The Thousand Secret Ways the Food is Poison: #2 - Cry Toxins

The most roundabout way of giving you a tummyache that fate has yet devised.

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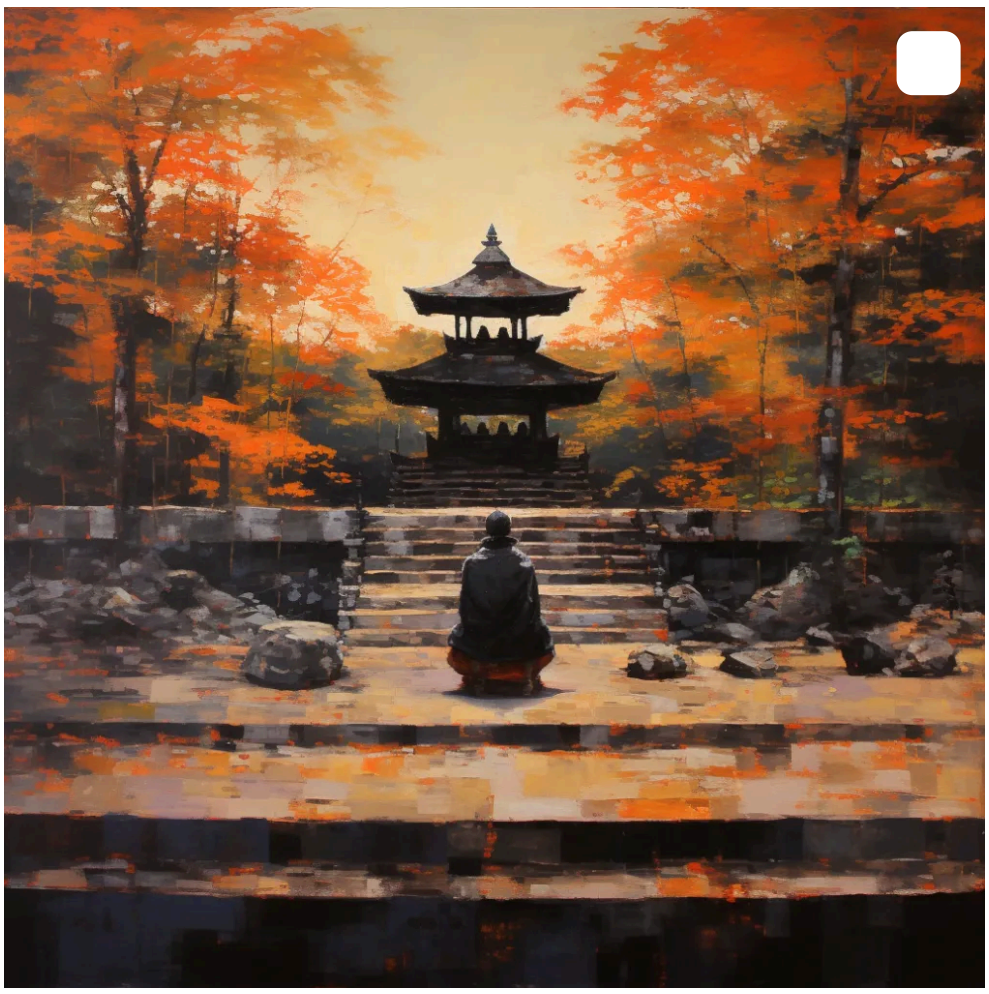

This is the first of the thousand secret ways. It is not the oldest or the most important, but it was the first to reveal itself to me. It opened my eyes to the existence of the rest, and taught me what to look for when searching them out.

It begins with the story of a minor biological miracle: Cry toxins.

The First Step

A Cry toxin is a special kind of protein, produced by a bacterium called *Bacillus thuringiensis* (or BT for short).[1] These proteins get their name—not because they make you cry—but from their shape. Like all proteins, they're produced by chaining amino acids together, one after another, like beads on a string. But in this case, the protein naturally aggregates into inert, microscopic crystals as it gets produced.

The bacterium isn't making jewelry, though; it's making weapons.

You might have used these weapons yourself, without even knowing their name. BT and its toxic crystals can be found at most hardware stores, in a product that's often called something like "mosquito pucks". These are little chunks of a brown, crumbly substance that you drop into stagnant water where mosquitoes are breeding. Newly hatched ones, still in their aquatic form, nibble at it and ingest a hefty dose of Cry toxin in the process.

That's when the magic starts.

See, when it’s produced, a Cry toxin is basically harmless. But when these crystals are dissolved in an alkaline environment like the mosquito’s digestive tract, and then hit with protein-degrading enzymes, all that changes.

The bug’s digestive enzymes try and tear the Cry toxin into its component parts, but this goes about as well as trying to dismantle a hand grenade by pulling the pin. The Cry toxin, an ingenious work of molecular origami, is activated by this attack, and unfolds into a strawlike shape: a pore-forming toxin.

Millions of these little straws poke millions of little holes in the insect’s intestinal cells. This causes the cells to die, which in turn causes the insect to die. I'm not exactly sure what the bacterium is supposed to gain from this interaction—maybe it eats the dead mosquitoes—but it's damn useful for killing bugs. Not just mosquitoes, either: Cry toxins work against a variety of insects, which has led to the use of BT not only in treating ditch water, but as a pesticide to keep insects from ruining crops like corn. Dust down your fields with Cry toxin, and you’ve turned your land into a biological battleground, booby-trapped against most insect invaders. As a bonus, it’s all-natural.

Of course, natural doesn't necessarily mean safe. [2] But under ordinary circumstances, Cry toxins *do* seem to be quite safe for humans and other mammals to eat. It’s not that our intestinal cells are immune to their mechanism of action, *per se*; it’s that—even though a human being’s small intestine is an alkaline environment full of digestive enzymes just like the mosquito's—we have an acidic portion to our digestive tracts first. Mosquitos don’t. When a human eats a Cry toxin, the strong acid of the stomach denatures and degrades it before it ever reaches the small intestine, where it would have a chance to unfold into its toxic form.

So in the mid-90s, reassured by decades of safety data which suggested that sprinkling BT on crops doesn’t hurt anyone, scientists took BT’s Cry toxin genes and engineered them into corn. The result—a crop which produces its own pesticide, toxic to bugs but safe for humans—was hailed as one of the first great success stories of genetic engineering and agricultural biotech, and “Bt” corn now accounts for *84% of all corn acreage grown in the US.*

That's where the story, as I learned it, wraps up: a nice, neat narrative of human ingenuity, filed away under “Why GMOs are actually quite safe.” [3]

The Second Step

But a few weeks after learning this, I looked a little too closely at a bag of Tostitos Scoops. For anyone unfamiliar with modern American cuisine, these are an even greater triumph of human ingenuity: a corn chip extruded and formed into a tiny bowl for optimal dipping. The kind of product that’s designed to appeal to the beast in all of us which rejects ascetic mysticism like "less is more", and asserts instead with inarguable certainty that *No, actually, more is more—especially where queso dip is concerned.*

And on this bag of Tostitos Scoops, near the top of the ingredients list, I saw a word that I had never seen before—“Nixtamalized”—as part of the phrase *Nixtamalized corn.*

Intrigued by the sound of the word, I looked it up, and discovered that it owes its unusual spelling to its origins in Nahuatl, the language of the Aztec. As for what it means: it describes an ancient food processing technique, a method for turning corn into hominy, or grits: separating the fibrous hulls of the kernels from the rich, sweet meat inside.

A bowl of corn that's been *nixtamalized* to remove the tough outer hull. Source: Glane23 via Wikipedia (CC BY-SA 3.0)

The process itself is simple enough in practice—you soak the kernels in lime water for a while, then squish 'em to pop out the innards—but there's some surprisingly sophisticated chemistry going on at the molecular level.

This chemical treatment breaks the bonds that attach the meat of the kernel to the hull, while simultaneously causing new bonds to form within the kernel itself. The net effect is that not only does the meat pop nicely out of its skin when squeezed, it behaves much more like a dough compared to untreated cornmeal, which makes for superior tortillas.

Interestingly enough, the process also liberates niacin, a critical B vitamin that would otherwise be inaccessible, bound up in the chemical matrix of the corn. As a result, a diet consisting mostly of un-nixtamalized corn can result in pellagra, a niacin deficiency syndrome—as Europeans discovered when they started using the crop without regard for the traditional preparation methods.

As time went by, nixtamalization eventually began to catch on among food manufacturers, but—even though it yields a product which is both more nutritious and more palatable—adoption has been hampered by two factors. One is that it's wasteful, in the sense that the hull makes up a small but significant fraction of a corn kernel's weight. When you're a billion-dollar-a-year food manufacturer, even tiny percents translate to millions of dollars of product. The other reason is that the process produces a lot of chemical waste: the mucky lime water left over from treatment isn't good for much, and costs money to treat and dispose of.

The Third Step

Here again, though, technological innovation comes to the rescue. A while back, some clever food scientists figured out that if you add proteolytic enzymes to the lime bath, you can separate the kernels from their hulls faster and produce much less waste water in the process.

Now, this is where I should mention a key detail: when I say “lime water”, I mean lime the mineral, not the fruit. Same word, but practically opposite meanings. Lime the fruit is acidic, while lime the chemical—which ancient people would get by roasting seashells or chalky earth—is a strong base.

Do you see the problem yet?

The Stumble

The problem is that most of the corn grown today, thanks to a clever bit of genetic engineering, is full of Cry toxins—which are supposed to be safe for human consumption because they’re denatured by stomach acid before they can be activated.

But nixtamalization, as it's currently practiced, involves soaking that corn in an alkaline solution, before treating it with digestive enzymes: the exact two chemical steps that it takes to unfold a Cry toxin from its inert form into its hole-poking, toxic one.

As far as I can tell, this is simply an extraordinarily unlucky coincidence—born of the fact that nobody in research and development at Bayer-Monsanto is talking to the people in product engineering at Frito-Lay…or if they are, they're not asking crazy questions like: *Hey, you weren't planning on soaking the corn in an alkaline solution and then attacking it with proteolytic enzymes before feeding it to people, were you?* [4]

The Takeaway

To be clear, I have no idea if this translates into actual health problems for actual people. It's possible that stomach acid destroys the active form of Cry toxins just as easily as the inert form, although this is by no means guaranteed. Even if it **is** a problem, it's far from being the largest issue with our food system; this enzymatic nixtamalization process is applied to a comparatively tiny fraction of all the corn products consumed in the US.

As far as I know, it’s pretty much just the Scoops you gotta worry about.

And I think it’s precisely the small stakes of this problem that helped me see the broader picture here. A realization with vast and horrible implications triggers psychological defenses: we need to believe that someone competent is driving the bus and that there are guardrails on the road, so that we can get on with our commute. It’s part of why, when people first see the statistics on roundup and autism prevalence, it tends to tends to trigger an instinctive reaction of disbelief, along the lines of “That can’t be right. There are smart people whose job is to look out for this kind of thing, and they would never let something like that happen.”

But even this need to believe in systemic competency is just a minor manifestation of one of the most fundamental and powerful forces in human psychology—inertia. People be lazy! They don't wanna change the way they live, especially if it involves sacrificing convenience and other material comforts.

It's the difference between *opinions* and *convictions*: An opinion is something that's consistent with your worldview, that you'd say you believe if asked—but a conviction is something that you live by, that you really *act* like you believe (or else at least feel bad about).

Most people's worldviews do a good job of minimizing cognitive dissonance, and preventing inconvenient opinions from becoming convictions. The more inconvenient something is, the more creatively we'll deploy our energy to find evidence against it. If we can't reject it on the evidence, we'll minimize our estimates on the likelihood that the thing matters. Failing that, we'll find ways to minimize the likelihood we can do anything to change it. Something as monumentally inconvenient as "Modern agricultural practices are driving a number of terrible chronic diseases, and we should all be eating organic food" is simply too big to ask most people to make into a conviction all at once.

There's none of that difficulty here, though: nobody reading this post is gnashing their teeth and lamenting: "*It cannot be! Even cruel fate could not conspire so craftily—so sneakily!—to make this one specific kind of ultra-processed corn product into a unique (but probably mild) gastrointestinal hazard!*"

At these low stakes, it's easier to acknowledge that the sheer size and complexity of our food system means there are probably some cracks in its safeguards. Experts do miss things, especially when catching them would require a person to be up-to-date on both molecular biotechnology and the latest advances in tortilla production.

But perhaps most importantly: there's nothing preventing your average person from turning this particular opinion into a conviction; all it really takes is picking a different kind of corn chip from the hundreds of bags on a supermarket shelf.

Of course, the real takeaway of this story is not "Don't eat Tostitos Scoops"; it's that **the system is too big to trust**. It reminds me of the feeling you get when you receive a notice in the mail from your car's manufacturer, which politely informs you that the vehicle you've been driving for the past five years has a weird quirk where depressing both pedals at the same time while honking the horn will cause the brake lines to snap…and that they will happily cover any service charges associated with repairing this minor issue.

The industrial processes that serve as the scaffolding of our lives are colossal and complex: Rube Goldberg machines with a million moving parts, built piecemeal by a billion different people bolting things on as they see fit. If you want to add something on, you do your best to design it such that none of the moving parts in your module jam together on somebody's fingers. If you're thoughtful, you also work to understand the parts of the system that your piece will interface with, and do the same there.

But there is no real architect to consult here, no master blueprint. Nor can there be, because the pace of human innovation means that the shape of the machine is constantly changing, as people tack on one ingenious invention after another. This combination of frantic pace and massive scope is why there are a Thousand Secret Ways, and why no one person can truly know them all.

Lindy and the Crocodile

It's also why you don't have to. A while ago, my wonderful fiancée Emily introduced me to the concept of *lindy*—a word which describes things that are preferable because they've been around a long time. Organic agriculture, traditional recipes, natural fabrics, even organized religion—these are lindy.

There's power in this, rooted in the understanding that the concept of evolution by natural selection applies just as much to behaviors and technologies as it does to genes. New technologies and behaviors are like mutations to the cultural genome, which can offer advantages: If you put filters on your cigarettes, maybe they're less likely to kill you. But the problem is that something which appears fit today can be a net-negative in the long run, like if you happened to make your cigarette filters out of asbestos. Over a long enough timescale, the genuinely disadvantageous behaviors start to select themselves out, so sticking with things that people have been doing a long time provides a good measure of safety.

It's a useful heuristic, but it's inherently limiting, because mutations are also what drive evolution. To see the philosophy applied *in extremis*, look no further than the crocodile—an organism that effectively locked its genome in "read only" mode a few million years ago, when it figured out that there are few game plans more reliable than:

1. *Look like a log.*
2. *Have lots of teeth.*

But I don't want to be a crocodile, or one of those freaks who wears socks with no elastic in them for fear of the electric fields produced by synthetic fibers. I want to innovate, and to enjoy the fruits of others' innovation, which is why I'm not against GMOs generally—but the complexity of things like our food system highlight why I think it's equally unwise to take a blanket stance like"trust the science". This stuff *can* be done right, but it requires us to continuously question the assumption that it's already being done right.

It's a tricky balance to strike, and it places a lot of burden on the individual; a reader recently told me that children are now expected to receive something like 72 vaccines over the course of their youth. I haven't fact-checked that, but if it's true, I fully understand the instinct to reject it all out-of-hand: that's an absolutely overwhelming number of things to do your own research on, unless you call listening to an episode of Joe Rogan "doing your own research." [5]

And consider the level of understanding it takes to spot things like the (Cry Toxin) x (Nixtamalization) interaction. It's too much to ask, especially when most of us are not scientists—just people trying to keep ourselves and our loved ones fed and healthy.

The most that any of us can do is to learn as much as we can, use all the information available to us, and try to err on the side of caution. Sometimes that means making mistakes, but more often than not, you'll find it's worth trusting your gut.

Years before I learned about Cry toxins and nixtamalization, and thus embarked on my path of the Thousand Secret Ways, I swore off Tostitos Scoops specifically. It was the result of an incident where I ate half of a family-sized bag dipped in salsa for lunch, shortly before being struck by a stomachache so bad that I thought I was dying of appendicitis.

Was it the Cry toxins? A coincidence? I don't know. Frankly, I don't really care.

I don't miss them, except sometimes at the holidays when Emily's aunt puts out a tray of buffalo chicken scoops, and that beast inside me rattles the bars of my convictions, chanting: *MORE IS MORE*.

It's good to know he's still in there.

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1 If you've read the piece on Natto: King of Fermented Foods, you likely recognize the genus, *Bacillus,* as the one which contains the natto bacterium, *Bacillus subtilis.*

2 See, for example, botulism, tetanus, cholera, or any of the dozen other lethal diseases caused by bacterial toxins

3 If your first instinct upon hearing this is to ask "what about people taking proton pump inhibitors, or other antacids?"...well, gold star.

4 I described it as an unlucky coincidence, but this isn't quite true. There's overlap between nixtamalization and digestion because, at their core, most food processing techniques are trying to do the same thing digestion does, i.e. make nutrients more available. This is a specific instance of the biggest recurring problem in biology and medicine: when so much of the machinery of life is shared among nearly all living things, it's hard to find ways to kill only one certain sub-set of things.

5 I have nothing against Rogan, aside from the fact that he hasn't invited me on his show yet.

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