

Carrageenan

How a “Natural” Food Additive is Making Us Sick



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Executive Summary

Carrageenan is a common food additive extracted from red seaweed. For the past four decades, scientists have warned that the use of carrageenan in food is not safe. Animal studies have repeatedly shown that food-grade carrageenan* causes gastrointestinal inflammation and higher rates of intestinal lesions, ulcerations, and even malignant tumors.

In the past decade, researchers have successfully identified several ways in which food-grade carrageenan causes harm. The chemical structure of carrageenan—unique chemical bonds not found in other seaweeds or gums—affects the body in several ways. Most notably, it triggers an immune reaction, which leads to inflammation in the gastrointestinal system. Prolonged inflammation is a precursor to more serious diseases, including cancer.

Animal studies have repeatedly shown that food-grade carrageenan causes gastrointestinal inflammation and higher rates of intestinal lesions, ulcerations, and even malignant tumors.

What is carrageenan?

Carrageenan is derived from specific seaweeds, which are processed with alkali into a widely used “natural” food ingredient. When processed with acid instead of alkali, carrageenan is degraded to a low molecular weight, and is called “degraded carrageenan” or poligeenan. Degraded carrageenan is such a potent inflammatory agent that scientists routinely use it to induce inflammation and other disease in laboratory animals, to test anti-inflammation drugs and other pharmaceuticals.

* In this report, we use the term “food-grade carrageenan” and “undegraded carrageenan” interchangeably, to distinguish it from “degraded carrageenan” which has a low molecular weight and has been used in thousands of studies to predictably cause inflammation and disease in laboratory animals.



Carrageenan is a common food additive extracted from red seaweed.



Many individuals experiencing gastrointestinal symptoms (ranging from mild “belly bloat,” to irritable bowel syndrome, to severe inflammatory bowel disease) have noticed that eliminating carrageenan from the diet leads to profound improvements in their gastrointestinal health.

Which foods commonly contain carrageenan?

DAIRY: whipping cream, chocolate milk, ice cream, sour cream, cottage cheese, “squeezeable yogurt” marketed to children

DAIRY ALTERNATIVES: soy milk, almond milk, hemp milk, coconut milk, soy desserts, soy pudding

MEATS: sliced turkey, prepared chicken

NUTRITIONAL DRINKS: examples include Ensure™, SlimFast™, Carnation Breakfast Essentials™ and Orgain™

PREPARED FOODS: canned soup, broth, microwavable dinners, frozen pizza



Degraded carrageenan is not allowed in food, but scientists have raised concerns for decades that the use of food-grade (undegraded) carrageenan also causes harm. A convincing body of scientific literature shows negative effects caused by food-grade carrageenan. Moreover, scientists are concerned that the acid environment of the stomach may “degrade” food-grade carrageenan once it enters the digestive system, thus exposing the intestines to this potent and widely recognized carcinogen.

These scientific findings, coupled with the food industry’s extensive use of carrageenan, raise serious questions for consumers.

Why is carrageenan in processed foods and beverages?

Though carrageenan adds no nutritional value or flavor to foods or beverages, the food industry uses it in a wide variety of applications; its unique chemical structure makes it useful for several reasons.

Carrageenan serves as a substitute for fat, and to thicken nonfat or low-fat foods or dairy replacements. It recreates a fatty “mouthfeel” in products such as low-fat or nonfat dairy (e.g., low-fat cottage cheese, low-fat sour cream) and vegetable-based dairy substitutes (e.g., soy milk, coconut milk).

Carrageenan can also serve as a stabilizer for beverages that separate, and must be stirred or shaken before use to redistribute the particles. Addition of carrageenan allows beverages like chocolate milk or nutritional shakes to be consumed without first shaking or stirring.

Carrageenan is also used in meats, especially deli meat and prepared chicken. It is sometimes injected as a brine in pre-cooked poultry to improve tenderness and maintain juiciness. It is added

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to low-sodium or low-fat deli meat (e.g. sliced turkey) as a binder.

It is found in many processed foods, even some certified organic frozen pizzas and nutrition bars. And many varieties of canned pet food contain carrageenan.

Why is carrageenan harmful?

The unique chemical structure of carrageenan triggers an innate immune response in the body, which recognizes it as a dangerous invader. This immune response leads to inflammation.

For individuals who consume carrageenan on a regular or daily basis, the inflammation will be prolonged and constant, which is a serious health concern since prolonged inflammation is a precursor to more serious disease. In fact, the medical community has long recognized that inflammation is associated with over 100 human diseases, including inflammatory bowel disease, rheumatoid arthritis, and arteriosclerosis. Inflammation is also linked to cancer.

Many individuals experiencing gastrointestinal symptoms (ranging from mild “belly bloat,” to irritable bowel syndrome, to severe inflammatory bowel disease) have noticed that eliminating carrageenan from the diet leads to profound improvements in their gastrointestinal health.

Researchers are exploring other ways in which carrageenan is harmful. Scientists have recently found that contact with carrageenan reduces the activity of certain beneficial enzymes in human cells.¹ And a recent study exposing mice to carrageenan in drinking water showed impaired insulin action and profound glucose intolerance—precursors to diabetes.²

How long have scientists been concerned about the use of carrageenan in food?

Starting in the late 1960s, research linked the type of carrageenan used in food to gastrointestinal disease in laboratory animals, including ulcerative colitis-like disease, intestinal lesions, and colon cancer.

“The rising incidence and prevalence of ulcerative colitis across the globe is correlated with the increased consumption of processed foods, including products containing carrageenan. Since carrageenan has been found to cause colitis in animal models of ulcerative colitis we felt it would be important to perform a well-controlled dietary study to determine whether carrageenan causes exacerbations (flare ups) of ulcerative colitis in patients in clinical remission.”

—Dr. Stephen Hanauer, MD, Chief, Section of Gastroenterology, Hepatology and Nutrition, and Joseph B. Kirsner, Professor of Medicine and Clinical Pharmacology, University of Chicago School of Medicine

“Carrageenan exposure clearly causes inflammation; the amount of carrageenan in food products is sufficient to cause inflammation; and degraded carrageenan and food-grade carrageenan are both harmful.”

—Dr. Joanne Tobacman, MD, Associate Professor of Clinical Medicine, University of Illinois at Chicago

“[Dr. Tobacman] explained that all forms of carrageenan are capable of causing inflammation. This is bad news. We know that chronic inflammation is a root cause of many serious diseases including heart disease, Alzheimer’s and Parkinson’s diseases, and cancer. All told, I recommend avoiding regular consumption of foods containing carrageenan.”

— Dr. Andrew Weil

“Now that serious harmful effects have become apparent in animals fed degraded and undegraded [food-grade] carrageenan, the safety of carrageenan must be seriously reconsidered, and, in view of the long-term effects, caution must be applied in the continued use of carrageenan.”

—Written in 1981 by Dr. Raphael Marcus and Dr. James Watt, Department of Pathology, University of Liverpool, United Kingdom

Since eliminating carrageenan from my diet, I have had no problems with stomach cramps, body aches or extreme bloating. I am extremely careful not to ingest even the smallest amount, as it will cause me hours of suffering.

—Kim DeLaroque, Warren, Manitoba, Canada

My wife always wondered why I had diarrhea, and I just told her it was normal and that I’d always had it. These symptoms were from carrageenan.

—Jeff Pokorny, Bend, Oregon

Before I identified carrageenan as the cause of my symptoms, I was afraid to go out anywhere, because I never knew when I would be “hit” with a sudden bout of diarrhea and nausea.

—Diane Jordan, Ottawa, Ontario, Canada

In 1981, two researchers conducted a literature review of the science published since the late 1960s, and raised concerns about the widespread use of carrageenan in the diet. The researchers wrote in the journal *Cancer Detection and Prevention*: “[U]ndegraded carrageenan is still widely used throughout the world as a food additive. Its harmful effects in animals are almost certainly associated with its degradation during passage through the gastrointestinal tract. There is a need for extreme caution in the use of carrageenan or carrageenan-like products as food additives in our diet.”³

In the two decades between 1981 and 2001, more published research studies showed harmful effects of consuming food-grade carrageenan. In 2001, the official journal of the National Institute of Environmental Health Sciences, which is part of the National Institutes of Health, published a review of the scientific literature. Its author, Dr. Joanne Tobacman, concluded: “The widespread use of carrageenan in the Western diet should be reconsidered” due to evidence that “exposure to undegraded as well as to degraded carrageenan was associated with the occurrence of intestinal ulcerations and neoplasms.”⁵

Meanwhile, carrageenan manufacturers and the food industry commissioned scientists to perform similar studies.⁶ As is to be expected when a profitable industry faces scientific scrutiny from publicly funded research, the carrageenan manufacturers and food industry even commissioned scientists to publish criticisms of the prior scientific findings pointing to harm.⁷

In recent years, publicly funded scientists have moved beyond animal studies, which repeatedly point to harm, and have conducted studies using human cell cultures to identify the biological mechanisms by which carrageenan causes inflammation. One of these mechanisms has now been identified: one of the particular immune pathways activated by carrageenan is similar to those activated by other “natural” poisons, such as pathogenic bacteria (including *Salmonella*).⁸

In 2008, Dr. Tobacman, the author of the 2001 *Environmental Health Perspectives* review, urged the Food and Drug Administration (FDA) to prohibit the use of carrageenan in food. The FDA, relying primarily on industry-funded research and failing to review additional studies published since 2008, denied the petition in 2012.

These concerns extend beyond our borders. Scientists in other countries as well have been urging regulators to take action for

It is time for consumers to take action and pressure the food industry to remove this harmful ingredient from our food supply.

over three decades, but whenever government agencies raised concerns (especially in the European Union), they have come under intense pressure from the international trade-lobby group, Marinalg International, and from the food manufacturing industry to continue allowing carrageenan in food.

It is time for consumers to take action and pressure the food industry to remove this harmful ingredient from our food supply.

Who is affected by carrageenan?

Many individuals who lived for years, sometimes decades, with gastrointestinal discomfort or disease—ranging from mild bloating to serious ulcerative colitis—have noticed that eliminating carrageenan from the diet dramatically improves their gastrointestinal health.

But the absence of noticeable gastrointestinal symptoms does not signify that an individual is unaffected by carrageenan. Research shows carrageenan predictably causes inflammation. Low-grade inflammation of the intestines may go unnoticed; nevertheless, chronic low-grade inflammation in the body is profoundly unhealthy. Scientists are increasingly concerned about the negative effects of low-grade inflammation on overall health, especially as it often leads to more serious disease down the road.

The episodes—which included pain, nonstop throwing up, and sweats/chills—were intolerable. If I had not stopped ingesting carrageenan, I would have outrageous medical bills and be unable to eat without fear of such an episode.

—Kyla L., Morgantown, West Virginia

I no longer have Irritable Bowel Syndrome flare ups and am now able to do things I couldn't do previously. Before, I was afraid to go on overnight camping trips, day canoeing trips, or Kendo seminars, because the pain would literally incapacitate me, and now, after eliminating carrageenan from my diet, it's not an issue.

—Katie M., St. Louis, Missouri

A Summary of the Science on Carrageenan

Food-grade carrageenan (“undegraded”) is distinguished from “degraded” carrageenan, which has a lower molecular weight. For decades scientists have used degraded carrageenan to induce gastrointestinal inflammation in laboratory animals in order to test the effectiveness of new anti-inflammation drugs.^{9 10 11 12 13} This type of carrageenan is specifically classified as a “possible human carcinogen” by the International Agency for Research on Cancer of the United Nations.¹⁴

Food manufacturers claim that only degraded carrageenan is harmful, and that food-grade carrageenan is safe. Both independent scientists and the carrageenan manufacturers’ own data¹⁵ have disproved this claim.

While pharmaceutical scientists indeed use non-food-grade, degraded carrageenan to test new pharmaceuticals, a separate track of scientific inquiry has investigated food-grade carrageenan for its effects on human health.

Since 1969, dozens of studies of food-grade carrageenan have been published in peer-reviewed academic journals.[†] Results from these scientific experiments, cited in the Appendix, point to harmful effects from food-grade carrageenan in the diet. Studies from the 1960s, 1970s and 1980s link food-grade carrageenan to higher rates of digestive disease, including colon cancer, in laboratory animals. In 2001, a review published in the official journal of the National Institute of Environmental Health Sciences questioned the safety of food-grade carrageenan, based on an examination of the extant scientific literature.¹⁶

In response to that 2001 review, scientists set out to explore the ways in which carrageenan affects the body. As of the publishing of this report, February 2013, researchers have identified three biological mechanisms by which food-grade carrageenan negatively affects the human body. Numerous stud-

ies have been published identifying carrageenan’s unique chemical structure and how it triggers an immune response in the body, which is similar to the effects of pathogenic bacteria like *Salmonella*.¹⁷

Another concern is that degraded carrageenan has been shown to contaminate food-grade carrageenan. In response to a European Commission request¹⁸ to ensure that contamination with degraded carrageenan be kept to levels below 5%, the carrageenan manufacturers tested samples of food-grade carrageenan at six different laboratories.¹⁹ Test results varied widely from laboratory to laboratory, suggesting that even the carrageenan manufacturers have no reliable way of determining the levels of contamination with degraded carrageenan in their food-grade products.²⁰

Eight of the 12 samples of food-grade carrageenan contained higher than 5% degraded carrageenan according to at least one of the laboratories (in many cases, according to multiple laboratories). The highest level of degraded carrageenan found in a sample was 25%. And all samples contained at least some degraded carrageenan according to the majority of laboratories.

Numerous studies have been published identifying carrageenan’s unique chemical structure and how it triggers an immune response in the body, which is similar to the effects of pathogenic bacteria like *Salmonella*.

† Articles in peer-reviewed journals are accepted for publication only after expert scientists, who were not involved in the study, have reviewed them.

Not a single sample could confidently claim to be entirely free of the material that is classified as a “possible human carcinogen.”

Yet food manufacturers, unwilling to replace this convenient and useful stabilizing and thickening ingredient in their processed foods, and unwilling to be honest with their customers about the scientific data pointing to harm, cling to scientific knowledge about carrageenan as if it were 1968, the year before the first study was published showing higher rates of ulcerative colitis-like disease in rats given food-grade carrageenan in the diet.

Carrageenan used in pharmaceutical studies is degraded with the use of acid hydrolysis.²¹ What happens to carrageenan in the stomach’s acid en-

vironment? Researchers have suggested that acid digestion may degrade carrageenan, so that it essentially transforms into a harmful substance by the time it reaches the intestines. Several studies that subjected food-grade carrageenan to conditions similar to those found in the human stomach have found that some degradation occurs.^{22 23 24}

Further research continues. An ongoing study with ulcerative colitis patients at the University of Chicago and the University of Illinois at Chicago aims to shed light on the effects of carrageenan in the diet on gastrointestinal disease.²⁵ Another study currently underway will provide additional data to examine the link between food-grade carrageenan and diabetes.²⁶

Consumer Responses: Carrageenan & GI Symptoms

Individuals who suffered for years from gastrointestinal symptoms—abdominal bloating, “spastic colon,” irritable bowel syndrome, and diagnosed disease such as ulcerative colitis—often find relief when they eliminate carrageenan from their diet.

The Cornucopia Institute developed an online questionnaire for individuals to fill out if they eliminated carrageenan from their diet in an effort to improve their gastrointestinal health. In the first five months, 120 individuals filled out the survey and checked either “Gastrointestinal symptoms completely disappeared” or “gastrointestinal symptoms improved” after eliminating carrageenan from their diet.

Responses to the online questionnaire will be shared with medical researchers, and are confidential. The following individuals agreed to share their stories:

Before I knew about carrageenan, I suffered tremendous stomach cramps, body aches and extreme bloating from eating certain foods, sandwich meat, ice cream, etc. My symptoms would last for a minimum of 24 hours, sometimes lasting for 48 hours. I had several exploratory procedures done to see if I had a blockage somewhere in my intestinal tract. I started to record a food journal and a list of ingredients of everything I ate, and suddenly discovered my symptoms were caused solely by carrageenan.

Since eliminating carrageenan, I have had no problems with stomach cramps, body aches or extreme bloating. I am extremely careful not to ingest even the smallest amount, as it will cause me hours of suffering. I am extremely strict about the products I purchase, and after having researched the terrible effects of this awful ingredient, I have taken extra precautions that my four children do not ingest anything that contains carrageenan.

Kimberly DeLaroque,
Warren, Manitoba, Canada

I learned that carrageenan was bad but was not yet aware of what the symptoms were from exposure. Upon learning that it affected the lower GI, and upon recognizing that my elimination of symptoms coincided with my elimination of carrageenan from my diet, it became clear that it was likely more than coincidence that these symptoms were from carrageenan.

My wife always wondered why I had diarrhea, and I just told her it was normal and that I'd always had it. She also wondered why I defecated so frequently (3-6 times per day). Now I'm down to 1-2. Damn the corporations that put this junk in our food and pass it along as though it's totally safe and 'made from seaweed.'

Jeff Pokorny
Bend, Oregon

I wrote extensive food journals for at least a year—what I ate, the ingredients, and the effects which occurred. There were several Emergency Room visits where I didn't know what was wrong, and I needed fluids and sometimes medication because I couldn't stop vomiting. It was painful, and I became severely dehydrated. I had several tests done including a barium upper GI and a gastrointestinal nuclear scan. Those tests came out OK, but the barium drink used for the x-rays had carrageenan and I was vomiting profusely after ingestion (since I had to fast) and it occurred pretty much as soon as the drink hit my small bowel. At the point of this test, I realized what had to be the cause of my GI distress—mostly due to the food journals commonality, but also that precise moment. Discovering this reaction was a long, horrible process and I felt like my own science experiment every time I ate.

The episodes—which included pain, nonstop throwing up, and sweats/chills—were intolerable. If I had not stopped ingesting carrageenan, I would have outrageous medical bills and be unable to eat without fear of such an episode.

Kyla L.,
Morgantown, West Virginia

I discovered that carrageenan caused my gastrointestinal symptoms after correlating my stomach upsets with the consumption of ice cream and prepared coffee shop drinks. Since I was not lactose intolerant, I started looking for common ingredients and noticed carrageenan in the ice cream, creamer and coffee shop smoothies. When I removed things with carrageenan from my diet, there were no more problems.

I no longer have Irritable Bowel Syndrome flare ups and am now able to do things I couldn't do previously. Before, I was afraid to go on overnight camping trips, day canoeing trips, or Kendo seminars, because the pain would literally incapacitate me, and now it's not an issue.

Katie M.,
St. Louis, Missouri

Before I identified carrageenan as the cause of my symptoms, I was afraid to go out anywhere, because I never knew when I would be “hit” with a sudden bout of diarrhea and nausea. Had no idea what was wrong with me. I was even starting to have anxiety attacks over my health.

Now that I have eliminated carrageenan from my diet, I can finally lead a normal life. I can enjoy myself again, not afraid to travel, get on an airplane, bus or train. No more feeling nausea or having diarrhea almost every day.

I don't trust any foods with cream, soups, etc., and will not try any sauces. I am still very nervous about what I eat, but what a difference this has made on my life.

Diane Jordan
Ottawa, Ontario, Canada

Myths and Truths: Carrageenan in Food

MYTH: Carrageenan is natural and therefore safe.

TRUTH: Not all natural substances are safe. Many species of plants and seaweed contain substances that are very potent, either as medicine or poison. Other “natural” materials with powerful effects on the human body include tobacco, poison ivy, and rhubarb leaves, which are poisonous.

Carrageenan has a unique chemical structure that leads to prolonged inflammation and other negative health effects. Its effect on the body is similar to the effect of certain pathogenic bacteria such as *Salmonella*, which are also “natural.”

The health impacts from consuming food-grade carrageenan are well documented in the scientific literature (see Appendix).

MYTH: Food processors only use undegraded carrageenan, which is safe.

TRUTH: In recent decades, researchers concerned with the effects of carrageenan in the diet have used undegraded, food-grade carrageenan. These studies point to harmful effects.

When the carrageenan manufacturers’ trade group tested 12 samples of food-grade carrageenan, it found every sample was considered contaminated with degraded carrageenan (classified as a “possible human carcinogen”) by at least one of the testing laboratories. Food processors have an ethical obligation to their customers to take these test results seriously. Their claims that food-grade carrageenan is safe cannot be backed by recent scientific studies and other test results.

MYTH: The controversy around carrageenan is due to the work and activism of one scientist.

TRUTH: This is an especially sinister myth aimed at discrediting a publicly funded, independent researcher. These claims, perpetuated by corporate agribusiness and trade lobbyists, refer to Dr. Joanne Tobacman, a Harvard-educated physician-scientist who is a researcher and associate professor at the nation’s largest medical school, at the University of Illinois at Chicago. The majority of her publications have been funded by the National Institutes of Health and the Veterans Administration’s Merit Grants. She has also received financial assistance from the Broad Medical Foundation, a private foundation that seeks to advance scientific understanding about gastrointestinal diseases, and the American Diabetes Association.

Singling out independent scientists who have the moral courage to speak out, and painting their work as an aberration from the dominant scientific paradigm, is a popular tactic with corporations who are unwilling to accept scientific evidence that the products they sell are harmful.

While it is a popular tactic, it is a weak defense of carrageenan, since it has no basis in reality. Concern about the use of carrageenan in food began in the 1970s, three decades before Dr. Joanne Tobacman became involved.

Before Dr. Tobacman’s 2001 review article, dozens of studies by numerous different teams of scientists had raised concern about carrageenan. Scientists from the following institutions have been involved, or are currently involved, in studying the harmful effects of carrageenan: University of Chicago Medical School, Sorbonne University (France), University of Iowa, University of Liverpool (UK), Michigan State University, and Rensselaer Polytechnic Institute.

Studies by these authors were all peer-reviewed, which means they were reviewed by other scientists who examined research methodology and the validity of conclusions. Studies were published in different journals at different times, which means they were scrutinized by different editors and reviewers.

To claim that one researcher is responsible for the controversy may be a useful Internet sound bite for those wishing to defend carrageenan, but it is a weak defense of carrageenan's safety.

MYTH: Scientific studies pointing to carrageenan's harmful effects have been discredited.

TRUTH: Scientists have been employed or commissioned by carrageenan manufacturers and the food industry to defend the continued use of carrageenan, and they do indeed criticize, and attempt to discredit, the studies pointing to carrageenan's harmful effects.

After two British scientists published a review study and a letter in *The Lancet* in 1980 and 1981, the journal published a letter in response, defending the safety of carrageenan. The letter's author was Herbert J. Sarett, a Vice President at Mead Johnson, a corporation that manufactures infant formula, including ready-to-feed infant formula containing carrageenan.²⁷

After the publication of Dr. Joanne Tobacman's 2001 review, the journal *Environmental Health Perspectives* published a letter criticizing the study; the letter's author was an employee of Unilever,²⁸ a Dutch-based multinational corporation with \$18 billion in annual food sales. Unilever owns Slimfast™, a nutritional drink that contains carrageenan.²⁹

Many of the studies that have been cited by the food industry to refute publicly funded studies have been performed by corporate scientists. These studies have been performed by scientists at FMC Corporation, a \$3.4 billion chemical corporation and leading carrageenan manufacturer,³⁰ and San-Ei Gen FFI, Inc., a Japanese company that markets carrageenan in addition to other food additives such as artificial sweeteners and colors.³¹

In contrast, within publicly funded, university-affiliated scientific circles, concerns about the harmful effects of both degraded and undegraded carrageenan are taken very seriously.

As just one example, in 2011, researchers at the Harvard School of Public Health wrote: "[Studies] suggest that both native [i.e. undegraded] and degraded carrageenan may have a pronounced effect on the exertion of an inflammatory pressure on colonic mucosal cells including colonic epithelial cells and monocytes/macrophages."³²

MYTH: Carrageenan is safe because the Food and Drug Administration (FDA) allows its use, and rejected a citizen's petition requesting carrageenan's removal from our food supply.

FACT: The FDA allows the use of hydrogenated oils (trans fats), artificial sweeteners such as aspartame, synthetic food dyes (artificial colors), and genetically engineered foods, despite scientific research questioning the safety of these ingredients.

When the FDA declared in 2012[‡] that it would not act on the citizen petition requesting to discontinue the use of carrageenan in food, the agency did not perform a thorough analysis of the scientific literature. Dozens of studies pointing to potential harmful effects of food-grade carrageenan were never identified and considered by the FDA before it reached its conclusion that "the existing literature does not provide support for [the] requested action."

Considering the size of the industry that profits from either the manufacture of carrageenan or its use in

‡ It is not unusual for the FDA to take four years to respond to a citizen petition. In fact, many petitions have languished with the agency for much longer. Since the FDA denial letter came just weeks after the NOSB vote on carrageenan, which raised public awareness about carrageenan's health concerns, it seems likely that the carrageenan industry exerted pressure on the FDA to move forward with denying the citizen petition. Cornucopia has filed a Freedom of Information Act request with the FDA to determine what, if any, role corporate lobbyists played in the regulatory agency's decision.

foods and beverages, industry trade lobby groups will likely fight for continued FDA approval. Since, given its track record, it is unlikely that the FDA will act in the public's interest in the near future, it is up to consumers to protect themselves and their families, carefully read labels, and stop buying foods containing carrageenan. This will pressure the food industry to make changes voluntarily, as happened with trans fats and "pink slime" (a food ingredient used as a filler in ground beef, containing meat residues and antimicrobial chemicals).

MYTH: Carrageenan is safe because other regulatory agencies, including the European Union, allow it in food.

TRUTH: Pointing to overseas regulatory agencies is another common tactic used by agribusiness and biotechnology corporations to defend their products.

Many food substances that are recognized by the medical and scientific community to be harmful are allowed by regulatory agencies overseas, including trans fats, artificial sweeteners like aspartame, and synthetic food dyes that have been linked to neurological harm in children. Claiming an ingredient is safe because it is allowed in other countries is a convenient tactic because it avoids a discussion about scientific data.

In fact, no single regulatory authority has unequivocally pronounced carrageenan to be safe, although every decision is inevitably celebrated by the carrageenan manufacturers as indisputable "proof" of carrageenan's harmlessness.

When the United Nation's Joint FAO/WHO Expert Committee on Food Additives (JECFA) reviewed carrageenan and approved its continued use, the carrageenan trade group, Marinalg, hailed the decision as confirmation of carrageenan's safety.³³ In fact, the Committee had raised concerns. An excerpt from the JECFA 68th meeting:

A recent *in vitro* study indicates that carrageenan (with an average molecular weight of 1000 kDa) induces inflammation in human intestinal epithelial cells in culture through a Bc110-mediated pathway that leads to NFkappaB and IL-8. Carrageenan may

be immunogenic owing to its unusual 1,3-galactosidic link, which is part of its disaccharide unit structure. This study suggests that carrageenan might have a role in intestinal inflammation and possibly inflammatory bowel disease, since Bc110 resembles NOD2 (the gene that activates NFkappaB), of which some mutations are associated with genetic susceptibility to Crohn disease (Borthakur et al., 2007)

One new study conducted in mice showed that carrageenan enhanced the tumorigenicity of a carcinogen, MNU, confirming the results of studies previously evaluated by the Committee at its fifty-seventh meeting.

Proliferative and inflammatory effects were observed in one new study in mice administered kappa-carrageenan in the drinking-water at concentrations of 1% and 4%.³⁴

Despite these concerns, JECFA allows the use of carrageenan.

When the European Commission's Scientific Committee on Food reviewed safety data on carrageenan, the Committee concluded that food-grade carrageenan is not safe unless the amount of degraded carrageenan is kept to a minimum.

The Committee declared that levels of degraded carrageenan in food-grade carrageenan should be kept at levels below 5%.³⁵ This decision prompted the laboratory testing of food-grade carrageenan by the industry, which revealed that no food-grade carrageenan sample could confidently be shown to be free from degraded carrageenan at concentrations below 5%.

Carrageenan manufacturers have an international trade lobby group, Marinalg International, with a mission of defending the worldwide use of carrageenan in foods. Through Marinalg, carrageenan manufacturers employ professional lobbyists charged with ensuring that regulatory agencies continue allowing carrageenan in food.

The decisions by overseas regulatory agencies (as well as the U.S. FDA) to continue to allow use of carrageenan in food testifies to the power and clout of the carrageenan manufacturers' lobbyists, not to the safety of carrageenan.

MYTH: For some products, like soy milk, there are no alternatives to carrageenan for food processors.

TRUTH: On supermarket shelves, equivalent products appear side-by-side with some containing carrageenan and others without it. Food processors use gums, including guar gum and locust bean gum, as alternatives to carrageenan. Others write “Shake Well” on the package,³⁶ since the simplest alternative to carrageenan in products such as chocolate milk is to have the consumer shake the product right before use.

The Cornucopia Institute has a consumer guide on its website (www.cornucopia.org, under the Scorecards tab) that provides a list of products with and without carrageenan.

Other gums used as stabilizers and thickening agents do not share the unique chemical structure of carrageenan, and therefore do not raise the same health concerns. In 1988, Food and Drug Administration researchers compared damage to the colon in rats given carrageenan and given guar gum as an alternative. The researchers found damage to the rats given carrageenan but no damage to the rats given guar gum in the diet.³⁷

What is Carrageenan Doing in Organic Food?

Organic foods should be a safe haven from harmful ingredients. In fact, the Organic Foods Production Act of 1990, the law governing organic foods, requires that non-agricultural ingredients must be determined safe to human health and not deleterious to the environment before they can be added to organic foods.³⁸ Federal organic standards also require that non-organic ingredients must be essential to producing the food (e.g., baking powder for producing organic cookies).³⁹ Since nearly every product on store shelves containing carrageenan can be found by another manufacturer using an alternative to carrageenan (e.g., locust bean gum, guar gum), or with the words “shake it” on the package, carrageenan does not appear to be an essential food-processing ingredient.

Yet carrageenan made its way into organic foods due to carelessness by government regulators, misinformation supplied by corporate “independent” scientists advising the USDA, and successful lobbying by carrageenan manufacturers and food processors.

For the past two decades, food industry executives and lobbyists have managed to convince enough members of the National Organic Standards Board (NOSB)—the citizen panel that determines which non-organic ingredients can be used in organic foods—to give carrageenan its stamp of approval. Their tactics have become increasingly more manipulative and ethically questionable as it becomes clearer that scientific evidence is not on their side.

The NOSB first approved carrageenan in the mid-1990s. As required by law, the USDA had hired three “independent” contractors to perform a thorough scientific and technical review of the additive. Their job was to provide an independent review, in-

Carrageenan made its way into organic foods due to carelessness by government regulators, misinformation supplied by corporate “independent” scientists advising the USDA, and successful lobbying by carrageenan manufacturers and food processors.

cluding any concerns about the additive’s effects on human health or the environment. In their official reports to the NOSB, the three contractors assured the NOSB that no effects on human health had been identified.

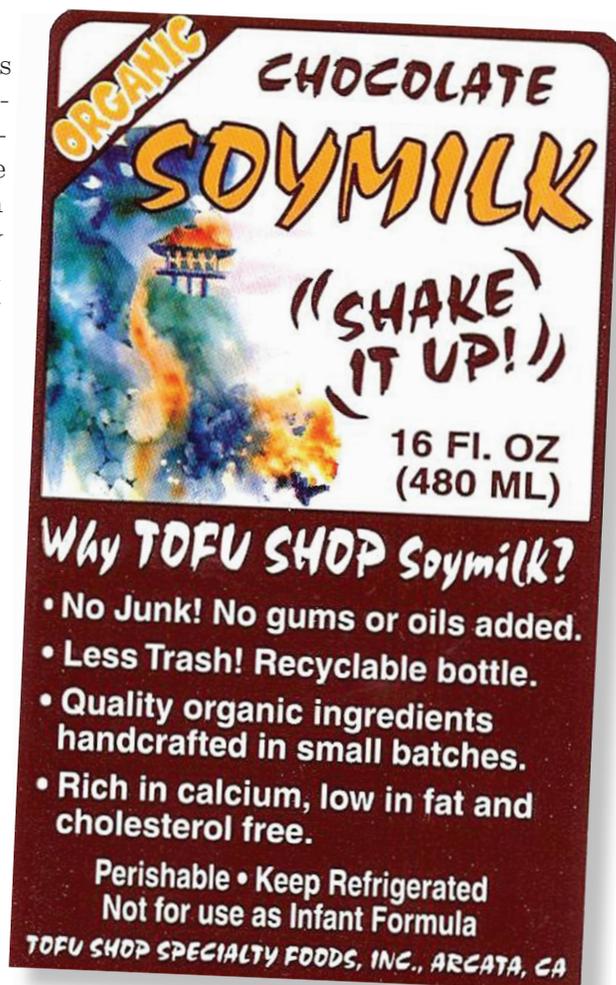
One of the three “independent” contractors was Dr. Richard Theuer, a former corporate executive who had been a colleague at Mead Johnson of Dr. Herbert Sarett, the author of the letter published in *The Lancet* defending the safety of carrageenan in food. Another contractor was Stephen Harper, a food scientist at Small Planet Foods, which is now owned by the multi-billion-dollar corporation General Mills. The third contractor was an academic. The three scientists claimed they had found no studies raising concern about food-grade carrageenan’s effects on human health.⁴⁰ The NOSB, unaware of the concerns about this food additive, approved carrageenan for use in organics.

The NOSB voted on whether to relist carrageenan as an approved substance in organic foods at its meeting in May 2012. Cornucopia staff members were at the meeting, presented scientific studies pointing to carrageenan’s harmful effects, and urged the NOSB to remove carrageenan from the list of approved additives. Meanwhile, industry lobbyists presented misinformation about carrageenan’s safety and questioned the credibility of independent research commissioned by the National Institutes of Health.

One of the NOSB members took an active role in assisting the carrageenan manufacturers. At one point, she read lengthy excerpts from a document written by Marinalg, the carrageenan manufacturers' trade lobby group, defending the safety of carrageenan. But before reading these lengthy excerpts, the Board member introduced the excerpts as "being from JECFA, a United Nations/FAO body" when in fact they were written by the industry's lobby group.

It is unclear whether this Board member intentionally misled her fellow NOSB members, or whether she herself was misled by the carrageenan manufacturers' lobbyists with whom she collaborated.

During the meeting, scientists with different perspectives presented oral testimony. A representative from FMC Corporation, a multi-billion-dollar chemical corporation that also manufactures pesticides and industrial chemicals, in addition to manufacturing carrageenan, defended carrageenan's safety. A scientist representing Marinalg International, the trade lobby group for carrageenan manufacturers, also defended carrageenan. Meanwhile, Dr. Joanne Tobacman, employed by the nation's largest medical school, presented publications that were funded primarily by public institutions including the Nation-



The easy alternative to carrageenan: shake the product before drinking.

al Institutes of Health, and urged the removal of carrageenan from organic foods and beverages. The NOSB voted, by a one-vote margin, to re-approve the use of carrageenan in organic foods.[§]

Sadly, even one of the NOSB members who was appointed as a "public interest/consumer" representative voted to approve carrageenan, despite strong opposition from every public interest and consumer group.

Several of the NOSB members with a clear conflict of interest voted to approve carrageenan after they failed to recuse themselves from voting, as the NOSB's policies require. One Board member who voted in favor of carrageenan was employed by Whole Foods Market, which produces and markets a wide variety of products containing carrageenan under its 365 Organic brand. Another NOSB member who voted in favor of carrageenan was employed by Organic Valley, which uses carrageenan in several of its

products. In fact, prior to the meeting, the CEO of Organic Valley spoke directly with several NOSB members to lobby for carrageenan's approval, and during the meeting a representative of the company presented formal testimony asking for carrageenan's continued use.

§ According to federal law, synthetics and non-organic ingredients used in organics "sunset" every five years unless the NOSB votes to reapprove their use.

Food Manufacturers' Responses to Scientific Data about Carrageenan

Conventional food manufacturers have not, to date, taken any action to remove carrageenan from their products.

In contrast, a number of organic companies, whose stated mission is to provide a healthy alternative to the conventional food supply, have taken the scientific literature on carrageenan seriously, and many are taking action to protect their customers' health.

Organic processors including Straus Family Creamery and Tofu Shop Specialty Foods, and many small-scale family-owned dairies have always offered foods without carrageenan, including products such as chocolate milk and chocolate soy milk that other companies claim cannot be made without carrageenan.

Organic companies that were previously misled or were unaware of the scientific concerns about carrageenan are now taking action to protect their customers. Independently owned companies including Eden Foods, and organic dairies Kalona Supernatural, Natural by Nature, and Clover Stornetta are presently reformulating products to remove carrageenan. Stonyfield Farm (85% owned by the French multinational corporation Group Danone), has also committed to removing carrageenan from its products, likely making them the largest food processor, conventional or organic, to boldly side with their informed customers in this debate.

Unfortunately, other companies have resisted removing carrageenan, after aggressively lobbying for its inclusion on the list of approved substances in organics. Some of these companies are now actively disseminating false information about carrageenan's safety. It is especially troublesome when this misinformation comes from major organic brands like Horizon Organic and Silk.

Both Horizon Organic and Silk are owned by the \$12 billion dairy conglomerate Dean Foods and its majority-owned WhiteWave Foods affiliate. Silk markets twenty-two products containing carrageenan, including certified organic soymilk. Horizon Organic sells numerous products containing carrageenan, including their Tuberz™ yogurt tubes marketed specifically to children.

Concerned consumers who post on Horizon Organic's Facebook wall, for example, receive a response that "degraded carrageenan and food-grade carrageenan are very distinct," and that "food-grade carrageenan is safe." When consumers reply that scientific studies have also shown food-grade carrageenan to be harmful, Horizon thanks them for their feedback and assures them that "as a company we're always monitoring for and reviewing emerging science around all of our ingredients, and will continue to do so to ensure that we're using the safest, high-quality ingredients we can in our products." But unlike many other organic companies, Dean/White Wave Foods has failed to commit to removing carrageenan from its Horizon Organic and Silk products.

Companies like Dean/WhiteWave, along with other large agribusinesses owning organic brands, and their lobby group the Organic Trade Association (OTA), are well aware of the existing science raising concerns about carrageenan.

In March 2012, Cornucopia compiled scientific studies about carrageenan and shared the document with numerous organic companies, including Dean/White Wave. Kelly Shea, Vice President and chief lobbyist at White Wave Foods, attended the May

2012 NOSB meeting and heard the various testimonies and discussions about carrageenan's harmful effects on human health. Ms. Shea then testified in favor of keeping carrageenan as an allowed non-organic additive for organic foods.

The Hain Celestial Group (Westsoy, Soy Dream, Rice/Coconut Dream) and J.M. Smucker (R.W. Knudsen, Santa Cruz juices) are two other prominent agribusiness-members of the OTA that own organic brands. They also are aware of the scientific concerns regarding carrageenan's safety, but none-

theless lobbied the NOSB for its continued use in organic foods.

Even the CEO of the iconic farmer-owned dairy cooperative, Organic Valley, lobbied NOSB members to maintain carrageenan on the list of approved materials for use in organics. The cooperative has since quietly reformulated its eggnog to remove carrageenan (it remains in their soy-based beverages, chocolate milk and ultrapasteurized whipping cream).

Consumers: Taking Action

In 2012, the FDA denied a 2008 citizen petition to remove carrageenan from foods, indicating the agency is unlikely to act anytime soon in the interest of public health concerning carrageenan. It is therefore up to individuals to take action.

Remember: together, consumers have more power than all corporate lobbyists and inappropriately influenced government officials combined. “Pink slime” and hydrogenated oils (trans fats) have virtually disappeared from our food supply, not due to FDA action but rather due to consumer pressure.

Putting carrageenan in food is like putting poison ivy in skin lotion. The only difference is we cannot see the inflammation, lesions, ulcerations, and polyps in our intestines. Both are natural, and both are cause for concern.

While the food industry and carrageenan manufacturers will likely continue for some time to dispute scientific findings pointing to harm, consumers have the power to send a strong message to the food manufacturers who put their profit and convenience above our nation’s health and well-being.

Putting carrageenan in food is like putting poison ivy in skin lotion. The only difference is we cannot see the inflammation, lesions, ulcerations, and polyps in our intestines. Both are natural, and both are cause for concern.

Action Checklist

1. Protect your health: read labels carefully and check the ingredients list.
 - a. As food manufacturers become aware that consumers want to avoid carrageenan, some are listing “Irish Moss” instead. “Irish Moss” is another name for carrageenan.
 - b. Do not rely on Internet data presented by companies that have an economic interest in carrageenan use. Check the label on the food itself, rather than exclusively relying on information supplied on websites.
2. Use Cornucopia’s shopping guide to find alternatives to foods that contain carrageenan (available online at www.cornucopia.org). Support the companies (generally certified organic) that have made a commitment to the health and well-being of their customers.
 - a. If your grocer does not yet stock carrageenan-free organic foods, ask them to carry the carrageenan-free alternative.
3. Contact companies and ask them to remove carrageenan from your favorite products. Tell them you will no longer buy their products until carrageenan is removed.
 - a. Customer service phone numbers and email addresses can be found on the “About Us” or “Contact Us” page of most food manufacturers’ websites as well as on many labels.
 - b. Some companies that have already committed to removing carrageenan will tell you so, while others will staunchly defend the safety of carrageenan based on outdated science.
4. Share this information with others. Tell your friends and family about carrageenan, so that they can also protect their health. Also tell your doctor if you have noticed improvements in your health after eliminating carrageenan from your diet.

Organic Dairy

Buttermilk with Carrageenan

(Organic buttermilk producers that used to add carrageenan have reformulated their products to be carrageenan-free)

- ✓ Clover Stornetta
- ✓ Friendship Brand
- ✓ Hawthorne Valley
- ✓ Kalona Supernatural
- ✓ Natural By Nature
- ✓ Organic Valley

Buttermilk without Carrageenan

Chocolate Milk With Carrageenan

- Clover Stornetta
- Horizon
- Kalona Supernatural (Kalona had committed to removing carrageenan by the end of 2012. As of February 2013, they have not. Check ingredients list)
- Natural By Nature
- Organic Valley
- Publix
- Simply Smart

Chocolate Milk without Carrageenan

- ✓ Castle Rock Organic Farms
- ✓ Crystal Ball Farms
- ✓ Equal Exchange Hot Chocolate (powdered)
- ✓ Strafford Organic Creamery
- ✓ Tricking Springs Creamery

Cottage Cheese with Carrageenan

- 365 Whole Foods (lowfat and fat)

Cottage Cheese without Carrageenan

- ✓ Kalona Supernatural (regular and

Cornucopia's Carrageenan Shopping Guide

Use Cornucopia's online shopping guide to help you avoid carrageenan in organic and non-organic products, including dairy, dairy alternatives, nutritional drinks, deli meats, dips, juice, prepared foods, desserts, and infant formula. Click the "Scorecards" tab at www.cornucopia.org.

If you notice improvements in your gastrointestinal health after removing carrageenan from your diet, please take a moment to fill out the online questionnaire (also available at www.cornucopia.org/carrageenan) to help medical researchers better understand the degree and severity of carrageenan-related gastrointestinal symptoms in the general public.

Appendix: Scientific Findings 1969–2012

Carrageenan has been scientifically studied for more than 40 years. The following studies are presented in chronological order. This is not a complete list of studies conducted using carrageenan, but is representative of studies by publicly funded scientists, raising concern.

It is important to note that all studies cited here used food-grade, undegraded carrageenan. This is the type of carrageenan that carrageenan manufacturers claim is safe. The findings summarized below reflect a very different conclusion.

The funding source is identified for studies that disclosed it.

1960s:

Watt J and Marcus R (1969) Ulcerative colitis in the guinea-pig caused by seaweed extract. *Journal of Pharmacy and Pharmacology* 21:187S–188S.

Summary of findings: This study was the first to show that food-grade carrageenan contributes to ulcerative colitis-like disease in laboratory animals (guinea pigs).

Author affiliations: University of Liverpool and Clatterbridge Hospital, United Kingdom

Author affiliations: The British Industrial Biological Research Association, a privately owned consulting firm.

Engster M and Abraham R (1976) Cecal response to different molecular weights and types of carrageenan in the guinea pig. *Toxicology and Applied Pharmacology* 38:265–282.

Summary of findings: In this short-term study, researchers administered different types of carrageenan in the diet and drinking water of guinea pigs for two weeks. They found ulceration of the intestines in guinea pigs given undegraded iota-carrageenan in the drinking water. No changes were observed in the other groups, and it is unclear what effects would have been seen if the experiment had been continued for longer than two weeks.

Funding: National Institute of Environmental Health Sciences, National Institutes of Health

Author affiliation: Albany Medical College

1970s:

Grasso P, Sharratt M, Carpanini FMB, Gangolli SD (1973) Studies on carrageenan and large-bowel ulceration in mammals. *Food and Cosmetics Toxicology* 11:555–564.

Summary of findings: The researchers administered both degraded and undegraded/food-grade carrageenan in the diet of several species of laboratory animals. Guinea pigs and rabbits experienced ulcerations in the large intestine, symptoms which were not detected in rats, squirrel monkeys, hamsters and ferrets.

Watanabe K, Reddy BS, Wong CQ, Weisburger JH (1978) Effect of dietary undegraded carrageenan on colon carcinogenesis in F344 rats treated with azoxymethane or methylnitrosourea. *Cancer Research* 38:4427–4430.

Summary of findings: This study found higher rates of tumors in rats fed undegraded carrageenan in the diet. All rats given food-grade carrageenan in the diet showed signs of gastrointestinal inflammation.

Funding: National Cancer Institute (National Institutes of Health)

Author affiliations: Naylor Dana Institute for Disease Prevention, American Health Foundation

1980s:

Watt J and Marcus R (1980) Potential hazards of carrageenan. *The Lancet* 315(8168): 602-603.

Letter to The Lancet: The authors of published research showing increased rates of ulcerative colitis-like disease in laboratory animals given food-grade carrageenan wrote the letter to *The Lancet*. Highly respected, *The Lancet* is one of the world's leading medical journals. The scientists express their concern with the safety of carrageenan in food.

Author affiliations: University of Liverpool and Clatterbridge Hospital, United Kingdom

Watt J and Marcus R (1981) Harmful effects of carrageenan fed to animals. *Cancer Detection and Prevention* 4(1-4): 129-34.

Review article: The authors reviewed the scientific literature and found "an increased number of reports ... describing harmful effects of degraded and undegraded carrageenan supplied to several animal species in their diet or drinking fluid."

"Harmful effects [of food-grade carrageenan] are almost certainly associated with its degradation during passage through the gastrointestinal tract. There is need for extreme caution in the use of carrageenan or carrageenan-like products as food additives in our diet."

Author affiliations: University of Liverpool and Clatterbridge Hospital, United Kingdom.

Watt J and Marcus R (1981) Danger of carrageenan in foods and slimming recipes. *The Lancet* 317(8215): 338.

Letter to The Lancet: Scientists repeat their concern with the use of carrageenan in food in a letter to *The Lancet*.

Author affiliations: University of Liverpool and Clatterbridge Hospital, United Kingdom

Arakawa S, Okumura M, Yamada S, Ito M, Tejima S (1986) Enhancing effect of carrageenan on the induction of rat colonic tumors by 1,2-dimethylhydrazine and its relation to β -glucuronidase activities in feces and other tissues. *Journal of Nutritional Science and Vitaminology* 32:481-485.

Summary of findings: This study found higher rates of tumors in rats fed undegraded carrageenan in the diet.

Author affiliations: Nagoya City University, Japan

Nicklin S and Miller K (1984) Effect of orally administered food-grade carrageenans on antibody-mediated and cell-mediated immunity in the inbred rat. *Food and Chemical Toxicology* 22:615-621.

Summary of findings: Researchers using undegraded carrageenan administered in the drinking water of rats found that carrageenan penetrates the intestinal barrier.

Author affiliations: The British Industrial Biological Research Association, a privately-owned consulting firm.

Calvert RJ and Reicks M (1988) Alterations in colonic thymidine kinase enzyme activity induced by consumption of various dietary fibers. *Proceedings of the Society for Experimental Biology and Medicine* 189:45-51.

Summary of findings: Researchers examined the reported effects of various dietary fibers on chemically induced colon carcinogenesis in rats. This study found a four-fold increase in thymidine kinase activity (a measure for malignant disease) in colonic mucosa following exposure to food-grade carrageenan. No differences were found following exposure to guar gum, a food additive used as an alternative to carrageenan.

Funding: Food and Drug Administration

Author affiliations: Food and Drug Administration

1990s:

Weiner ML (1991) Toxicological properties of carrageenan. *Agents and Actions* 32(1-2): 46-51.

Summary of findings: Based on a review of animal feeding studies, carrageenan is safe.

Author affiliation: FMC Corporation (multibillion dollar chemical corporation and leading carrageenan manufacturer)

Wilcox DK, Higgins J, Bertram TA (1992) Colonic epithelial cell proliferation in a rat model of non-genotoxin-induced colonic neoplasia. *Laboratory Investigation* 67:405-411.

Summary of findings: This study shows an association between loss of epithelial cells (the cell membranes in the intestine) and the consumption of both undegraded and degraded carrageenan.

Funding: Proctor & Gamble Company

Author affiliations: Proctor & Gamble Company

Corpet DE, Taché S, and Préclaire M (1997) Carrageenan given as a jelly does not initiate, but promotes the growth of aberrant crypt foci in the rat colon. *Cancer Letters* 114:53-55.

Summary of findings: Consumption of food-grade carrageenan promotes the growth of aberrant crypt foci in the rat colon. Aberrant crypt foci are abnormal glands in the colon that are precursors to polyps and are one of the earliest changes seen in the colon that may lead to cancer.

Author affiliations: French National Institute of Agronomic Research, Toulouse, France

Since 2000:

Suzuki J, Na HK, Upham BL, Chang CC and Trosko JE (2000) Lambda-carrageenan-induced inhibition of gap-junctional intercellular communication in rat liver epithelial cells. *Nutrition and Cancer* 36(1): 122-8.

Summary of findings: This study aimed to better

understand the role of food-grade carrageenan in carcinogenesis. The experiments in this study were designed to test the hypothesis that carrageenan might function as a tumor-promoting chemical by inhibiting GJIC (Gap-junctional intercellular communication is believed to help healthy cells fight cancer). The data revealed inhibition of GJIC by carrageenan similar to that by the well-documented tumor promoter phorbol ester.

Funding: National Cancer Institute

Author affiliations: Michigan State University

Tobacman JK (2001) Review of Harmful Gastrointestinal Effects of Carrageenan in Animal Experiments. *Environmental Health Perspectives* 109(10): 983-994.

Review study: This study examined existing research done to date (2001). The author concluded: "Because of the acknowledged carcinogenic properties of degraded carrageenan in animal models and the cancer-promoting effects of undegraded carrageenan in experimental models, the widespread use of carrageenan in the Western diet should be reconsidered."

Funding: No outside funding

Author affiliation: University of Iowa College of Medicine

Cornucopia Note: *The publication of this review, in the respected journal of the National Institutes of Health's National Institute for Environmental Health Sciences, marks a turning point.*

It prompted independent researchers to more closely study the biological mechanisms that cause the observed negative health effects of consuming undegraded, food-grade carrageenan.

These studies, focusing exclusively on food-grade carrageenan, have advanced scientific understanding about the way in which carrageenan causes harm.

Hagiwara A, Miyashita K, Nakanishi T, Sano M, Tamano S, Asai I, Nakamura M, Imaida K, Ito N and Shirai T (2001) Lack of Tumor Promoting Effects of Carrageenan on 1,2-Dimethylhydrazine-induced Colorectal Carcinogenesis in Male F344 Rats. *Journal of Toxicologic Pathology* 14; 37.

Summary of findings: This study found no statistically significant increases in malignant tumors in rats given food-grade carrageenan in the diet.

Author affiliations: Nagoya City University, Daiyukai Institute for Medical Science and San-Ei Gen FFI, Inc.

Cornucopia Note: This study has been widely cited by the carrageenan manufacturers and its trade lobby group Marinalg as “proof” that carrageenan is safe. One of the authors is a scientist with San-Ei Gen FFI, Inc, a Japanese carrageenan manufacturer.

The study has been criticized by publicly funded scientists, primarily because the study was terminated as higher rates of tumors in the carrageenan group were detected. The rats were killed after 90 days (a rat’s natural lifespan is 2 years). When the study was terminated, tumor rates were higher, but not yet high enough to be statistically significant.

Uno Y, Omoto T, Goto Y, Asai I, Nakamura M and Maitani T (2001) Molecular weight distribution of carrageenans studied by a combined gel permeation/inductively coupled plasma (GPC/ICP) method. *Food Additives and Contaminants* 18: 763-772.

Summary of findings: The study measured the molecular weight of 29 samples of food-grade carrageenan and concluded that no sample had a significant level of degraded carrageenan. The detection limit was 5%.

Author affiliations: San-Ei Gen FFI, Inc, a Japanese food additive manufacturer. In addition to carrageenan, San-Ei Gen FFI manufactures flavors, colors, preservatives and the artificial sweetener sucralose.

Cohen SM and Ito N (2002) A critical review of the toxicological effects of carrageenan and processed eucheuma seaweed on the gastrointestinal tract. *Critical Reviews in Toxicology* 32(5): 413-44.

Summary: The authors of this review criticized research studies pointing to gastrointestinal harm from consuming carrageenan. The authors conclude that “there is no credible evidence supporting a carcinogenic effect or a tumor-promoting effect on the colon in rodents.”

Funding: Marinalg International (trade lobby group

for carrageenan manufacturers)

Cornucopia Note: The authors, with ties to the carrageenan industry, criticized the studies that have found higher rates of gastrointestinal disease in laboratory animals. The authors reviewed 23 studies, and found fault with every one.

Such studies, commissioning scientists to serve as apologists “debunking” science in defense of a harmful substance, is a common tactic by corporate manufacturers whose product is scrutinized by publicly funded scientists (e.g. tobacco, aspartame).

Weiner M, Nuber D, Blakemore WR, Harriman JF and Cohen SM (2007) A 90-day dietary study on kappa-carrageenan with emphasis on the gastrointestinal tract. *Food and Chemical Toxicology* 45(1): 98-106.

Summary of findings: The study found no clinical signs in rats fed high doses of food-grade carrageenan with up to 12% degraded carrageenan, other than soft stool. The authors reported that the gastrointestinal tract “appeared normal” even in the rats given high doses of carrageenan in the diet.

Author affiliations: FMC Corporation, a leading manufacturer of carrageenan. In addition to manufacturing carrageenan, FMC Corporation (a \$3.4 billion conglomerate) produces pesticides and industrial chemicals.⁴¹

Borthakur A, Bhattacharyya S, Dudeja PK and Tobacman JK (2007) Carrageenan induces interleukin-8 production through distinct Bcl10 pathway in normal human colonic epithelial cells. *American Journal of Physiology, Gastrointestinal and Liver Physiology* 292(3): G829-38.

Summary of findings: Exposure of human colonic epithelial cells in tissue culture to small quantities of undegraded (food-grade) carrageenan produced inflammation by a second pathway of reactive oxygen species, as well as by the innate immune pathway.

Funding: Department of Veterans Affairs; National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health

Author affiliations: University of Illinois at Chicago and Jesse Brown Veterans Affairs Medical Center

Bhattacharyya S, Borthakur A, Dudeja PK and Tobacman JK (2007) Carrageenan reduces bone morphogenetic protein-4 (BMP4) and activates the Wnt/beta-catenin pathway in normal human colonocytes. *Digestive Diseases and Sciences* 52(10): 2766-74.

Summary of findings: This study identified mechanisms by which food-grade carrageenan influences the development of human intestinal polyps. Untreated intestinal polyps can develop into colon cancer.

Funding: National Institutes of Health

Author affiliations: University of Illinois at Chicago

Bhattacharyya S, Dudeja PK and Tobacman JK (2008) Carrageenan-induced NF-kappaB activation depends on distinct pathways mediated by reactive oxygen species and Hsp27 or by Bcl10. *Biochimica and Biophysica Acta* 1780(7-8): 973-82.

Summary of findings: Exposure to human colonic epithelial cells in tissue culture to small quantities of food-grade carrageenan produced inflammatory responses.

Funding: National Institutes of Health

Author affiliations: University of Illinois at Chicago

Bhattacharyya S, Borthakur A, Dudeja PK and Tobacman JK (2008) Carrageenan induces cell cycle arrest in human intestinal epithelial cells in vitro. *Journal of Nutrition* 138(3): 469-75.

Summary of findings: Exposure of human colonic epithelial cells in tissue culture to small quantities of undegraded (food-grade) carrageenan produced an increase in cell death with cell cycle arrest, effects that can contribute to ulcerations.

Funding: National Institutes of Health

Author affiliations: University of Illinois at Chicago and Jesse Brown Veterans Affairs Medical Center

Bhattacharyya S, Gill R, Chen ML, Zhang F, Linhardt RJ, Dudeja PK and Tobacman JK (2008) Toll-like receptor 4 mediates induction of the Bcl10-NF-kappaB-interleukin-8 inflammatory pathway by carrageenan in human intestinal epithelial cells.

Journal of Biological Chemistry 283(16): 10550-8.

Summary of findings: Exposure of human colonic epithelial cells in tissue culture to small quantities of food-grade carrageenan was associated with changes in molecular signaling pathways that resemble the changes found in human colonic polyps. Untreated polyps can develop into colon cancer.

Funding: National Institutes of Health; Veterans Administration

Author affiliations: University of Illinois at Chicago; Jesse Brown Veterans Affairs Medical Center; Rensselaer Polytechnic Institute

Bhattacharyya S, Borthakur A, Tyagi S, Gill R, Chen ML, Dudeja PK, Tobacman JK (2010) B-cell CLL/lymphoma 10 (BCL10) is required for NF-kappaB production by both canonical and noncanonical pathways and for NF-kappaB-inducing kinase (NIK) phosphorylation. *Journal of Biological Chemistry*. 1;285(1):522-30.

Summary of findings: Carrageenan stimulates innate immune-mediated pathways of inflammation.

Funding: National Institutes of Health; Veterans Administration

Author affiliations: University of Illinois at Chicago

Bhattacharyya S, Liu H, Zhang F, Jam M, Dudeja PK, Michel G, Linhardt RJ, and Tobacman JK (2010) Carrageenan-induced innate immune response is modified by enzymes that hydrolyze distinct galactosidic bonds. *Journal of Nutritional Biochemistry* 21(10): 906-13.

Summary of findings: This study examines the immune response by which food-grade carrageenan causes inflammation.

Funding: Veterans Administration

Author affiliations: University of Illinois at Chicago; Jesse Brown Veterans Affairs Medical Center; Rensselaer Polytechnic Institute; University Pierre and Marie Curie/Sorbonne University, Paris, France

Bhattacharyya S, Dudeja PK and Tobacman JK (2010) Tumor necrosis factor alpha-induced inflam-

mation is increased but apoptosis is inhibited by common food additive carrageenan. *Journal of Biological Chemistry* 285(50): 39511-22.

Summary of findings: This study examines the particular mechanisms by which food-grade carrageenan causes inflammation.

Funding: Veterans Administration

Author affiliations: University of Illinois at Chicago; Jesse Brown Veterans Affairs Medical Center

Borthakur A, Bhattacharyya S, Anbazhagan AN, Kumar A, Dudeja PK and Tobacman JK (2012) Prolongation of carrageenan-induced inflammation in human colonic epithelial cells by activation of an NF-kappaB-BCL10 loop. *Biochimica and Biophysica Acta* 1822(8): 1300-7.

Summary of findings: Inflammation of the colon caused by exposure to low levels of food-grade carrageenan persists beyond the initial period of exposure.

Funding: National Institutes of Health

Author affiliations: University of Illinois at Chicago

Yang B, Bhattacharyya S, Linhardt R and Tobacman JK (2012) Exposure to common food additive carrageenan leads to reduced sulfatase activity and increase in sulfated glycosaminoglycans in human epithelial cells. *Biochimie* 94(6): 1309-16.

Summary of findings: Exposure to small amounts

of food-grade carrageenan reduces the activity of sulfatase enzymes, which are critical for many vital cellular processes.

Funding: National Institute of General Medical Sciences, National Institutes of Health

Author affiliations: University of Illinois at Chicago; Jesse Brown Veterans Affairs Medical Center; Rensselaer Polytechnic Institute

Bhattacharyya S, O-Sullivan I, Katyal S, Unterman T and Tobacman JK (2012) Exposure to the common food additive carrageenan leads to glucose intolerance, insulin resistance and inhibition of insulin signalling in HepG2 cells and C57BL/6J mice. *Diabetologia* 55(1): 194-203.

Summary of findings: Carrageenan in the diet may contribute to diabetes. Carrageenan impairs glucose tolerance, increases insulin resistance and inhibits insulin signalling in vivo in mouse liver and human HepG2 cells. These effects may result from carrageenan-induced inflammation.

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Further research continues. An ongoing study with ulcerative colitis patients aims to shed light on the effects of carrageenan in the diet on gastrointestinal disease. Another study currently underway will provide additional data to examine the link between food-grade carrageenan and diabetes.

Endnotes

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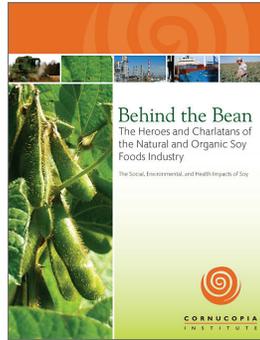
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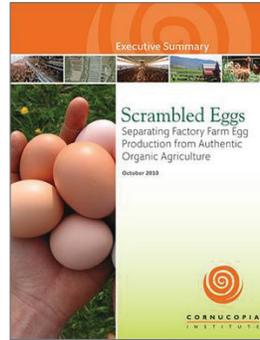
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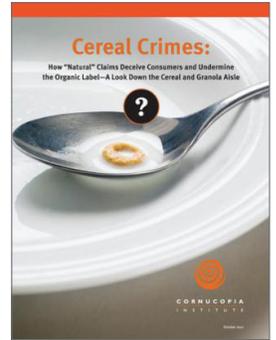
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