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EBOOK

Food Additives

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Food Additives: Harmful or Harmless?

One of the benefits of ancestral eating is that you avoid potentially harmful food additives like artificial colors, MSG, and artificial sweeteners. But even on a Paleo diet, it can be hard to avoid some fillers, thickeners, and additives.

In fact, many common Paleo foods contain more additives than their Neolithic counterparts! For instance, commercial nut milks and coconut milk often contain thickeners like gums or carrageenan, while your run-of-the-mill grocery store whole cow's milk is additive-free.

In this eBook, I'll review the science on some of the most common additives, and let you know whether you should be concerned about consuming them. First up – magnesium stearate!

Magnesium Stearate

Magnesium stearate is a salt that is produced when a magnesium ion bonds with two stearate molecules. Stearate is just the anion form of stearic acid, which you've most likely heard of before. Stearic acid is a long-chain saturated fat that is abundant in beef, cocoa butter, coconut oil, and other natural foods. It's also the only long-chain saturated fat that scientists and medical practitioners agree doesn't raise cholesterol levels, and doesn't increase risk of heart disease.

Magnesium stearate is most commonly used in supplement manufacturing as a 'flow agent,' which helps ensure that the equipment runs smoothly and the ingredients stay blended together in the correct proportions.

Given the seemingly benign components of this additive, it's a little surprising how controversial it is. There are a lot of misconceptions and inaccurate statements about it floating around the internet, and while I wouldn't recommend consuming vats of the stuff (not that you'd want to), I think the concern over magnesium stearate is largely overblown.

EFFECT ON IMMUNE CELLS

One study that many people have used as evidence against magnesium stearate is a 1990 experiment entitled "**Molecular basis for the immunosuppressive action of stearic acid on T cells**." This baffles me, and I suspect that anyone using this study to indict magnesium stearate hasn't actually read it.

In the experiment, scientists isolated T-cells and B-cells from mice, put them in a Petri dish, and bathed them in a solution containing stearic acid (along with some other components). They observed that the T-cells incorporated the stearic acid into their cell membrane, eventually de-stabilizing the membrane enough that the cell died.

First of all, this study has nothing to do with magnesium stearate. They just used the plain old stearic acid that you'd find in your beef, chocolate, or coconut oil, so this study could just as easily be used against those foods. If you're going to be concerned about this study (which you shouldn't be), you'd have much bigger sources of stearic acid to worry about than the magnesium stearate in your supplements.

Second, the study has nothing to do with stearic acid consumed in the diet. Under normal conditions, your T-cells are not bathed in stearic acid, even if you consume superhuman amounts of coconut oil, tallow, and cocoa butter.

Finally, the researchers used T-cells from mice, and in this case, the results cannot be applied to humans. The mouse cells incorporated stearic acid into their membranes because they lacked the ability to de-saturate fatty acids. However, human T-cells do have the ability to de-saturate fatty acids, so even if you did bathe your T-cells in stearic acid, they would be able to maintain their membrane function. (1)

In case you got lost, here's a summary: this study has no relevance whatsoever to human consumption of magnesium stearate, I have no idea why the study is being referenced in this manner, and you shouldn't be concerned about it.

CONCERNS ABOUT PESTICIDES AND GMOS

Another criticism is that because stearate is often derived from cottonseed oil, it can be contaminated with pesticides. Keep in mind that magnesium stearate is a highly purified substance, and goes through an intensive refining process before appearing in your supplements. So far, I haven't come across any reports indicating that magnesium stearate retains substantial amounts of pesticide residue.

As for the concern that cottonseed oil is often genetically modified, the source of crude fat shouldn't make a difference in the final form of the stearate. Stearic acid is an 18-carbon molecule with a specific chemical structure that will be the same whether the stearic acid is from a genetically modified cotton plant, a bar of Hershey's chocolate, or a grass-fed ribeye steak.

EFFECT ON NUTRIENT AND DRUG ABSORPTION

Another criticism is that magnesium stearate might inhibit nutrient absorption. One in vitro study conducted in 2007 found that tablets containing magnesium stearate dissolved more slowly than tablets without magnesium stearate when placed in artificial gastric juice. (2) The study authors concluded that in vivo studies are needed to determine whether this finding has any practical significance. However, an earlier study found that although magnesium stearate increased the time it took for a drug to dissolve, it had no effect on overall bioavailability, as evidenced by blood levels of the drug in test subjects. (3) Further, another study found that levels of magnesium stearate didn't affect tablet dissolution at all. (4)

All of this indicates that although magnesium stearate might affect the rate of tablet dissolution in some circumstances, it doesn't affect the overall bioavailability of the drug or supplement.

BIOFILMS

I've seen this claim pop up in a few places around the internet, so I'll address it briefly. Some critics of magnesium stearate claim that it can induce formation of harmful biofilms

in the intestine. This assertion appears to be based on the fact that soap scum contains magnesium and calcium stearate, so they insist that just as soap scum creates films on your sink or shower, magnesium stearate creates films on your intestines.

It should be pretty obvious that the intestinal lumen is a vastly different environment from a shower door, but some people still seem to be concerned. Rest assured, there is no conceivable reason why this would take place, and I haven't seen a single scientific article that even hints at this possibility.

ALLERGIES

A 2012 study entitled "**Magnesium stearate: an underestimated allergen**" reported on a 28-year-old woman who had an allergic reaction to magnesium stearate, resulting in hives. I'm very curious about this, because an allergy to either magnesium or stearate seems highly unlikely, but unfortunately I don't have full-text access to that study. But needless to say, if you develop hives (or another allergic response) after consuming magnesium stearate, you should probably avoid it in the future.

As a final note, a rat study determined that you'd have to take 2500mg of magnesium stearate per kilogram of bodyweight per day to start seeing toxic effects. (**5**) That means a 150lb person would have to consume 170,000 mg per day, which is so far beyond any amount you would encounter in supplements that it's a non-issue.

Overall, I haven't found scientific evidence to substantiate the claims against magnesium stearate, and the small amounts found in supplements shouldn't be a problem for the majority of the population.

Soy Lecithin

Soy lecithin is one of the most ubiquitous additives in our food supply. It's used primarily as an emulsifier, and you can find it in everything from salad dressing to tea bags. Paleo dieters avoid the brunt of it by eliminating most processed foods, but it almost always pops up in chocolate (everyone's favorite honorary Paleo food) and often appears in supplements.

I recommend avoiding soy as a general rule, but consuming small amounts of soy lecithin as an additive is very different from, say, eating a soy burger topped with soy cheese or drizzling soybean oil on your salad.

WHAT IS SOY LECITHIN?

The term 'lecithin' can have different meanings depending on the context, but for our purposes, it refers to a mixture of phospholipids and oil. Phospholipids are a component of the cell membrane in all plants and animals, but lecithin is most often derived from sunflower kernels, rapeseed (canola), milk, soy, and egg yolks. (6)

The specific composition of soy lecithin varies depending on its manufacturer and intended use, but on average, it contains about 35% soybean oil and 16% phosphatidylcholine. (7) Phosphatidylcholine is a type of phospholipid that is abundant in liver and egg yolks, and is the primary form of choline found in foods. (8) The remaining percentage is other phospholipids and glycolipids.

To make soy lecithin, soybean oil is extracted from the raw soybeans using a chemical solvent (usually hexane). (9) Then, the crude soy oil goes through a 'degumming' process, wherein water is mixed thoroughly with the soy oil until the lecithin becomes hydrated and separates from the oil. Then, the lecithin is dried and occasionally bleached using hydrogen peroxide.

There are many claims online about soy lecithin being full of nasty chemicals left over from the production process. Not surprisingly, there aren't many credible sources describing the chemical content of commercial soy lecithin, but I have found some relevant data about the safety of soy lecithin.

Before the 'degumming' step where lecithin is removed, the crude oil undergoes a multi-step process to remove the hexane. (10) However, it appears that the FDA doesn't regulate the amount of hexane residue in food products, and one paper estimated that the residual hexane concentration of soy oil is 500-1000ppm. (11) So, it's very possible that similar concentrations remain in the soy lecithin. (For comparison's sake, the concentration limit for hexane in pharmaceuticals is 290ppm.) (12)

According to one analysis, total pesticide residues in crude soy oil are around 400ppb. (13) Since the pesticide concentration of the oil after degumming is similar, it's pretty likely that some of those pesticides end up in the lecithin as well.

While it's unfortunate that soy lecithin likely contains pesticides and solvents, I would just encourage you to keep this information in perspective. **We're exposed to hundreds of chemical toxins** every day in our air, water, household products, and food, and contaminants in soy lecithin will contribute only slightly to your overall toxic load. After all, we're talking parts per million and parts per billion, and soy lecithin itself usually makes up no more than 1% of processed foods. (14)

Of course, in an ideal world, we would be able to avoid these things altogether, and I certainly recommend reducing your exposure as much as possible. It's also a good idea to make sure your **detox systems are functioning effectively**. But unless you have a severe chemical sensitivity to hexane or pesticides, occasionally consuming small amounts is not worth getting bent out of shape over.

ALLERGIES

Soy allergies are triggered by soy proteins, so whether lecithin triggers an allergic response or not depends on its protein content. One analysis found protein concentrations ranging from 100 to 1,400ppm in six different soy lecithin samples. (15) (For reference, the new FDA gluten-free labeling law requires a gluten concentration of less than 20ppm.) (16)

Another analysis of six different lecithin samples found that four had sufficient protein to trigger an IgE-mediated response in people with soy allergies, while two contained no detectable protein at all. (17) However, another study performed similar testing and concluded that even if protein is present in soy lecithin, it's not a significant allergen for people with soybean allergies. (18)

It's clear that the source of the soy lecithin is a major determinant in whether or not it will present a problem for those with soy allergies, but if you have a soy allergy, I'd say better safe than sorry. However, because protein is present in such a low concentration, and soy lecithin itself usually makes up no more than 1% of processed foods, it's probably not a problem for those with minor sensitivities to soy.

GMO

Most of the soy grown in the US is genetically modified, so unless the label says 'organic soy lecithin,' it probably came from a genetically modified soybean. **You know I'm not a fan of GMOs**, due to the presence of potentially transferrable DNA and potentially immunogenic proteins.

However, as I discussed in the section on allergies, soy lecithin contains very little soy protein, and lecithin from some sources contains no detectable protein at all. Soy lecithin also contains very little DNA, and the DNA present is usually degraded to the extent that it's impossible to tell whether the soy is genetically modified or not. (19) Thus, most of the risks associated with consumption of GMOs aren't relevant for soy lecithin, and shouldn't be cause for concern.

PHYTOESTROGENS

Soy is the greatest food source of phytoestrogens, and one group of researchers discovered significant estrogenic activity in soy lecithin. (20) Interestingly, none of the soy lecithin they tested contained genistein, which is the predominant phytoestrogen in soy. They concluded that "a so-far unidentified estrogen-like compound" is present in soy lecithin that accounts for its estrogenic activity.

We know **how problematic phytoestrogens can be**, but again, the dose makes the poison. Remember, soy isn't the only source of phytoestrogens we're exposed to. (Did you know that flaxseed is also a significant source of phytoestrogens? In fact, **one study** showed that supplementation with ground flaxseed altered estrogen metabolism even more than supplementation with soy flour.)

It's definitely best to keep phytoestrogens to a minimum, and individuals dealing with cancer or fertility problems might want to avoid them more strictly. But for most generally healthy people, the small amounts of phytoestrogens from soy lecithin shouldn't be a problem.

TOXICITY

One study that has been used widely as ammunition against soy lecithin is titled "**Effects of a Commercial Soy Lecithin Preparation on Development of Sensorimotor Behavior and Brain Biochemistry in the Rat**." Researchers found that soy lecithin in

concentrations of 2% and 5% in the diets of pregnant and newborn rats resulted in impaired reflexes and swimming ability, along with other cognitive deficiencies.

It's important to understand that these effects are due to choline toxicity, not soy lecithin per se. The elevated brain/body weight ratios, plus elevated acetylcholine and choline acetyltransferase levels that resulted from soy lecithin supplementation were caused by the phosphatidylcholine, and would've still occurred even if they had used a source of phosphatidylcholine other than soy; even egg yolks.

It would be very difficult to consume as much choline as these rats did, especially from soy lecithin. In fact, **most people are deficient** in choline! This is just another case of a study being misinterpreted, and you certainly don't need to worry about soy lecithin causing developmental problems.

THERAPEUTIC USES

It's worth mentioning that soy lecithin is also being recommended and consumed as a dietary supplement. There is a growing body of research supporting its use for improving blood lipids, reducing inflammation, and treating neurological disorders. (21) For instance, one study found that after 2 months of supplementing with 500mg of soy lecithin per day, total cholesterol levels fell by 42% and LDL levels decreased by 56%. (22)

However, most of these studies involve supplementation with a purified form of soy lecithin, which usually contains less soy oil and more phosphatidylcholine than the commercial soy lecithin that shows up in foods. Additionally, isolated phosphatidylcholine is often referred to as 'lecithin' in scientific contexts, so some studies supplementing with 'soy lecithin' are really just supplementing with phosphatidylcholine.

So once again, it's not the soy lecithin; it's the choline. Luckily, you can derive all the benefits of phosphatidylcholine supplementation just by increasing your consumption of choline-rich foods like **egg yolks** and **liver**.

The only people who need to make a point of avoiding soy lecithin are those with severe soy allergies or chemical sensitivities, and of course, those who notice that they personally react badly to it. And if you don't have a soy allergy, almost all of the

remaining concerns about soy lecithin (pesticides, solvents, and GMOs) can be completely eliminated by purchasing products that contain organic soy lecithin.

But for the vast majority of the population, even conventional soy lecithin isn't worth worrying about one way or the other. If it's just as easy for you to avoid it as it is to consume it, then do so. (For example, **Enjoy Life** is one popular brand of chocolate that is soy-free.) Ultimately, I think most people can just enjoy their occasional chocolate treat without worrying about whether it contains soy lecithin.

Carrageenan

Carrageenan, a heavily discussed additive in the world of alternative health, is an indigestible polysaccharide that is extracted from red algae, and is most commonly used in food as a thickener or stabilizer. Carrageenan-containing seaweeds have been used for centuries in food preparations for their gelling properties, but the refined, isolated carrageenan found in modern processed foods has raised concerns in the health-conscious online community. (**23**)

Carrageenan is especially common in non-dairy milks such as almond milk and coconut milk, which means that some people who transition to a Paleo diet might actually be increasing their exposure if they use these products. I discussed carrageenan on a **recent podcast**, but I want to give you a more detailed summary of the evidence.

There are a few distinct types of carrageenan that differ in their chemical properties, but the most important distinction is between degraded carrageenan and undegraded carrageenan. From a chemical standpoint, the difference between these two types is in their molecular weight. From a practical standpoint, undegraded carrageenan is approved for use in food products, while degraded carrageenan is not. (**24**)

Although both substances are often referred to as 'carrageenan,' they have very different chemical properties and should really be treated as separate compounds. Degraded carrageenan is also called 'poligeenan,' which is how I will refer to it in the rest of this eBook to avoid any confusion.

ANIMAL STUDIES

Most of the carrageenan hysteria stems from animal studies that implicate carrageenan in the formation of ulcerations and cancerous lesions in the colon. A thorough **review** of the approximately 45 available animal studies on carrageenan was published in 2001, and at first glance, these studies seem alarming.

However, it turns out that the majority of these animal experiments used poligeenan instead of carrageenan, and as I mentioned before, these are two separate compounds with different effects. Poligeenan is significantly more detrimental to the health of lab animals than carrageenan, so the lack of a clear designation between them has given carrageenan a worse reputation than it deserves.

One important difference is that while poligeenan can cause cancer on its own when given in high enough concentrations, undegraded carrageenan has only ever been shown to accelerate cancer formation when administered with a known carcinogen. (**25**) In other words, food-grade carrageenan has not been shown to cause cancer in animal models. That doesn't necessarily mean carrageenan is in the clear when it comes to cancer, but contrary to popular belief, it is not a known carcinogen.

Additionally, poligeenan produces more severe ulceration and inflammation than carrageenan, and at lower concentrations. As an example, a study on rhesus monkeys using poligeenan at 0.5-2% resulted in diarrhea, hemorrhage, and ulcerations, while carrageenan at 1-3% resulted in no colonic changes. (**26**) (For reference, the concentration of carrageenan in processed food is usually between 0.01% and 1%.) (**27**)

However, carrageenan has produced intestinal damage in some animal studies. Observed effects in rats include epithelial cell loss, increased intestinal permeability, and diarrhea. (**28**) In guinea pigs, carrageenan at a 5% concentration in the diet caused ulcers in the colon, although a similar concentration in the diets of rats and hamsters resulted in no difference from controls. (**29**)

In pigs, concentrations of carrageenan between .05 and .5% administered for 83 days resulted in abnormalities in the intestinal lining, but no ulcerations or tumors. (**30**) Still, a more recent rat study found no ulcerations or lesions in the colon after 90 days of carrageenan administration. (**31**) These studies suggest that the effects of carrageenan

are highly species-dependent, which makes it more difficult to extrapolate these results to humans.

There are a few other important considerations when determining how applicable these results are to humans. Many of these experiments administered the carrageenan through the animals' drinking water as opposed to their food, which tends to increase the severity of the resulting symptoms. Because carrageenan interacts with protein molecules, consuming it as part of a solid food is much less harmful than consuming it in water.

Also, although many of the concentrations administered are comparable to concentrations found in processed foods, many experiments were conducted at concentrations much higher than humans would ever encounter on a normal diet. Remember, these studies are looking at carrageenan as a percentage of the entire diet, not just less than 1% of a small portion of the total diet, as is the case when using milk replacement products.

HUMAN STUDIES

Experimental evidence on the effects of carrageenan in humans is extremely limited, for obvious ethical reasons. However, a few in vitro experiments have been conducted on isolated human intestinal cells.

One study found that in intestinal epithelial tissue, carrageenan exposure increased the expression of two pro-inflammatory transcription factors. (32) This reaction appears to be protective of the intestinal tight junctions, because suppression of either of the inflammatory factors resulted in increased permeability of the isolated epithelial tissue. Unfortunately, it's unclear whether they used food-grade carrageenan rather than poligeenan in this experiment.

Two similar studies that did use food-grade carrageenan also found that isolated intestinal epithelial tissue responded to carrageenan by up regulating inflammation. (33, 34) Another study on human intestinal epithelium found that undegraded carrageenan reduced the activity of many sulfatase enzymes, with potential negative ramifications for the function and vitality of the cell. (35)

Finally, another study found that exposing human intestinal epithelial cells to undegraded carrageenan in concentrations lower than what would be found in a typical diet caused increased cell death, reduced cell proliferation, and cell cycle arrest. (36)

These studies provide some support for the generalization of the animal studies to humans, implicating carrageenan in the potential for intestinal inflammation. However, it's important to remember that not only were these studies in vitro (aka not in the human body), they also didn't administer the carrageenan with any food, so the effects observed may differ significantly from what actually occurs when humans ingest carrageenan in a real-world setting.

EXPOSURE TO POLIGEENAN

Because poligeenan can be produced from carrageenan, many researchers and laypeople have expressed concern that we might be exposed to poligeenan through contamination of the food supply. However, the most recent sources indicate that the poligeenan contamination level of food-grade carrageenan is less than 5%. (37)

Another encouraging data point in this situation is that while carrageenan is an extremely effective thickener and emulsifier at concentrations as low as .01%, poligeenan has no functional effect in food even at concentrations up to 10%. (38) Specific chemical processing is necessary for carrageenan to be degraded to poligeenan, and because poligeenan is of no use in the food industry, it seems unlikely that poligeenan would show up in appreciable quantities in processed foods.

Another concern is whether small percentages of ingested carrageenan are degraded to poligeenan in the digestive tract after consumption, either because of the acidic environment or because of intestinal bacteria. Some experimental evidence indicates that as much as 10-20% of carrageenan could be degraded to poligeenan during digestion, while other researchers (not surprisingly funded by the carrageenan industry) assert that carrageenan is stable throughout digestion. (39, 40)

Regardless, the significant differences between poligeenan and carrageenan as evidenced by the reactions of lab animals make it pretty clear that even if some degradation does take place, carrageenan still doesn't have the potential for harm that poligeenan does.

As with magnesium stearate and soy lecithin, carrageenan has been frequently portrayed as significantly more harmful than is supported by available evidence. Contrary to popular belief, it's not a known carcinogen, and although some studies implicate carrageenan in ulceration and inflammation, some show no adverse effects.

However, I do still think caution is warranted. If I had to rank additives, I'd say carrageenan is a bit more concerning than the other two additives we've discussed so far because of its association with gut issues. Remember, in cases involving modern ingredients, the burden of proof should be on manufacturers to prove that they're safe, rather than on consumers to prove that they're harmful. Because the evidence isn't conclusive either way, I recommend avoiding carrageenan, especially if you have a history of digestive problems.

Personally, I adhere to the "precautionary principle" for anything I eat; in other words, in the absence of proven safety, I choose to avoid foods that have questionable adverse effects. Carrageenan fits this description, as there's still some doubt about its safety and no evidence has convinced me that there isn't a potential for harm if consumed regularly.

Occasional exposure is likely nothing to worry about, but for most people reading this eBook, avoiding carrageenan is probably as simple as making your own **nut milk** or **coconut milk**, so I would encourage you to give that a shot. Also, if you follow the links to those two posts, some commenters have shared brands of almond and coconut milk that don't contain carrageenan (although watch out for other additives that may be present).

Xanthan Gum

Food additives are commonly used as stabilizers, thickeners, or emulsifiers. Another additive that shares many of these functions in commercial foods is xanthan gum, which is also popular in gluten-free baked goods for the elasticity it lends to dough.

Although it isn't as heavily discussed in the blogosphere as the other additives I've covered thus far, many health-conscious people see it on ingredient lists and wonder what it is, and whether they should be eating it. So now, I'll do my best to answer those questions.

Xanthan gum is a largely indigestible polysaccharide that is produced by bacteria called Xanthomonas Camestris. (41) Manufacturers place the bacteria in a growth medium that contains sugars and other nutrients, and the resulting product of bacterial fermentation is purified, dried, powdered, and sold as xanthan gum. (Makes you wonder who first thought to put it in food, doesn't it?)

ANIMAL STUDIES

Overall, the results from animal studies on xanthan gum aren't very concerning. In one experiment, rats were fed xanthan gum for two years in concentrations of 0.25, 0.50 or 1.0 g/kg body weight per day. (42) The only notable difference between the xanthan gum groups and the control group was that rats fed xanthan gum experienced soft stools somewhat more frequently than the control rats, but even that barely reached statistical significance. There were no differences in growth rate, survival, blood markers, organ weights or tumor incidence.

Another experiment followed a similar design but used dogs instead of rats, and the results were the same: no changes other than occasional soft stools. (43) In a three-generation reproductive study, rats were fed either 0.25 or 0.50 g/kg per day, and there were no significant changes in the parents and offspring from the xanthan gum-receiving groups. (44)

Based on those initial studies, it was concluded that xanthan gum is a perfectly safe food additive. Since then, a few additional animal studies with different aims have been published.

One study, conducted to evaluate the effects of xanthan gum on digestion in rats, found that a diet containing 4% xanthan gum increased the amount of water in the intestines by 400%, and also increased the number of sugars remaining in the intestine. (45) Another study found that in rats fed 50 g/kg of xanthan gum (an incredibly high dose) for 4 weeks, the stool water content and short-chain fatty acid (SCFA) content increased significantly. (46)

This last study actually relates to the potential anti-tumor properties of xanthan gum, and researchers found that orally administered xanthan gum was able to slow tumor growth

and prolong the survival of mice with melanoma. (47) The mechanism is unclear, but it's interesting nonetheless.

HUMAN STUDIES

Due to the lack of harmful effects observed in animal studies, there are few human studies on xanthan gum. The first study aimed to determine the safety of xanthan gum when consumed by humans in an everyday dietary setting, but at levels much higher than people would normally encounter in their diet. (48) For 23 days, 5 adult men with no GI issues consumed between 10.4g and 12.9g of xanthan gum daily (based on the subjects' weight), which is 15 times the current Acceptable Daily Intake of 10mg/kg. Overall, they experienced a reduction in serum cholesterol, an increase in fecal bile acid, and an increase in stool output and water content.

Another study had volunteers consume 15g of xanthan gum per day for 10 days. (49) They found xanthan gum to be a "highly efficient laxative," and subjects experienced greater stool output and gas. That's not very surprising considering the high dose, but what I found particularly interesting about this study was their measurement of the ability of subjects' fecal bacteria to metabolize xanthan gum.

The researchers found that before the trial period, bacteria from the stools of only 12 of the 18 subjects could break down the xanthan gum, while after the trial period, bacteria from 16 of the subjects could break it down. (50) Additionally, the stool samples containing bacteria that could break down the xanthan gum showed a much greater production of hydrogen gas and SCFA after the trial period as compared to baseline, indicating that the intestinal bacteria of the subjects quickly adapted to this new food source. Clearly, xanthan gum (like many indigestible carbohydrates) can have a profound impact on the gut microbiota in large doses.

COLITIS IN INFANTS

The only concerning research I found on xanthan gum relates to the development of necrotizing enterocolitis (NEC) in infants. Recently, the New York Times published an **article** relating the tragic deaths of infants who had developed NEC after consuming a diet of formula or breast milk that had been thickened with a xanthan gum-based product called SimplyThick. This product was widely used in hospitals to thicken feed for infants with swallowing difficulties.

Two papers reviewed the cases of xanthan gum-associated NEC, and while there isn't enough data to establish causation, the general consensus seems to be that the xanthan gum caused increased bacterial production of SCFA in the newborns' intestines, and this contributed to the development of NEC. (51, 52) Although SCFA are vital to colon health, the immature digestive systems of newborns appear to be extremely sensitive to them. (53, 54) Since then, general practice guidelines suggest avoiding manufactured thickening products in babies under 12 months old, and rice cereal or baby oatmeal is used instead.

I wanted to address this because while it's clearly important to avoid giving xanthan gum to infants (especially in large amounts), I'd like to emphasize that none of this changes the fact that xanthan gum appears to be relatively harmless in adult humans. None of the animal or human studies found damage to the intestinal mucosa following xanthan gum consumption, even in large doses, so this danger appears to be unique to newborns. For everyone else, SCFA aren't something to be afraid of, and they are actually beneficial for the gut and for metabolic health, as I mention in previous articles **here** and **here**.

WHEAT, CORN, SOY, AND DAIRY ALLERGIES

I mentioned in the opening section that xanthan gum is produced by bacterial fermentation of a sugar-containing medium. Unfortunately, that 'medium' is often a potentially allergenic substance such as corn, soy, dairy, or wheat. Many xanthan gum manufacturers **aren't eager to share** what their 'medium' is, but one common supplier, Bob's Red Mill, discloses their production practices.

It looks like they **originally used corn or soy** as a medium, but they've since **changed their medium** to a glucose solution derived from wheat starch. However, they claim that the xanthan gum is still gluten-free, and it continues to be marketed as such.

It can be difficult to find production info online, but just be aware that if you have a severe allergy to corn, soy, wheat, or dairy, it would be prudent to either avoid xanthan gum entirely or check with the manufacturer to see how it's produced.

Based on the available evidence, the worst xanthan gum seems to be capable of (in adults) is causing some digestive distress in those who are susceptible by increasing

stool bulk, water content, and sugar content. But as I just mentioned, those with severe allergies should also be careful.

I recommend that people with digestive problems generally avoid xanthan gum, not because there's evidence that it could damage your gut, but because its structural properties make it likely to produce unpleasant gut symptoms. Unlike carrageenan, there's no evidence that xanthan gum can cause serious harm (even in human studies using doses much higher than people would normally encounter), so if you are able to tolerate it, I see no compelling reason to strictly avoid it.

I wouldn't recommend consuming large amounts every day, because xanthan gum appears to have a high propensity for altering the gut microbiome, and it's unclear whether that alteration could be problematic in the long run. But the small amounts that you would normally encounter in the context of an overall real-food diet shouldn't present a problem.

Guar Gum

I talked briefly about guar gum a while ago in my unexpectedly controversial **article on coconut milk**, but I'll give you a bit more detail here. Unlike xanthan gum, which is a product of bacterial fermentation, guar gum is derived from an actual food: the guar bean, or Indian cluster bean, which grows primarily in India and Pakistan. They look similar to green beans, and are a common vegetable dish in the areas in which they grow.

The physiological effects of guar gum have been extensively studied, first on animals and then on humans. In rats, the only significant effects from guar gum supplementation were reduced body weight and lower blood glucose, even with guar gum making up 15% of the diet (over 100 times the FDA Acceptable Daily Intake). (**55**) Because guar gum is a soluble fiber, neither of these effects is particularly surprising. Other animal studies conducted to test the safety of guar gum concluded that it is not carcinogenic or teratogenic (harmful to growing fetuses). (**56**, **57**, **58**)

Because the animal studies showed no harm even at very high doses, guar gum is now being studied in humans as a therapeutic tool for reducing blood glucose and cholesterol

levels. Studies have shown guar gum supplementation to be effective for reducing fasting blood glucose, improving glycemic control, reducing insulin requirements in insulin-dependent diabetics, and reducing LDL cholesterol, although whether these effects could be maintained long-term is uncertain. (59, 60, 61, 62, 63, 64)

Unfortunately, these studies do report gastrointestinal side effects such as increased gas. In one study where subjects were given 21g of guar gum per day for 3 months, two participants dropped out due to excessive gas and abdominal discomfort. (65)

Although 21g per day is far more guar gum than anyone would reasonably encounter in their diet, even small amounts could cause unpleasant symptoms in those with sensitive digestive systems, and I've had patients with gut issues improve after removing guar gum from their diet. With that in mind, I think it makes sense to avoid guar gum if you have gut issues, like small intestinal bacterial overgrowth (SIBO) or IBS, unless you've removed it and added it back in without noticing any harmful effects.

Locust Bean Gum

Locust bean gum, also known as carob bean gum, is derived from the seeds of the carob tree. During a two-year animal study, rats were given locust bean gum as 5% of their diet, and no carcinogenic or other toxic effects were observed. (66)

Similar to guar gum, locust bean gum has also been studied in humans as a potential cholesterol-lowering compound. (67) Normal subjects and subjects with familial hypercholesterolemia were given between 8 and 30 grams per day of locust bean gum for 8 weeks, resulting in reduced total cholesterol and an improved HDL to LDL ratio. Participants did report increased gas, but it went away after a week or two, and no other harmful effects were reported.

I think the same recommendation I gave for guar gum applies here: if you have gut issues, it would probably be best to avoid locust bean gum. Otherwise, I see no indication that it will cause harm.

Gum Arabic

Gum arabic is derived from the sap of the acacia tree. Under FDA regulations, gum arabic is given an Acceptable Daily Intake level of 'not specified,' which is assigned to additives with little or no observed toxic potential. Animal studies have shown that it is not carcinogenic, mutagenic, or teratogenic, and even at very high doses, the animals did not display any effects of toxicity. (68, 69)

In a small human study, 5 healthy men were given 25g of gum arabic per day for three weeks, and no side effects were reported. (70) In fact, gum arabic had very little effect on the participants, positive or negative, aside from a modest reduction in serum cholesterol and an increase in breath hydrogen.

The increased breath hydrogen indicates metabolism by intestinal bacteria, which has been confirmed by more recent studies on the prebiotic properties of gum arabic. A study using healthy human volunteers found that gum arabic acts as a powerful prebiotic, selectively stimulating the growth of bifidobacteria and lactobacilli. (71) The study authors concluded that gum arabic is at least as effective a prebiotic as inulin, if not more so. Many of you are probably aware that inulin is sold as a prebiotic supplement, so that's pretty significant!

Based on the available research, gum arabic seems pretty benign, even for those with gut issues. I certainly wouldn't be concerned about consuming small amounts of it, although as always, be aware of your individual tolerance.

Tara Gum

Like guar gum and locust bean gum, tara gum is derived from the endosperm of a legume. Tara gum is a relatively new food additive so there's less data on it, but it has been thoroughly studied for toxic effects in animals. Researchers conducted multiple 90-day trials in rats, mice, and beagles with tara gum as 5% of the diet, and found no adverse effects other than decreased body weight in the experimental groups. (72)

Three-generation reproductive rat studies and genotoxicity studies found no harmful effects of tara gum. (73) In 2-year trials, the experimental groups had more tumors than

the control groups, but due to the “high spontaneous incidence” of this particular tumor and the fact that nearly all of the control mice developed the tumor as well, researchers concluded that this was not a result of the tara gum supplementation. (74)

I’m slightly more skeptical of tara gum compared with the other gums because the toxicity results are less conclusive. Also, while all of the other gums have been tested on humans, tara gum has not. That doesn’t mean it’s not safe, because the available evidence indicates it is; it just means we don’t have as much to go on, and it’s always good to be cautious of new food additives.

Gellan Gum

Gellan gum is similar to xanthan gum in that it is an exopolysaccharide produced by bacterial fermentation. Unfortunately, the routine animal toxicity studies conducted for new food additives aren’t available online, but we do have a human study to look at. To test the safety of gellan gum, the diets of ten volunteers were supplemented with gellan gum at approximately 30 times the level of normal dietary exposure for 23 days. (75) Gellan gum acted as a bulking agent similar to xanthan gum, but no adverse effects were reported. However, a rat study with gellan gum supplemented at 5% of the diet for 4 weeks resulted in abnormalities in intestinal microvilli, which is concerning. (76)

This rat study, as well as the lack of data overall, makes me cautious, and I think those with sensitive guts should avoid it just to be on the safe side. For everyone else, I doubt the small amounts found in food will cause a problem, but it might be best to avoid it if possible.

Conclusion

As a general rule, gums can be problematic for those with digestive issues simply because they’re mostly indigestible, but it’s very unlikely any of them will actually cause harm. Of course it’s ideal to avoid food additives altogether, but I know it’s not realistic for everyone to prepare all food from scratch, and unless you have digestive issues or a sensitivity to certain gums, I don’t think it’s necessary.

Because I've covered a lot of different additives with similar applications (primarily thickening or emulsifying), I'll try to rank them for you. Let's say you're buying some almond milk, and there are a bunch of different brands that use different additives. First, do your best to avoid carrageenan. In general **the** concerns have been largely overblown, but it definitely shows the highest potential for harm among the additives we've discussed, and with all of the choices available to us, it should be pretty easy to find a brand that doesn't use it.

Next, I would avoid tara and gellan gums, not because they appear to be harmful, but because we have less information on them.

I'd probably rank guar gum above xanthan gum because it's derived from a food instead of a bacterial exopolysaccharide, and it isn't produced using common food allergens. Locust bean gum is probably on about the same level as guar gum, although based on the available studies, the gut symptoms associated with locust bean gum appear to be less severe.

Gum arabic seems the least likely to create digestive symptoms, and it even stimulates the growth of beneficial bacteria, so out of all the gums, it appears to be the least problematic.

Finally, just remember that the overall quality of your diet is far more important than how well you avoid these additives. Luckily, the two correlate pretty well!