BALDWIN'S ACS WEBINAR — November 21, 2013

Thank you Bill for the nice introduction. I'm so happy the American Chemical Society has invited me back to give another webinar. I'll be talking about sous vide cooking again. I define sous vide as a method of cooking in vacuumized pouches at precisely controlled temperatures. Government regulations, like the 2013 food code, prefer a narrower definition that includes rapid chilling after cooking followed by refrigeration. Last time I explained why it's the precise temperature control that's really important, and not the vacuum sealing. This time I have step-by-step videos of four recipes: turkey, beef chuck roast, acorn squash, and apple ice cream. So expect less science and a lot more practical tips.

Now back when I was an applied math graduate student, I threw extravagant dinner parties. I'd spend weeks planning the 6 to 12 courses meal I'd serve my fellow mathematicians. But despite this planning, things didn't always work out as I'd hope. I'd overcooked a lot of dishes waiting for "fashionably late" dinner guests. Often I hadn't attempted a recipe before because the ingredients were so expensive. And I often had dinner guests with dietary restrictions, like an allergy to shellfish or not eating beef or pork.

Sous vide cooking solved a lot of these problems for me. Late guests no longer ruined my dishes. Because precise temperature control makes timing much less critical. Since I could make less expensive ingredients taste great, I could test my recipes before the big night. And it didn't take me long to perfect these dishes because sous vide cooking has great repeatability. Finally, since the food is cooked in

individually sealed pouches, I could easily heat separate pouches for my guests with dietary restrictions. And I could heat these right along side my other guest's food.

[SLIDE 2] Before we begin, I'd like to know what you do for your big holiday meal. Do you usually have (a) turkey, (b) beef, (c) pork, or (d) something else? [Comment on the results.]

[SLIDE 3] I like my dark meat fall-apart tender and my white meat moist, plump, and juicy. You can't have both at one time-temperature combination. So cook the white meat at one time-temperature combination and the dark meat at another. This means butchering the turkey before cooking.

Lean meat and poultry is only plump and juicy if it doesn't exceed 60–65 degrees Celsius. But we've been told we have to cook lean poultry to 75 degrees Celsius to make it safe. That's because pasteurizing turkey takes only seconds at 75 degrees Celsius compared with about 30 minutes at 60 degrees Celsius. And it's not so easy holding the center of a turkey breast at 60 degrees Celsius for 30 minutes with traditional cooking methods. Thankfully, this is trivially easy with sous vide cooking. Just set the water bath to 60 degrees Celsius, add the food, and wait until it's pasteurized.

For fall-apart tender dark meat, we can use higher temperatures and longer times. You could put the dark meat in a pressure cooker and it'd be done before your turkey breast is at 60 degrees Celsius. But blind taste-tests have given the nod to sous vide cooking over using a pressure cooker. My preference is 70 degrees Celsius for about 8 to 12 hours; say, overnight or while you're at work.

[SLIDE 4] After butchering the turkey, I vacuum seal the breasts and legs in separate pouches.

Notice how I fold down the tops of the pouches before inserting the raw food. This helps ensure a good seal after the vacuum pump removes the air. Since if anything's between the plastic when the heating element tries to fuse the plastic together, it may not be air tight or may fail during cooking. I recommend doing a double seal – one next to the other – to further reduce these risks.

[SLIDE 5] [SLIDE 6] I've accumulated many water baths over the years. So I've heated one to 70 degrees Celsius and the other to 60 degrees Celsius.

If you only have one water bath, heat it to 60 degrees Celsius. Then cook the breasts for two and a half to three and a half hours. Refrigerate the legs while the breasts cook. Then chill the breasts in ice water for at least 45 minutes before moving them to your refrigerator. Increase the water bath's temperature to 70 degrees Celsius and then cook the legs for 8 to 12 hours. After they've cooked, rapidly chill the legs in ice water for about an hour before moving them to your refrigerator, too.

If you're big meal is only a few days off, you can store the cooked turkey in your refrigerator. But if it's more than a few days off, I recommend freezing them. You can safely store your turkey indefinitely in your freezer. Not so in your refrigerator because pathogens can grow at refrigerator temperatures, just much more slowly than at higher temperatures. Food cooked sous vide has a much longer refrigerator shelf life than other foods, but there's no reason to risk food poisoning or illness when freezing doesn't noticeably affect its taste or texture.

[SLIDE 7] Not to be wasteful, I use the rest of the bird to make a stock for gravy. I just add carrots, celery, onions, and water. Here, I've placed everything in a enameled cast-iron pot and will heated it on the stove for 2 to 4 hours. But blind taste tests at the French Culinary Institute have shown that pressure cookers make better stocks. Not every pressure cooker though. Only non-venting pressure cookers beat the traditional method, with venting pressure cookers actually doing worse than the traditional method. Of course, you can use your autoclave or sterilizer if you have one. If you use a pressure cooker or autoclave, heat at 121 degrees Celsius for 30 to 60 minutes; then cool before releasing the pressure to reduce the number of volatile flavor compounds that are released.

[SLIDE 8] If you refrigerated or froze your cooked turkey, put it in a 55 to 60 degrees Celsius water bath to bring it back to serving temperature. Once they've been heated through, remove them from the bath and from their pouches.

I don't want to eat pale, flabby turkey skin, but I also don't want to overcook the flesh I've taken so much time cooking. The answer? Brown the skin as quickly as possible. The quicker you brown the skin, the less the flesh below will overcook. Of course, drying the surface with paper towels will reduce the amount of water on the surface that'll need to evaporate away before browning can begin.

[SLIDE 9] There are many tools you can use for browning. A broiler is my preferred method for turkey. For beef – as you'll see shortly – I like a blowtorch.

This non-enzymatic browning is also called the Maillard reaction. The Maillard reaction gives the savory and roast flavors, while the species characteristics come from the fat. So you can make beef taste like lamb by basting it with lamb-fat.

The Maillard reaction is a very complex reaction between amino acids and reducing sugars, like glucose, fructose, and lactose. After the initial reaction, an unstable intermediate structure is formed; it undergoes further changes and produces hundreds of reaction by-products. The Maillard reaction rate can be increased by increasing the temperature, adding a reducing sugar, or increasing the pH. Increasing the pH, say with a pinch of baking soda, works great when browning onions but doesn't help much when browning turkey skin. So we'll stick with using as high a temperature as is practical.

[SLIDE 10] After browning, slice and serve the turkey immediately. There's no need to rest it, as the traditional method requires, because we've cooked the turkey at its ideal temperature. So I'd recommend waiting to remove, brown, and serve the turkey until everyone's arrived and ready to eat.

Now if turkey isn't your main holiday dish of choice, perhaps I can interest you in preparing a chuck roast that'll surpass most prime-ribs in taste and texture.

[SLIDE 11] Here, I picked up some chuck roasts from Costco. They conveniently cut them so they'll fit in my favorite vacuum pouches. You can, of course, use a larger bag for a larger roast. Again, I've turned down the edges before inserting the roasts to assure a better seal.

I like chuck roasts because they have a good beef flavor. I used to braise them or grind them because they're a tougher cut of beef. But I can make tough cuts tender with sous vide cooking. These cuts are tough because the have a lot of the connective tissue collagen. Braising denature collagen into the water soluble gelatin and reduces inter-fiber adhesion at temperatures near 100 degrees Celsius. [SLIDE 12] But I want

my chuck roast to be medium rare, which means cooking it at 55 degrees Celsius. Fortunately, there are many enzymes that haven't been denatured and can catalyze chemical reactions, like protein hydrolysis, at 55 degrees Celsius. Protein hydrolysis is basically the digestion of proteins. And digesting connective tissue increases tenderness. Also, collagen can unfold into gelatin starting around 51 to 53 degrees Celsius – if it's held there long enough. How long is enough? For chuck roast, 20 to 24 hours seems about right.

[SLIDE 13] After cooking for a day, I remove the pouches from their water bath. As you can see, the pouches' contents don't look very appetizing. Water soluble protein have leached out of the meat and have a dark red color. The meat is pale with an almost greenish cast. But don't worry! It'll look great and taste great after we sear it. So remove the roast from it's pouch and pat it dry with paper towels.

[SLIDE 14] Now's the fun part. Take a butane blowtorch, like this one from Iwatani, and begin searing the surface until it's a beautiful mahogany brown. I prefer slowly moving the flame back-and-forth across the surface. But experiment and see what technique works best for you. I don't recommend using one of those little "crème brûlée" torches; a blowtorch from a hardware store for soldering pipes is a better choice. You can also use a skillet with smoking-hot oil or a broiler or a grill. Also, many report an off taste when using a propane blowtorch and prefer butane instead. Of course, you can always use an idea from the 19th-century chemist Sir Humphry Davy: put a fine mesh screen between the meat and the flame, then the flame won't pass through the screen but will give off enough radiant heat to brown the meat.

[SLIDE 15] After you're done searing the roast, slice and serve. Again, unlike a traditionally cooked roast, you don't need to rest the meat before serving.

After all this meat, perhaps we should turn our attention to vegetables.

[SLIDE 16] When you cook vegetables, do you usually (a) boil them, (b) steam them, (c) microwave them, (d) stir-fry them, or (e) use some other method, like baking or sous vide cooking? [Comment on the results.]

[SLIDE 17] Recent studies have shown that many vegetables cooked sous vide are preferred in double-blind taste tests and loose fewer nutrients than traditional cooked vegetables. That said, the results aren't as dramatically different as meat, fish, and poultry that've been cooked sous vide.

Traditional methods use temperatures near 100 degrees Celsius and this bursts the cells. This, of course, causes their nutrients to leach out. In sous vide cooking, we use lower temperatures that dissolve the pectic substances that cement the cells together. Once this pectic cement has weakened, then we can easily break apart the vegetables with our teeth. The science behind cooking vegetables is surprisingly interesting: for instance, you can heat carrots at a lower temperature, say 50 degrees Celsius, and this will keep them from getting as mushy at higher temperatures. See the references in my review article on sous vide cooking for more details.

First, I cleaned the outside of these acorn squash to reduce the number of surface pathogens. Now I cut them in half and scoop out the seeds with a spoon.

[SLIDE 18] I like my acorn squash with butter and sugar. So here I add one tablespoon of butter and one tablespoon of brown sugar to each squash half. Then I carefully place them in individual vacuum pouches and vacuum seal them.

[SLIDE 19] Next I put the vacuum sealed squash into a water bath that's been heated to 80 degrees Celsius. Cooking vegetables at 80 to 85 degrees Celsius takes a lot longer than at 100 degrees Celsius. I find non-starchy vegetables take about three times longer at 82 to 85 degrees Celsius than at 100 degrees Celsius. While starchy vegetables take about twice as long at 80 degrees Celsius than at 100 degrees Celsius; you can use a lower temperature because their texture is also changed by starch gelatinization. For these acorn squash, I like to cook them for two to two and a quarter hours at 80 degrees Celsius.

[SLIDE 20] After I'm done cooking the squash, I remove them from the water bath. Then I remove them from the vacuum pouch and serve immediately – careful, of course, not to pour out the butter and brown sugar in the middle.

Now let's move on to dessert.

[SLIDE 21] What's the last frozen dessert you made? Did you (a) make an ice cream that didn't contain egg yolk, (b) make a French or custard ice cream that did contain egg yolk, (c) a sorbet or ice that didn't contain milk, (d) a frozen yogurt, or (e) you haven't made a frozen dessert or can't remember which you did make? [Comment on the results.]

[SLIDE 22] We're going to make a French or custard ice cream sous vide. A custard ice cream is made from a stirred custard base known as a crème anglaise. The traditional method of making crème anglaise is time-consuming and labor-intensive: first you scald the milk and cream; then whisk the egg yolks into the sugar until lightened in color; then temper a third of the hot milk mixture into the yolk mixture while whisking constantly; then add the tempered yolk mixture to the

pan; then slowly cook, while whisking constantly, until the custard just thickens but before it curdles; and, finally, straining it into a bowl over ice water and stirring until it's cold. The hands-on time for making sous vide crème anglaise is trivial in comparison.

First we blend all the cold ingredients together with a blender. For the fresh apple ice cream from my cookbook, blend 425 grams of diced, skinned tart apples, 240 grams heavy cream, 70 grams of granulated sugar, 100 grams of egg yolks, 90 grams of nonfat dry milk powder, 45 milliliters lemon juice, and a pinch of salt.

[SLIDE 23] Now we pour the blended mix into two vacuum pouches. I have a chamber vacuum sealer, which works well for sealing liquids. If you have a clamp-style vacuum sealer, then you have to be very careful not to pull the liquid into the vacuum pump. You can also use resealable food-safe plastic bags and the water-displacement method that I demonstrate in my YouTube videos.

[SLIDE 24] Now put the sealed pouch with the ice cream mix into your water bath. In an 82 degrees Celsius water bath, it only takes about 20 to 22 minutes.

[SLIDE 25] I like to vigorously shake it part way through. Many chefs believe this improves the texture, but there's no scientific evidence that it's necessary.

[SLIDE 26] After cooking, transfer the pouches to an ice water bath to rapidly chill it. If you plan to serve it as crème anglaise – and not as ice cream – agitate it part way through chilling by squeezing the pouch. This will keep your crème anglaise from being lumpy.

After rapidly chilling, refrigerate it for 8 to 24 hours or up to a week. Many chefs believe this improves the flavor and texture of the resulting ice cream, but this hasn't been shown scientifically.

[SLIDE 27] You can use your favorite ice cream maker to churn your crème anglaise into ice cream. There are some amazing products for making ice cream, like the PacoJet that's made in Switzerland.

Here I'm using a basic, consumer ice cream maker to churn my ice cream. Ideally, I'd churn it until the mixture is about -5 degrees Celsius – but I can't quite get there with this unit. Since churning creates friction that heats the mixture, -5 degrees Celsius is a good balance between cooling and frictional heating for most units. Of course, you can use liquid nitrogen to make amazingly smooth ice cream if you have it available to you. That's because such rapid freezing makes very small ice crystals. And ice crystal size is what determines smoothness: smaller than 35 microns is very smooth, 35 to 55 microns is smooth, and over 55 microns is course.

[SLIDE 28] After churning, transfer the soft-serve consistency ice cream to a container. Put this container in a freezer to harden for about an hour. Since we didn't use any stabilizers – as commercially made ice creams do – you won't be able to store it very long. If you store it too long, the ice crystals will grow and it'll become course and grainy. So I'd recommend churning it only a few hours before you plan to serve it.

[SLIDE 29] After hardening, serve and enjoy.

For more details and recipes, please check out my cookbook *Sous Vide for the Home Cook* – now in its second edition. You can also visit my webpage and read my

free web guide and the review article I wrote for the inaugural issue of the International Journal of Gastronomy and Food Science.

Questions?