maximum XG level (from a rheological aspect—usually 0.5% or less) is used. Since the water phase makes up over 80% of this dressing, additional preservatives (benzoate and sorbate) are used to allow for lower vinegar levels and better flavor.

Mayonnaise-Type (7% Oil) Spoonable Salad Dressing		
Ingredients	Grams (g)	Percent (%)
Water	1163.00	58.15
Egg whites, pasteurized	300.00	15.00
Soybean oil	140.00	7.00
Vinegar, distilled, 100 grain	112.00	5.60
Sugar, granular	108.00	5.40
Microcrystalline cellulose	*60.00*	*3.00*
Modified waxy maize starch (instant)	55.00	2.75
Salt	34.00	1.70
Xanthan gum	*13.00*	*0.65*
Flavor, spices, color, etc. (to suit)	13.00	0.65
Sodium benzoate	1.00	0.05
Potassium sorbate, powdered	1.00	0.05
	2,000.00	100.00

Preparation

(Use a 5 quart Hobart-type mixer, equipped with wire whip.)

1. Add emulsifiers and all dry ingredients (except for salt and sugar), to the water.
2. Dry blend hydrocolloids (MCC, starch, and XG) with the sugar.
3. Add hydrocolloid (HC) or sugar dry blend to the water under high-speed agitation and mix for 5 minutes.
4. Add liquid egg whites and mix until uniform (ca. 1 minute).
5. Add chilled oil slowly, and mix for 2 minutes at high speed.
6. Add the salt and continue to mix.
7. Add vinegar and any other liquid flavors or acids, and mix 3 minutes at medium speed.
8. Optional: Pass through colloid mill at 0.06″.

Note: In order to achieve a mayonnaise-like flavor, acidity must be kept as low as possible. Therefore, using a considerably lower vinegar concentration than needed for proper preservation requires the use of additional preservatives (e.g., sorbate and benzoate). Since the preserving function of vinegar depends on the amount of undisassociated acetic acid present, other acids (citric or mineral acids, for example) may also be added to lower the pH and make the formula vinegar more efficient in its preserving role.

MCC is used mainly as a fat mimetic and to provide spoonable texture similar to starch, but without calories. Both XG and MCC allow for the lowest possible starch level, which contributes to better flavor release and a texture more like real mayonnaise than typical spoonable salad dressing.

Determining the type and level of hydrocolloid (HC) needed

1. The particle size (or mesh size) of the HC needed depends on the type of dressing being produced. For dressings produced with high shear mixing equipment, a "regular" particle size (e.g., 80 mesh) is desirable. For dry mix dressings to be used in home settings, "fine" particle (e.g., 200 mesh) sized HCs are needed, since they are hydrated under very low shear, gentle mixing conditions (e.g., hand shaking in a cruette). This also requires careful choice of other dry ingredients to act as dispersing agents for the fine mesh gums which will have greater tendencies to form lumps. Fine mesh sugar may be required for such applications, for example.
2. To *determine how much HC is needed* for a particular function, prepare two identical dressings, except that one should contain a significantly higher HC concentration than needed and one should have a significantly lower concentration than needed. Mix the two dressings together in different proportions to create a spectrum of different HC concentrations, measure viscosity values and store them in 100 ml graduated cylinders to observe for particulate settling, oil separation, heat stability, etc.
3. To *obtain a desired rheology*, a similar method may be used, except this time two dressings are prepared with equal viscosity, but stabilized with different gums possessing differing rheological characteristics. Consider the typical French dressing formula above as an example. This formula calls for 0.25% XG. If a smoother flowing dressing is desired, prepare an equal viscosity dressing with PGA at 0.5% instead of XG. Subsequently, the two equal viscosity dressings

may be mixed together in different proportions to determine which proportion gives the desired rheology for the dressing. This procedure becomes even more useful when dealing with low calorie/no oil dressings which must use high gum levels, due to the expanded aqueous phase. Rheology becomes an even greater factor in such cases.