American Chemical Society AMA: Hi Reddit! My name is Matt Hartings, a chemistry professor at American University. Let's talk cooking and chemistry!

AmerChemSocietyAMA [1] and r/Science AMAs[1]

[1]Affiliation not available

April 17, 2023

the WINNOWER

REDDIT

American Chemical Society AMA: Hi Reddit! My name is Matt Hartings, a chemistry professor at American University. Let's talk cooking and chemistry!

AMERCHEMSOCIETYAMA R/SCIENCE

[removed]

READ REVIEWS

WRITE A REVIEW

CORRESPONDENCE:

DATE RECEIVED:
November 23, 2016

DOI:
10.15200/winn.147981.19045

ARCHIVED:
November 22, 2016

CITATION:
AmerChemSocietyAMA , r/Science , American Chemical Society AMA: Hi Reddit! My name is Matt Hartings, a chemistry professor at American University. Let's talk cooking and chemistry!, *The Winnower* 3:e147981.19045 , 2016 , DOI: 10.15200/winn.147981.19045

What are some of the most harmful natural and artificial ingredients that we as humans put into our bodies and unfortunately eat on occasion? What foods/ingredients really mess with our bodies' chemistry the most?

Not_Donkey_Brained

As with all chemicals: The dose makes the poison!! We chemists like to repeat that in our sleep :-)

So, in that regard, one of the most dangerous substances we put in our bodies is alcohol. Ethanol does some really nasty stuff to our inner workings, but we gladly take it in. On this same note, the amount of sugar and sodium that we eat can also lead to very bad health outcomes.

As far as the "what we don't know we ingest" sort of thing ... there is more arsenic, naturally in the ground, than many people appreciate. It will, naturally, make its way into a lot of our foods. Rice is an example that's been in the news lately. There aren't many ways around this. But, if you keep your exposure low, there aren't many real health risks that we need to worry about.

Can you please provide us with the top 10 basic chemistry cooking concepts that everyone should know to be a better home cook?

JesusLuvsMeYdontU

Some cooking tips that I think everyone should have. In my opinion, your best friend is time. Be prepared. Be patient. Allowing time to help you do some of your cooking (most primarily in flavor and texture development) will make you a better cook. 1) Dry your meat before you sear it. 2) Use a thermometer (for meat, ice cream, and all sorts of other foods) 3) Salt your meats early 4) Measure ingredients with a kitchen scale (something we're not very good at doing here in the states). 5) Be careful measuring volumes when making cocktails 6) Know how to thicken a pan sauce and how to react when it starts to break down

Could you broadstroke the kitchen chemistry into some groupings for the truly clueless?

Tintcutter

What is kitchen chemistry? Well … everything we do in the kitchen contains some aspect of chemistry. From the food production to its preparation and eating, there are chemical activities at the forefront of how we interact with food.

I'd like to take a brief moment to speak to the difference between "kitchen chemistry" and "laboratory chemistry." In my lab, I am likely to study a single chemical transformation to try and understand how I can optimize what comes out of it. In the kitchen, I am running a thousand different, individual reactions all at the same time. I am looking for ways to control these reactions so that they all reach their peak at the exact same time. In many ways, kitchen chemistry is so much more complex than laboratory chemistry. But, because we (everyone, even non-scientists) cook everyday, we don't appreciate the beautiful complexity of these activities.

So, what are some important things that I describe as kitchen chemistry? Mixing oil and water so that they don't separate (making emulsions like vinaigrette, mayonnaise, and ice cream). Thickening sauces (prompting food molecules to interact with one another to slow down their motion). Flavor creation (caramelization and the Maillard reaction) and extraction (making coffee and tea and sautéing onions or garlic). Protein unfolding and aggregation (cooking meat and eggs and fish to their "proper" consistency). There are many more examples, but these point the way to how I think about food and kitchen chemistry.

I am constantly looking for cooking substitutes because of my allergies. My biggest pain is finding a replacement for eggs. I've been doing the flax seed/water thing for a while, but it doesn't hold things together in the same way an egg can. Can you recommend any other agglutinating ingredients?

NotBridget

In my class I teach an entire section on substituting ingredients (I have a chapter in my book on the same). I don't really go through with examples of: this is the perfect substitute for that. What I try to do, in both, is to give examples of how other people attack this problem. I also try to highlight some of the important chemicals and chemical properties that are critical when substituting ingredients. The one example I always go back to is from "gluten free girl" (a blog and several cookbooks by Shauna Ahern). Gluten is obviously a very tricky substance to substitute for. But, understanding what it does, you can try to use different combinations of food additives to replicate its effects.

Now ... as for egg substitutes. I know a lot of people have been swearing by aquafaba lately (the liquid that chickpeas are canned with). I've never tried it, but I know that there are online forums dedicated to figuring out how to use it.

What is currently known about the chemistry behind the "smoke ring" (the pinkish layer just beneath the surface of smoked meat)?

6thReplacementMonkey

One of the proteins that I use in my lab is myoglobin. This is the protein that gives meat its red color (much like hemoglobin is the protein that gives blood its red color). The reason for this color, in both proteins, is the presence of an iron complex called a heme group. When the iron-heme is situated in the middle of a huge protein and has an oxygen attached, it can maintain a nice red color. As you heat the meat, the protein takes on a new shape, the iron-heme doesn't interact with oxygen in the same way anymore, and it turns brown. When we smoke meats at just the right temperature, gases let off by the wood or charcoal (nitric oxide, for example) start interacting with the iron-heme. These iron-heme-NO complexes don't degrade with heat like the iron-heme-oxygen complexes. So they keep their pink

color. The outside gets the coloration because that is the part of the meat that is in direct contact with the smoke ... making a ring.

What is an emulsion? I commonly see chefs on YouTube create a quick pan sauce using butter and other ingredients and simply stirring and swirling them in the pan. They comment on how if you do it correctly the emulsion holds. What typically causes an emulsion to break when making a quick sauce in a pan? Thanks you.

twoiron

Hooray for emulsions! We all understand that oil and water don't mix. When we get the chemistry and physics just right, though, oil and water can mix in a substance called an emulsion.

Whenever you make an emulsion, you have to bring the mixture right up to its tipping point (mix so much oil and water together that they are so close to separating). As I eluded to, there are lots of chemical and physical games you can play to stabilize your emulsion to keep it from "breaking" (re-separating). You can use food chemicals called emulsifiers to cloak the oil in a jacket of chemicals that water mixes well with. We do this when we make mayonnaise. The proteins and lecithin found in egg yolks are different examples of food chemicals that are used. We can also use hydrocolloids (xanthan gum and others) to thicken a sauce, slowing down all of the individual molecular motions, and preventing oil and water from separating. As always, we need to keep a watchful eye over our emulsions when we are making them. A big step in the wrong direction (add too much oil or too much water, jostle it wrong, look at it cross-eyed) and the emulsion will break.

Harold McGee has a great section on emulsions (and the rules for making them) in On Food and Cooking.

What's a little-known, cool chemistry trick that produces a improved result in the kitchen?

BakoMan

The “trick” that I use most often in the kitchen is salting my proteins early (2 days in advance). I learned this trick from Judy Rodgers and her cookbook based on her restaurant The Zuni Café in San Francisco. Salting early does a wonder for both flavor development and meat tenderness. And, it’s so easy to do. You just have to have the foresight to do it.

Why do egg whites get -more solid- when heated, as oppose to most elements/molecules/things turning less solid when heated?

heradsinn

Great question! Egg whites change their texture in the same way that beef and chicken and pork and fish change their texture when you cook them.

You are right to recognize that heating usually leads to materials becoming "more liquid", which is just a another way to say that all of the molecules in the material move faster. But, with protein-heavy foods, like eggs, the proteins change shape as you cook them. While these proteins tend to avoid each other while they're in their original shape, the "cooked" shapes tend to seek each other out. These unfolded proteins aggregate together and form a solid. This transformation is absolutely key for many of the foods that we cook.

When cooking chopped onion, what's going on when it caramelizes? After initially cooking on high heat with oil, it seems like the water evaporates and it's dry. Splashing some water then creates a violent reaction and the onions transform into that perfect caramelized brown. This happens far above boiling point.

sprocket86

That's really interesting. I've never tried this before. Any other folks out there tried this?

Caramelizing onions is a slight misnomer. The primary reaction is really the Maillard reaction. At least, it is when I brown onions (at seemingly lower temperatures than what you are describing). Water is a key component to lots of the individual reaction in both he Maillard reaction and caramelization. So, its not surprising that adding a bit of water could drastically shift or kickstart some of the reactions.

Hi! Thanks for doing this. I know that bread dough gets chewy when you knead it because of gluten, but why does "glutinous"/sticky rice dough (*mochi* in Japanese) get chewy when kneaded, just like bread dough, even though it contains no gluten?

Pianomanos

Great question! So all seeds (whether they are grains of rice or wheat or corn) do have some protein associated with them. The gluten proteins in wheat (glutenin and gliadin) are well known because they are so useful in cooking.

When you cook rice, some of those proteins will interact with one another, making them chewy. But, what is likely more important, is how the starches in the rice are cooked. As the individual starch crystals expand (like a water balloon), the individual strands of starch can start reaching out. Eventually, these strands will start interacting with one another and the rice will get chewy. Part of preparing "chewy" rice is through the addition of other food chemicals (some sort of acid, like vinegar). That helps this process along.

If you were allowed only one appliance [oven, grill, stovetop, microwave etc] to cook all of your food, which would you choose and why?

themadd

What a fun question! Thanks for asking it!

If I could only use one appliance, I'd have to say that it'd be my grill. I can use it in so many different ways (high temperature cooking, smoking, baking, etc). And, you can get such good flavor from a grill as well.

How much conscious thought (and instruction to others) do you give to the effect air flow has on things like sautéing, grilling, etc.

For example, you want perfect, crisp hashbrowns? You need to make sure you use smaller amounts of potato spread out over a well-lubricated pan to allow the moisture to escape.

NaranShona

Getting a good crisp on your food does require good air flow. The biggest reason for that is that you need to allow water (from your food) to evaporate. So, crowding hash browns in a skillet reduces the

ability of water from the potatoes to evaporate. You end up steaming your potatoes instead of searing them. Same is true for meat. Don't crowd your meat into a pan if you want to get a good sear.

Do you feel that the potential carcinogens created when smoking meats is a real danger, or is the amount minimal enough that it's not worth worrying about?

cexshun

If you are eating smoked meats several times a week every week for your entire life, then the risk of eating these does increase. If you keep it in check, though, you are most likely going to be fine.

How do you like your eggs?

Sheriff_Jibbers

Over-easy! Egg yolks are for dipping. Yolks are Nature's perfect sauce. We couldn't come up with anything near as well on our own with all of our access to technology. Why fight it!

I also like scrambled eggs and have dedicated a chapter in my book pitting my mom's scrambled eggs against Chef Gordon Ramsay's.

Why are cookies fluffier when you mix the ingredients by hand?

Edit: fluffier, as opposed to flat...

OccamsRazer

Great question! If you overmix your ingredients, you can over-develop the gluten (the protein glue that holds your dough/batter together). As long as you don't over-do it, your dough/batter will be more pliant.