Behind the Dazzling Smile

Toxic ingredients in your toothpaste?

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The Cornucopia Institute is chartered as a tax-exempt public charity focusing on research and education. Cornucopia aims to empower organic producers, consumers, and wholesale buyers to make discerning marketplace decisions protecting the credibility of the organic food and farming movement and the value it delivers to society.

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Executive Summary

CARCINOGENS, ENDOCRINE DISRUPTERS, ALLERGENS, IRRITANTS, and other toxic chemicals do not belong in cosmetics or personal care products. Yet, they may all be found in toothpastes and other oral health products, even in those marketed as "natural."

The United States Food and Drug Administration (FDA), does not systematically assess the safety of personal care products. The $71 billion cosmetics industry reviews, assesses, and evaluates its own products—self-regulating in the absence of strong and meaningful federal regulatory oversight.

The U.S. lags behind many other countries in cosmetic safety, allowing the use of hazardous chemicals banned in Canada, Japan, and Europe. Just 11 of more than 12,000 ingredients used in cosmetics are restricted for use in the U.S., while more than 1,300 chemicals have been prohibited in cosmetics sold throughout Europe.

Every day the average man uses five to seven personal care products, containing 85 unique ingredients. The average woman uses nine to 12 products daily, containing 168 unique ingredients, while the average teenage girl will use up to 17 products, containing more than 200 unique ingredients. But outdated, obsolete, and overall toothless regulations, as well as a glaring lack of public information, imply that millions of Americans are kept in the dark about the safety of personal care products used on our bodies and in our mouths.

The law governing cosmetics was passed in 1938 and, despite the development of a plethora of synthetic compounds commonly used in personal care items, has not been significantly amended since it was enacted. In fact, compared to its authority to oversee pharmaceuticals and food products, the FDA is virtually powerless when it comes to regulating cosmetics.

The FDA has no power to review products before they go on the market. Companies do not have to list all of the ingredients in their products, nor are they required to register their manufacturing facilities with the government or report "adverse events," making it difficult for regulators to spot potential problems. Essentially, the cosmetics industry regulates itself.

Outdated, obsolete, and overall toothless regulations, as well as a glaring lack of public information, imply that millions of Americans are kept in the dark about the safety of personal care products used on our bodies and in our mouths.

As a result, it's nearly impossible for the average consumer to evaluate all the chemical ingredients in, and potentially harmful effects of, cosmetics and personal care products.

The Cornucopia Institute's research on toothpaste uncovered some interesting information:

- When potentially toxic chemical ingredients are present in toothpaste and mouthwash, they are likely to pass directly and quickly into the bloodstream, **even if the toothpaste is not swallowed**. This is because the membrane lining of the mouth (oral mucosa) has an absorption efficiency of more than 90%, according to the Physician's Desk reference Handbook.[1]
- A label containing the word "natural" does not necessarily mean a toothpaste is free of potentially harmful ingredients.
- Some prominent "natural" brands are manufactured by companies that primarily sell mass-marketed brands. For example, Tom's of Maine is owned by Colgate-Palmolive, the company that also makes Colgate toothpaste.
- Toothpastes sold in Europe have different, safer formulations **than the same products, made by the same companies** sold in the U.S., to accommodate stricter EU cosmetics laws.
- The American Dental Association is heavily subsidized by the cosmetic industry, creating a conflict of interest. Its seal does not guarantee the safety of toothpastes, or other oral products, or the quality of the ingredients in these products.
- The drive to maximize profit margins focuses investment in advertising and packaging, rather than safe and high quality ingredients.
- Many ingredients in toothpastes are synthetics derived from petroleum or from heavily processed and synthesized natural ingredients, which, in their final formulation, are not remotely related to the natural parent compound (e.g. coconut oil), and some may become potentially toxic.
- Toothpaste ingredient labels are often unintelligible, with difficult to pronounce ingredients that only a cosmetics chemist might decipher and understand.
- Some toothpastes may contain contaminated ingredients. In addition, toxic compounds may be formed by the interaction of ingredients under certain conditions or may be released slowly over time.
- The average American will use about 20 gallons of toothpaste over his or her lifetime.
- Children are at greater risk of exposure, because they tend to ingest more toothpaste than adults; in addition, their exposure, will be greater than adults' in terms of amount of toothpaste used per body weight.
- Toothpastes specifically targeted to children often contain artificial colors (food dyes), which have been linked to hyperactivity and related behavioral problems in children. Some of which also pose a risk of cancer and allergic reactions.[2]

It's nearly impossible for the average consumer to evaluate all the chemical ingredients in, and potentially harmful effects of, cosmetics and personal care products.

When it comes to cosmetics, especially the personal care products we put in our mouths, it would be easy to assume that the companies selling them, and the governments regulating them, would ensure their safety. However, the cosmetic industry, aided by a lack of government oversight, has become quite similar to the processed junk food industry—using cheap and potentially toxic ingredients to manufacture questionable products that are marketed under faddish and misleading health claims. However, several third-party certifications do exist that help assure the quality of toothpaste ingredients and the safety of certified products.

The following report explains how the cosmetics industry is regulated and highlights specific toothpaste ingredients to avoid. It discusses organic brands and provides consumers with recipes to make your own safe and effective toothpaste.

In addition, The Cornucopia Institute has created a web-based scorecard, designed to help consumers determine the safest toothpastes with the least objectionable ingredients.

THE STORY OF COSMETICS

For a quick overview of the issues related to cosmetic ingredients in the U.S., we recommend a short animated video called *The Story of Cosmetics* with Annie Leonard by the Story of Stuff Project in association with the Campaign for Safe Cosmetics.

[See https://youtu.be/pfq000AF1i8]

Cosmetics Industry Regulations

EVERY DAY, THE AVERAGE WOMAN USES as many as 12 personal care products, containing 168 chemicals, while the average man uses approximately six products with 85 unique ingredients.[3] Teens use even more. But weak laws and a lack of public information means that millions of Americans are uninformed about the safety of personal care products they use on their bodies and in their mouths.

Most people assume cosmetics and personal care products are tested for safety before being distributed and sold. In reality, the personal care products industry is one of the least regulated industries in the U.S.

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Toothpastes are considered cosmetics and, as such, are regulated by the Food and Drug Administration (FDA) under the Federal Food, Drug, and Cosmetic Act (FFDCA). However, the FDA is very limited in its ability to regulate cosmetics. The FFDCA includes 112 pages of standards for food and drugs, but just a single page for cosmetics. The cosmetics title of the FFDCA, which has not been amended significantly since it was enacted more than 75 years ago, provides virtually no power to perform even the most rudimentary functions to ensure the safety of an estimated $71 billion cosmetic industry.[5]

As a result of the FDA's lack of authority, serious problems exist in cosmetics regulations, and regulatory weakness and loopholes allow for the use of questionable ingredients in personal care products that could negatively impact the health of the users.

According to the FDA:

> Firms and individuals who market cosmetics have a legal responsibility to make sure their products and ingredients are safe under labeled and customary conditions for use, and that they are properly labeled.

Under U.S. law, cosmetic products and ingredients do not need FDA approval before they go on the market. The one exception is color additives, which must be approved for their intended use.[6]

A DEEPER LOOK AT WHAT THE FDA DOES NOT KNOW AND CANNOT DO ACCORDING TO THE CAMPAIGN FOR SAFE COSMETICS:[7]

What the FDA cannot do:

- Require companies to conduct pre-market safety testing of cosmetics products and ingredients;
- Review or approve cosmetic products or ingredients before they are sold to the public;
- Effectively and efficiently regulate cosmetics products without facing cumbersome legal proceedings with manufacturers;
- Require product recall (The agency must go to court to remove misbranded and adulterated products from the market); or,
- Require manufacturers to register their cosmetic manufacturing facilities, file data on ingredients, or report cosmetic-related injuries. Instead, the FDA relies on voluntary reporting of ingredients, injuries, and establishments. It should be noted that many food and cosmetic ingredients are reportedly from China and elsewhere (with questionable manufacturing and agricultural practices).

What the FDA does not know:

- The overall number of ingredients in personal care products;
- The individual ingredients in a particular product that lists "fragrance" as a front for dozens of chemical components;
- The number and location of companies that manufacture and distribute personal care products (The FDA's primary enforcement tool is facility inspections, but it can't inspect facilities it doesn't know exist);
- The extent of health impacts from harmful ingredients (Companies are not required to report adverse health effects to the FDA or share studies they may have conducted on chronic health effects); or
- The presence or potential health impact of nanomaterials in cosmetics.

Under U.S. law, cosmetic products and ingredients do not need FDA approval before they go on the market.

In effect, the safety of cosmetic ingredients (if they are evaluated) is assessed by the Cosmetic Ingredient Review (CIR) panel. However, not only is this program run by the very industry it is intended to oversee, but compliance with CIR recommendations is totally voluntary. The CIR has reviewed fewer than 20% of the 12,500 chemicals estimated by the FDA to be used in cosmetics and, of those, only nine chemicals have been found unsafe for use in cosmetics. What safety data does exist focuses on acute reactions to products, such as skin rashes or allergic reactions, as opposed to studies that look at chronic health effects from chemicals in personal care products. Chronic effects may include cancer and reproductive or nervous system effects, driven by genetic susceptibility, the timing of exposure, and aggregate exposures over a lifetime.

In addition to the nine ingredients that the CIR has found unsafe, or for which it suggests restrictions,[8] the FDA restricts or prohibits another 11 ingredients.[9] In comparison, the European Union (EU) prohibits more than 1,300 ingredients, and restricts more than 250, for use in cosmetics.[10] In fact, the U.S lags significantly behind other countries on cosmetics safety, and allows the use of hazardous chemicals banned in Canada, Japan, and Europe.[11]

The Voluntary Cosmetic Registration Program (VCRP), initiated in 1973 by the FDA and updated in 2005, is an *entirely* voluntary program that collects information from cosmetic manufacturers, packers, and distributors, and on ingredient listings of cosmetic products that are in commercial distribution in the U.S. The FDA estimates 12,500 cosmetics ingredients, and a similar number of fragrance ingredients, but has formal records for only 4,066 of them.[12] The Environmental Working Group (EWG) has documented 8,821 unique ingredients in its online cosmetic product database.[13] The FDA also estimates that cosmetics are manufactured in more than 1,400 domestic establishments, but because it cannot mandate participation, the agency cannot accurately assess how many companies may be avoiding registration.[14]

The PCPC's Consumer Commitment Code

The Personal Care Product Council (PCPC) is the cosmetic industry trade-lobby association. The PCPC's Consumer Commitment Code encourages voluntary reporting of adverse health effects. Companies are urged to report "serious and unexpected adverse consumer experiences with cosmetic products."[15] However, in addition to being completely voluntary, the program requires the FDA to proactively file a written request for the information *"based on explicit, legitimate and specific safety*

concern or question related to the product" and can review the safety information summary at *"mutually agreed upon location."* This process requires the FDA to spend scarce resources to obtain information, which really should be automatically provided, given the threat to public health demonstrated by adverse health events associated with cosmetic use (as is the case when manufacturers encounter problems with pharmaceuticals or medical devices).[16]

Another regulatory weakness that benefits companies and can be literally toxic to cosmetics/toothpastes users pertains to the labeling of fragrance/flavor ingredients.

According to the FDA, under U.S. regulations, fragrance and flavor ingredients can simply be listed as "fragrance" or "flavor". The Fair Packaging and Labeling Act (FPLA) gives the FDA the authority to require the listing of ingredients in food, drugs, and cosmetics; however, the law cannot be used to force companies to reveal "trade secrets." Fragrance and flavor formulas are complex mixtures of many different natural and synthetic compounds (a single listing of fragrance can refer to a mixture of up to 100 individual chemicals),[17] which are likely to be considered "trade secrets."[18] Unfailingly, companies claim the exact chemicals used in "fragrance" and/or "flavor" are confidential business information (CBI) and thus, do not have to be disclosed to the public. In reality, because advances in reverse engineering enable accurate reconstruction of fragrance/flavor formulas (a common practice between competitors), this level of secrecy has become a moot point and a specious argument.

Furthermore, the FDA adds that the possibility exists that some individuals may be allergic or sensitive to certain ingredients in cosmetics, food, or other products "even if those ingredients are safe for most people."[19] The FDA goes on to admit that some components of fragrance (or flavor) formulas can potentially cause allergic reactions or sensitivities (in fact, chemicals of concern in fragrance are linked to allergies, cancer, birth defects, and infertility).[20] Finally, the FDA states that it does not have the same legal authority to require allergen labeling for cosmetics as it does for food products, and so the agency advises the potential consumer to choose products that are fragrance-free, and to check the ingredient list carefully. It goes on to say, "If consumers have questions they may choose to contact the manufacturer directly."[21]

The U.S. lags significantly behind other countries on cosmetics safety, and allows the use of hazardous chemicals banned in Canada, Japan, and Europe.

Essentially, cosmetics are regulated by the free market, which means that most companies will only modify or remove a problematic ingredient if enough consumers express concern, accompanied by a decrease in sales, and perhaps the initiation of legal actions.

Regulatory Reform, a Possibility?

On April 20, 2015 Senators Dianne Feinstein (D-Calif.) and Susan Collins (R-Maine) introduced the Personal Care Products Safety Act of 2015.[22] The bill attempts to reform a powerful industry currently regulated by approximately two pages of federal law. Strong provisions in the bill would enhance the FDA's ability to protect Americans' health, but some reform activists feel certain areas are weak and need strengthening amendments.

For more info about this law and what you can do go to: http://www.safecosmetics.org/get-the-facts/regulations/us-laws/

Toothpaste Ingredients

IT IS HELPFUL TO INTRODUCE THIS SECTION with a discussion from the American Dental Association (ADA) about typical toothpaste ingredients taken directly from the ADA's website. As you will see later, many of these ingredients [i.e., those that are **bolded**, emphasis added] are problematic and/or present potential health hazards.

When potentially toxic chemical ingredients are present in toothpaste and mouthwash, they may pass directly and quickly into the bloodstream, even if not swallowed. This is because they can be absorbed through the mucosal lining of the mouth, which has an absorption efficiency of over 90 percent according to the Physician's Desk Reference Handbook.[24]

Most people use toothpaste every day, commonly two times a day for several minutes and, inevitably, regularly ingest some quantity. It is then easy to assume that oral products used daily and backed by the ADA should be safe, right?

Actually, dental hygiene products that you and your family use every day may contain potentially harmful ingredients that have been linked to allergies, mouth mucosa irritation, reproductive system toxicity, endocrine disruption, and cancer, as well as a number of other health problems.

It is possible that even the most conscientious consumers who scrutinize ingredients on product labels may need some help to evaluate ingredients in oral care products in order to determine which toothpastes can be safely used by their family.

This section reviews potentially problematic ingredients currently found in several brands of toothpaste – whether major mass-marketed brands, "natural" brands, or brands containing organic ingredients.

TYPICAL TOOTHPASTE INGREDIENTS

- Mild abrasives to remove debris and residual surface stains. Examples include calcium carbonate, **dehydrated silica gels**, hydrated aluminum oxides, magnesium carbonate, **phosphate salts**, and silicates.
- **Fluoride** to strengthen tooth enamel and remineralize tooth decay. All ADA-accepted toothpastes contain fluoride.
- Humectants to prevent water loss in the toothpaste. Examples include **glycerol, propylene glycol**, and sorbitol.
- Flavoring agents, such as **saccharin and other sweeteners**, to provide taste. Flavoring agents do not promote tooth decay. (No ADA-Accepted toothpaste contains sugar or any other ingredient that would promote tooth decay.)
- Thickening agents or binders to stabilize the toothpaste formula. They include mineral colloids, natural gums, **seaweed colloids** [e.g. **carrageenan**], or synthetic cellulose.
- Detergents to create foaming action, including **sodium lauryl sulfate** and **sodium lauroyl sarcosinate**.
- Some toothpastes contain ingredients such as potassium nitrate or strontium chloride to help reduce tooth sensitivity; stannous fluoride and **triclosan** to help reduce gingivitis; **pyrophosphates**, **triclosan**, and zinc citrate to help reduce a build-up of hardened plaque; modified silica abrasives or enzymes to help whiten teeth by physically removing surface stains; and some additional ingredients, such as **triclosan**, to help reduce bad breath.[23]

Artificial Colors, Flavors, and Sweeteners

FD&C and D&C dyes (certified by the FDA for use in food, drugs and cosmetics or drugs and cosmetics) were derived originally from coal tar (bituminous coal) and are now mostly manufactured from petroleum. These dyes are used widely because they impart an intense, uniform color and are more stable, inexpensive, and blend easi-

ly to create a variety of hues. Colors from plant, animal, and mineral sources, utilized in earlier times, remained in use in the early 20th century, but were rapidly phased out because they were more expensive and their coloring properties inconsistent. However, natural colorings are making a comeback. Consumers' growing preference for natural foods and adverse publicity about artificial dyes have prompted several major companies to pledge to either remove them in at least some of their products or to switch to natural colorings altogether.

In industrial production of colorants, "lake" is a term used for pigments made by combining dyes with metal salts such as aluminum, calcium, zirconium, barium, or others, creating an insoluble pigment. Dyes dissolve readily in water but not in oils or fats. Lakes are insoluble in water, oils or fats, but disperse well in oils and fats. More on the naming of lakes as explained by the FDA:

Examples of nomenclature of lakes:

- The name of a lake is formed from the name of the color additive combined with the name of the basic radical and the word "lake". For example, the name of the lake prepared by extending the aluminum salt of FD&C Blue No. 1 upon alumina would be FD&C Blue No. 1 - Aluminum Lake.
- If a lake is prepared by extending an FD&C color additive on a substratum other than alumina, the symbol "FD&C" will be replaced by "D&C". For example, the name of the lake prepared by extending the aluminum salt of FD&C Blue No. 1 upon a substratum other than alumina would be D&C Blue No. 1- Aluminum Lake.[25]

There are nine certified color additives approved for use in the U.S.; however, Orange B is no longer used.[26]

Health and Environmental Hazards

Food dyes are made from petrochemicals and are not pure compounds; they may contain upward of 10% impurities, either from the initial manufacturing chemicals or by-products of the manufacturing process. In addition to a slew of synthetic contaminants, they can also contain heavy metals, such as lead, mercury, and arsenic.[27] The three most widely used dyes, Red 40, Yellow 5, and Yellow 6, are contaminated with known carcinogens.[28]

In addition to the toxic contaminants they may contain, artificial food dyes are very controversial and, since the 1970s, have been suspected of triggering behavior problems in children. Dr. Ben Feingold, a San Francisco allergist, reported that his patients improved when artificial dyes were removed from their diets.[29] Since then, numerous controlled studies prove that artificial food dyes affect children's behavior, and that mixtures of dyes (as well as dyes together with the preservative sodium benzoate, also found in toothpastes) adversely affect children's behavior and are likely to be linked to hyperactivity and ADHD.[30,31,32] Some studies have also linked certain dyes with cancer and genotoxicity.[33]

Lake dyes are obtained using the same artificial dyes and, while they are perhaps less problematic because they are insoluble (and thus not as biologically available or active), are nevertheless petro-chemical mixtures that contain potentially toxic contaminants. In addition, because lake dyes are manufactured by reacting a dye with a metal salt, they are a source of heavy metals such as aluminum, chromium, barium, strontium, and zirconium. Aluminum compounds and many heavy metals are toxic to the brain.[34]

LIST OF COLOR ADDITIVES, PIGMENTS AND COLORANTS CURRENTLY USED IN SOME TOOTHPASTES

These are mainly found in mass-marketed toothpastes, such as Crest, Colgate, Aquafresh, Arm & Hammer, etc.:

- FD&C Blue 1 (also known as Blue 1)
- FD&C Blue 1 Aluminum Lake (also known as Blue 1 Aluminum Lake or Blue 1 Lake)
- FD&C Red 40 (also known as Red 40)
- FD&C Red 40 Aluminum Lake (also known as Red 40 Aluminum Lake or Red 40 Lake)
- FD&C Red 33
- D&C Red 33 (also known as Red 33)
- D&C Red 30 (also known as Red 30)
- D&C Red 30 Lake Aluminum (also known as Red 30 Aluminum Lake or Red 30 Lake)
- FD&C Yellow 5 (also known as D&C Yellow 5 or Yellow 5)
- FD&C Yellow 5 Aluminum Lake (also known as D&C Yellow 5 Aluminum Lake, Yellow 5 Aluminum Lake or Yellow 5 Lake)
- FD&C Yellow 6 Aluminum Lake (also known as Yellow 6 Aluminum Lake or yellow 6 Lake)
- D&C Yellow 10 (also known as Yellow 10)
- D&C Yellow 10 Aluminum Lake (also known as Yellow 10 Aluminum Lake or Yellow 10 Lake)
- FD&C Green 3 (also known as Green 3)
- titanium dioxide
- zinc oxide
- iron oxides

D&C dyes are artificial colorings the FDA found not suitable for use in food, but are allowed for use in drugs or cosmetics.

Jane Hersey, the director of the Feingold Association,[35] which works to educate people about the dangers of artificial colors and other synthetic additives, commented about the irony:

> *"Disturbing is the fact that medicines [or cosmetics] are permitted to use dyes that have been banned from use in foods. If they are too harmful to eat, how can they be safe to give to a sick child?"*[36]

Clearly, this question applies to toothpastes that contain these same harmful ingredients.

REGULATIONS: The FDA requires food dyes to be individually tested, but does not require the testing of dye mixtures. In spite of the scientific evidence demonstrating the potential neurotoxicity of dye mixtures, the FDA has refused to further regulate food dyes. The FDA's guidance on Acceptable Daily Intake (ADI) of food dyes is currently higher than the amount found to trigger detrimental effects in children. In addition, the FDA does not require warning labels on products containing food dyes, nor has it banned the most concerning dyes.[37]

In answer to concerns raised by the Feingold Association and many others since, the British government commissioned and funded two large studies in 2004 and 2007 that established a definitive link between food dye mixtures and adverse behavioral effects as well as hyperactivity in children.

Based on these studies, the Food Safety Agency (the UK's counterpart of the FDA) pressured food makers to discontinue the use of dyes, and many companies have dropped artificial colors from their products.

Following the British actions, the European Parliament passed a law in 2010 requiring a warning label on products containing any of six artificial colorings tested by the British studies. The warning states: "[dye name] may have an adverse effect on activity and attention in children." The EU Parliament also prohibited the use of food dyes in foods for infants and young children. Because of that law, most dyed food disappeared from the food supply, thus the warning appears on very few products.

However, American companies that now sell dye-free versions of their products in Europe are selling them in the U.S. with the added synthetic dyes—a double standard.

Numerous controlled studies prove that artificial food dyes affect children's behavior, and that mixtures of dyes adversely affect children's behavior and are likely to be linked to hyperactivity and ADHD.

How does this relate to toothpaste?

Most "natural" toothpastes do not contain artificial dyes, but considering that many toothpastes do contain them, it is important to know how to recognize them on labels. Of great concern is the fact that children are already exposed to artificial dyes, likely on a daily basis, through their diet. Many products targeting children contain mixtures of artificial dyes. Following the same marketing logic in order to increase appeal, toothpastes intended for children contain more artificial dyes than toothpastes for adults, thus increasing their exposure.

Unfortunately, even natural toothpastes contain metals in the form of oxides, such as titanium dioxide, zinc oxide, and iron oxides. Of course, some metals play important roles in normal functions of the body. For instance, iron is necessary for blood oxygenation. However, metals can accumulate if ingested in excess of the body's metabolic needs, and can have deleterious effects. In fact, iron, beyond the small amount needed by the body, becomes a dangerous substance that promotes the formation of cancer-causing free radicals.[38] Biopsies of cancerous breast tissues show higher accumulations of iron, nickel, chromium, zinc, cadmium, mercury, and lead than non-cancerous biopsies.[39,40] In addition, several metals show estrogen-like activity in some breast cancer cells.[41]

Titanium dioxide, as an abrasive and a whitening pigment, is most commonly found in candies, sweets, and chewing gums, as well as in personal care items such as sunscreen lotions and toothpastes. Again, children are exposed to greater amounts of titanium dioxide due to diets consisting of more candies, sweets, and gum.

Titanium dioxide is insoluble, relatively inert, and does not seem to pose health risks, except via inhalation (not a concern with toothpaste). However, recent research indicated that 5% of the titanium dioxide used in food or personal care products is likely to be in the form of nanoparticles.[42] Most research on titanium dioxide nanoparticles has focused on inhalation risks; however, studies into the impact of ingested nanoparticles are still in their infancy, and a great deal more research is needed.

Some studies, but not all, suggest potential for harm by titanium dioxide nanoparticles.[43] The main concern associated with nanoparticles in general is that certain compounds that are inert and innocuous in their normal form, may have very different properties at the nano size, such as being able to penetrate the skin or the mouth mucosa, as well as being more biologically active and, thereby, potentially toxic.[44,45]

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Carrageenan

Carrageenan is a non-nutritive food additive extracted with alkali from different red seaweed species (Rhodophyceae). It is used as a thickener, stabilizer, and emulsifier in a variety of processed foods prevalent in the Western diet, such as some dairy products, sandwich meats, infant formulas, dairy substitutes (e.g. almond and soy milk), frozen pizza dough, wet pet food,[46] and toothpaste, among other products.

Carrageenans are highly sulfated polysaccharides with different molecular structures. The most common types added to food are kappa, iota, and lambda carrageenans, found in varying combinations in different red seaweeds and during different life stages of the various red algal species. The types of carrageenan differ in "degree of sulfation, extent of branching, solubility, cation binding, and ability to form gels under different conditions."[47]

Carrageenan, in its non-degraded form, is a Generally Recognized As Safe (GRAS) food additive by the FDA. However, under U.S. law, cosmetic products and ingredients do not need FDA approval before they go on the market. Carrageenan, without any restrictions, is thus allowed in cosmetics and personal care products.

Extensive peer-reviewed and published research indicates that food-grade carrageenan causes intestinal inflammation with the potential to lead to cancer, even in small doses.

There is much misinformation surrounding the safety of carrageenan, largely generated by its manufacturers and the processed food companies that use it, along with the industry's trade-lobby group.

Low-molecular-weight carrageenan, known as poligeenan, is classified by the International Agency for Research on Cancer as a "possible human carcinogen" (Group 2B). Poligeenan is widely used in cancer research to give test animals inflammation cancer, for testing cancer treatments and anti-inflammatory drugs.

While poligeenan has well-documented inflammatory and carcinogenic properties, food-grade carrageenan was thought to be "high molecular weight" and safe to eat. However, the viscosity requirement to qualify carrageenan as food-grade does not exclude the presence of low-molecular-weight poligeenan. In fact, the carcinogenic molecular-weight poligeenan is found naturally, in varying percentages, in all food-grade carrageenan, and exposure to heat, acid (including stomach acid), digestive enzymes (such as saliva and stomach enzymes), and bacteria (i.e., mouth and gut microflora) increases the amount of poligeenan detected.[48] Meanwhile, industry-funded propaganda often fails to point out that food-grade carrageenan does in fact contain dangerous poligeenan in varying amounts, in some tests exceeding 5%.

The European Commission requires that carrageenan for use in food must not contain more than 5% poligeenan (more specifically, 5% molar mass with molecular weight less than 50,000 Da).[49] However, the industry's own studies show a failure to reliably measure amounts of poligeenan.[50] The fact that food-grade carrageenan contains poligeenan in any amount should be enough to ban its use in human food, considering its well-documented carcinogenic properties even at small doses.[51]

For more than 20 years, independent research has demonstrated that food-grade carrageenan increases free radicals, disrupts insulin metabolism, and induces inflammation–a precursor to cancer. Studies funded by the American Diabetes Association have linked the consumption of food-grade carrageenan to insulin resistance and glucose intolerance.[52] Meanwhile, industry-funded studies assure that it is safe.[53]

Independent research at the Jesse Brown Veterans Administration Medical Center in Chicago, using both hu-

man and mouse epithelial cells, further demonstrates the mechanism by which inflammatory responses occur after exposure to food-grade carrageenan in doses less than the anticipated average daily intake (50 mg/30 g mouse vs. 250 mg/60 kg person).[54] This research confirms that carrageenan-induced inflammation occurs in both humans and mice, indicating that it is likely to cause a similar reaction in all mammals.

The mechanism by which food-grade carrageenan contributes to colon carcinogenesis is also well-documented.[55,56] Carrageenan interrupts a homeostatic signaling pathway that enables uncontrolled proliferation and tumorigenesis to occur, potentially leading to polyp formation and colorectal cancer in mouse and human colonic epithelial cells. The research concludes that "because carrageenan is a common food additive, widely used in the Western diet, the current studies may be highly relevant to disease, and exposure to carrageenan may be a risk factor for development of colorectal cancer."

Prohibiting the use of carrageenan in personal care products that can be ingested, such as toothpastes, would make sense for several reasons; one consideration being that there is no restriction on the amount of carcinogenic poligeenan[57] in the grade of carrageenan used in toothpastes. Another consideration is that exposure to carrageenan (due to the amount of processed food in the Western diet) is widespread and pervasive, increasing the human population's overall exposure to this unsafe substance, particularly in children who are more likely to ingest toothpaste. In addition, children are more susceptible than adults to the effects of foreign substances.[58]

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Unfortunately, FDA regulatory actions are often years behind the latest scientific research due to corporate lobbying pressure and, as was the case in the tobacco industry for decades, industry-funded studies that conflict with independent research.

For an independent review of the scientific literature on food-grade carrageenan, please see Cornucopia's report Carrageenan: How a "Natural" Food Additive Is Making Us Sick (found under the Reports tab at cornucopia.org).

DEA (diethanolamine), Related Compounds and Nitrosamines Contamination

DEA (diethanolamine) and DEA compounds are used to make cosmetics creamy or sudsy. DEA is used as a foaming agent in several types of toothpastes. DEA also acts as a pH adjuster, used to neutralize the acidity of other ingredients in cosmetic products.

DEA and its compounds cause mild to moderate skin and eye irritation.[59] Laboratory experiments have shown that exposure to these chemicals causes liver cancers and precancerous changes in skin and thyroid in mice.[60,61] DEA is classified as harmful by the European Union, due to risks of serious health damages from long-term exposure.[62]

A major concern associated with DEA and related compounds, as well as other amine-based ingredients, is the fact that they can react with other cosmetic ingredients (generally preservatives) which act as nitrosating agents, such as 2-bromo-2-nitropropane-1,3-diol (Bronopol, Onyxide 500), 5-bromo-5-nitro-1,3-dioxane (Bronidox C) or tris (hydroxymethyl) nitro-methane (Tris Nitro); or with contaminants that are nitrosating agents, (e.g., sodium nitrite, or nitrogen oxides) to form nitrosamines, a well-known class of bioactive compounds considered carcinogenic to humans.[63,64]

Nitrogen oxides are found in trace amounts in the air. Nitrites can be present as contaminants, or are released as the result of the degradation of chemicals used as preservatives in some toothpastes, when exposed to air. In the presence of such preservatives, DEA can form N-nitrosodiethanolamine (NDELA), a nitrosamine compound that has been shown to cause cancer in rodents.[65] NDELA is readily absorbed through the skin (and mouth mucosa).

MEA (monoethanolamide) and TEA (triethanolamine) are related chemicals. Like DEA, they can react with other chemicals in cosmetics to form carcinogenic nitrosamines. They are found in many cosmetics but rarely in toothpastes. Other ingredients' names to look for on the label: cocamide DEA, cocamide MEA, DEA-cetyl phosphate, DEA oleth-3 phosphate, lauramide DEA, linoleamide MEA, myristamide DEA, oleamide DEA, stearamide MEA, TEA-lauryl sulfate. But there are many other cosmetic ingredients, some of them in natural toothpastes, which can form nitrosamines in the presence of nitrosating agents under certain conditions. For a more complete list check the Environmental Working Group's Skin Deep cosmetics database.[66]

A major concern associated with DEA and related compounds, as well as other amine-based ingredients, is the fact that they can react with other cosmetic ingredients.

Fluoride

Fluoride is a naturally occurring mineral which, when applied topically (in small amounts) to the surface of teeth, can help prevent cavities. According to the ADA, before teeth break through the gums, fluoride (mainly from diet, a systemic effect) makes tooth enamel stronger and more resistant to tooth decay. After teeth erupt, fluoride, as topical applications with toothpastes or other dental products, helps re-mineralize weakened tooth enamel and reverses early signs of tooth decay.[67]

However, the benefits of ingesting fluoride (systemic effects) have recently been disputed,[68,69,70] bringing into question the usefulness or effectiveness of adding fluoride to drinking water (water fluoridation). The Center for Disease Control stated in 1999, and reiterated in 2001, that "fluoride's predominant effect is after tooth eruption and its actions primarily are topical for both adults and children." [71,72]

Furthermore, the heralded topical benefits of fluoride against tooth decay may have been exaggerated. In recent years there has been increasing scrutiny of this mineral, and a relatively recent study demonstrated that the supposedly beneficial fluorapatite protective layer formed on teeth from fluoride is only six nanometers thick[73] (you would need 10,000 of these layers to equal the width of a strand of hair). The question raised by these results is whether such ultra-thin layer can actually provide enamel protection, considering that simple chewing would disrupt this so-called protective layer.[74,75]

In addition, fluoride is a poison[76] and ingesting it during childhood can cause yellow or brown stains and pits to form in the tooth enamel. This enamel mottle, or dental fluorosis, occurs in children who ingest or drink significant amounts of fluoride during tooth formation in the first eight years of life. This is a legitimate risk, considering that young children frequently swallow more fluoride from toothpaste alone than the maximum recommended daily intake from all sources combined (e.g., diet, water, and oral products).[77]

One of the main concerns with fluoride is its potential chronic toxicity. Fluoride accumulates in bones, which can lead to a condition called skeletal fluorosis, characterized by reduced flexibility, chronic joint pain, arthritic symptoms, and bone fracture.[78] In a 2006 study, a link was been found between drinking fluoridated water and risk of developing osteosarcoma (a form of bone cancer) in young men but not women. Further studies are still needed to confirm this result.[79]

Fluoride can affect other tissues, including the brain and the thyroid gland. Fluoride exposure can significantly impact thyroid function in some individuals[80] and may be linked to hypothyroidism.[81] According to the National Research Council (NRC), "fluorides have the ability to interfere with the functions of the brain."[82] In 2012, a meta-analysis by a team of Harvard researchers found an association between fluoride exposure and reduced IQ in children.[83] In 2014, a review in the prestigious medical journal The Lancet concluded that fluoride is one of only 11 chemicals known to damage the developing brain.[84]

The main sources of fluoride are drinking water, food, and dental care products and treatments. Besides the naturally occurring amounts of fluoride in vegetables, fruits, and nuts, processed food, sodas, and other beverages may

Young children frequently swallow more fluoride from toothpaste alone than the maximum recommended daily intake from all sources combined (e.g., diet, water, and oral products).

contain higher levels of fluoride if they have been manufactured using fluoridated water, likely in the U.S.

Considering the multiple sources of fluoride exposure today, many people are getting too much of this mineral. While fluoride may be useful in small doses as a topical cavity prevention, it is also a potential poison when ingested. According to the U.S. Dept. of Health and Human Services (HHS) and the U.S. Environmental Protection Agency (EPA), infants and young children ingest three to four times more fluoride than adults on a per-body-weight basis. In fact, compared to adults, children are more likely to swallow toothpaste and mouth rinses or use more of the product than directed.[85,86,87]

When deciding whether or not to use a fluoride-containing toothpaste, the consumer would benefit from considering the potential cumulative and chronic effects of this mineral, as well as taking into account the risks of synergistic effects when combined with the multitude of other potentially toxic chemicals to which our bodies are continuously exposed, either through food, water, air, or personal care products.

Formaldehyde-Releasing Preservatives

Formaldehyde-releasing preservatives (FRPs) are used in a wide range of cosmetics and personal care products, particularly in shampoos, liquid baby soaps, nail products, eyelash glue, hair smoothing products, color cosmetics, and some toothpastes. The anti-microbial action of these synthetic ingredients is due to the continuous release of small amounts of formaldehyde, a human carcinogen.[88] FRPs can be absorbed through the skin[89] and the mucosal lining of the mouth, and have been linked to cancer and allergic skin reactions.[90]

Ingredients to look for on the label: DMDM hydantoin, diazolidinyl urea, imidazolidinyl urea, polyoxymethylene urea, methenamine, quaternium-15, sodium hydroxymethylglycinate, 2-bromo-2-nitropropane-1,3-diol (Bromopol), 5-bromo-5-nitro-1,3 dioxane (Bronidox), and glyoxal.

Health and Environmental Hazards

Formaldehyde-releasing ingredients (FRPs) are a concern because they slowly and continuously release small amounts of formaldehyde. Laboratory studies suggest that formaldehyde in cosmetics can be absorbed through the skin[91] and, thus, through the mucosal lining of the mouth. In addition, formaldehyde may off-gas from cosmetics containing these ingredients and be inhaled (most of the cancer research on formaldehyde has focused on risks from inhalation).[92]

In addition to releasing formaldehyde, some of these FRPs can be irritants and environmental pollutants. DMDM hydantoin and quaternium-15 can irritate skin and eyes and trigger allergies at low doses.[93] Health Canada and Environment Canada categorized methenamine and quaternium-15 as "moderate human health priorities" and possibly persistent in the environment.

Formaldehyde gas is ubiquitous in our environment. In fact, formaldehyde is a common contaminant of outdoor air quality,[94] as formaldehyde gas is produced from the incomplete combustion of organic material and is released by combustion engines, power plants, incinerators, refineries, forest fires, wood stoves, and cigarettes, as well as by photochemical reactions of hydrocarbon pollutants. Additionally, formaldehyde gas is a common indoor air pollutant (i.e., off-gassing from carpet, building materials, home furnishing products, and household products) and levels can be higher in indoor air than in outdoor air.[95]

Considering the formaldehyde exposure to which people are constantly subjected, additional exposure via such intimate products as cosmetics and personal care products is deeply concerning.

More about formaldehyde

Formaldehyde is a colorless, strong-smelling gas that is most commonly available commercially as an aqueous solution generally referred to as 'formalin.' Formaldehyde-based resins are used in a wide range of industries such as the textile (permanent press fabric), leather, rubber, and cements industries, and in such products as building materials, walls, and furniture.

Formaldehyde is used as an intermediary in the manufacture of polyester and polyacetal plastics, polyurethane, synthetic resin coatings, synthetic lubrication oils, plasticizers, surface coatings, vinyl flooring, explosives, some detergents, dyes, crop protection agents, animal feeds, perfumes, vitamins, flavorings, and drugs. Formaldehyde itself is used to preserve and disinfect, as well as in the preparation of disinfectants.[96] It is used as an antimicrobial agent in several cosmetic products, including hair conditioners, shampoos, hair grooming aids and other hair preparations, nail hardeners, bath soaps, and detergents.[97] While formaldehyde occurs naturally in the environment at low levels, worldwide industrial production tops 21 million tons per year.[98]

The industry-funded Cosmetic Ingredient Review Panel recommends that cosmetic products should not contain more than 0.2% formaldehyde and considers formaldehyde-containing aerosol products to be unsafe. However, currently in the U.S. there are no restrictions on the levels of formaldehyde allowed in any body care products.

Formaldehyde is classified as "carcinogenic to humans" by the International Agency for Research on Cancer (IARC),[99] and the US National Toxicology Program has classified it as 'known to be a "human carcinogen."[100]

In spite of the considerable health problems associated with this chemical, until recently, formaldehyde was still a common ingredient in nail polish. Consumer pressure has now forced many major cosmetics manufacturers to voluntarily remove this ingredient from their nail products.

Regulatory Status

European health protections limit the concentration of formaldehyde in cosmetics to 0.2%, and require that body care products containing formaldehyde or formaldehyde-releasing ingredients be labeled with the warning "contains formaldehyde" if the concentration of formaldehyde in the product exceeds 0.05%.[101] Formaldehyde is a restricted ingredient in cosmetics in Canada. It cannot be added in concentrations greater than 0.2% in most products. However, there is no restriction on the low levels of formaldehyde released by DMDM hydantoin, diazolidinyl urea, imidazolidinyl urea, methenamine, quaternium-15, and sodium hydroxymethylglycinate, nor on the use of these ingredients themselves.

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GMO-Based Ingredients

When it comes to genetically modified organisms (GMOs) there may be confusion among consumers. What is certain is that certified organic ingredients are never, by law, sourced from GMO crops. This section is provided for consumers who prefer to avoid products that may contain GMO-derived ingredients.

GLYCERIN. Glycerin (also known as glycerol) is a by-product of soap manufacture. It is also a by-product of the conversion of animal fats or vegetable oils into fatty acids or fatty acid methyl esters, in which case it is known as natural

More than 90% of U.S. grown soy, canola and cotton are genetically modified and more than 70% of the world soybean crop is genetically modified.

glycerin, in contrast to synthetic glycerin obtained from propene, a petroleum-based derivative.[104]

It is used as a humectant in many personal care products, as well as a texture agent and (natural) sweetener in a number of natural toothpastes. If the glycerin in your toothpaste is manufactured from vegetable oil (a significant percentage of it is), it is likely derived from a GMO soybean, canola or cottonseed oil crop – unless the label specifies otherwise. More than 90% of U.S. grown soy, canola and cotton are genetically modified and more than 70% of the world soybean crop is genetically modified. [105,106]

The other option is synthetic glycerin, a petroleum-based product. Synthetic glycerin may also be contaminated with diethylene glycol, a relatively toxic compound linked to developmental/reproductive and kidney system toxicity, and a potential contaminant resulting from the manufacturing process.[107] Diethylene glycol is banned from cosmetics in the EU, and severely restricted in Canada, Japan, and the U.S.[108] Glycerin is restricted in cosmetics in Canada because of the potential contamination of glycerin with diethylene glycol.[109] In the U.S., the FDA issued in 2007 a legally non-binding guidance to drug and cosmetics manufacturers to minimize potential risks of diethylene glycol contamination in glycerin.[110]

The choice between synthetic and natural glycerin may seem difficult considering the options, but the savvy consumer may question the necessity of glycerin as a toothpaste ingredient at all, and may choose to do without. In addition, there are natural toothpastes that contain non-GMO or organic ingredients; therefore, a careful examination of the ingredient label will help determine the best choice of toothpaste.

CITRIC ACID AND CITRATES. Originally, citric acid was extracted from citrus or pineapple juice, but nowadays citric acid is almost exclusively produced by microbial fermentation of sugar. The sources of sugar can be corn, beet, or sugar cane. Sugars from corn or beet are likely to be derived from GMO crops.

XANTHAN GUM. A viscosity agent, a texturizer, and emulsion stabilizer. Produced by microbial fermentation of sugar. The sources of sugar can be corn, beet, or sugar cane. Sugars from corn or beet are likely to be derived from GMO crops.

In term of human health, animal and human studies show no harmful effects from the ingestion of xanthan gum. However, in large doses it can stimulate the gut microbiome to significantly increase the bacterial production of short-chain fatty acids (SCFA).[111] While this is a positive pre-biotic action in adults, as SCFA are vital to colon health, it can lead to the development of necrotizing enterocolitis in infants,[112] who are inherently very sensitive to SCFA.[113] Thus, xanthan gum appears to be able to alter the gut microbiome, and it is unclear whether or not that alteration could be problematic over time.

It is strongly recommended to avoid the use of xanthan gum-containing toothpastes by babies or young children who may swallow unknown amounts.

XYLITOL. A sugar alcohol, used as a humectant and flavoring agent (sweetener). Currently a very trendy substance, as it appears that Xylitol benefits dental health by reducing cavities and by inducing enamel remineralization.[114,115]

It is found in birch sap and in low concentrations in the fibers of many fruits and vegetables; it can be industrially produced either from hardwood or corncob, but is commercially produced mainly from corncobs. Most (89%) of the corn grown in the U.S. is GMO[116] so it is likely that most Xylitol is derived from a GMO crop. Look on the label or contact the manufacturer to inquire about the source of xylitol.

SORBITOL. A sugar alcohol, used as a humectant and sweetener. It is the sweet constituent of many berries and fruits, and was first isolated from the European Rowan in 1872.[117] Sorbitol is commercially produced today from starch by enzymatic hydrolysis and catalytic hydrogenation. Starch from grain or root crops, as well as purified starch of any origin (corn, wheat, potato, or cassava) can be used to produce sorbitol. Thus, if cornstarch is used, it is likely that sorbitol could be derived form a GMO crop.

LECITHIN. A naturally occurring lipid found both in plants and animals, lecithin is used as an emulsifier, a surfactant, and texture agent. It is primarily commercially obtained as a by-product of soy oil manufacturing. Some lecithin can also be commercially obtained from eggs or from sunflower seeds.

Most of the soy grown in the U.S. is GMO,[118] thus lecithin in cosmetics is likely to be from a GMO source. However, there are other concerns about lecithin. It can be contaminated with a toxic solvent, because the bulk of the commercial production is obtained from soybeans by an extraction process involving hexane, a synthetic petroleum-based solvent and known neurotoxicant.[119] In addition, if the toothpaste also contains a nitrosating agent, formation of nitrosamines is possible under certain conditions. See Diethanolamine (DEA) in previous section for more details.

Maltodextrin. An absorbent, emulsion stabilizer and binder, maltodextrin is obtained through the hydrolysis of starch. In the U.S. the source of starch used is primarily corn,[120] and most of the corn grown is the U.S. is GMO.

To avoid toothpastes with GMO-derived ingredients, look for the USDA Organic label, the NSF/ANSI 305 label, which guarantees that at least 70% of the ingredients are certified organic (the rest are non-GMO), or the Non-GMO Project Verified seal. However, the savvy consumer may question the necessity of many of these compounds as toothpaste ingredients, and may choose to do without.

Parabens

Parabens are a group of synthetic preservative ingredients that include methylparaben, propylparaben, ethylparaben, butylparaben, isobutylparaben, and isopropylparaben among several others.[121] They are very effective in preventing the growth of fungi, bacteria, and yeast that could cause products to spoil, thus enhancing the shelf life and perceived safety of products. They are used in a broad range of products, including processed food, pharmaceuticals, and very widely in cosmetics (75% to 90%) and personal care products. They are also used as fragrance ingredients, but won't be listed on the label, because fragrance recipes are considered trade secrets, and manufacturers are not require to disclose individual fragrance chemicals in the list of ingredients.[122]

Parabens mimic estrogen and can act as potential endocrine disruptors; exposure to these compounds can lead to cancer, as well as developmental and reproductive toxicity.[123] This is of concern, considering that parabens can penetrate the skin[124] (and thus the mouth mucosa) and are so ubiquitous that repeated use of a product, or multiple products containing parabens, may result in near continuous exposure to these compounds.[125] Indeed, parabens are found in nearly all urine samples from U.S. adults, regardless of ethnic, socioeconomic, or geographic backgrounds.126 Certain parabens appear to reduce sperm production and decrease testosterone levels.[127,128]

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Parabens occur naturally at low levels in certain foods, such as barley, strawberries, currants, vanilla, carrots, and onions, although synthetic versions derived from petrochemicals are used in cosmetics. Parabens in foods are metabolized when eaten, decreasing or neutralizing their estrogenic potential.[129] In contrast, when applied to the skin (or the mouth mucosa) and absorbed into the body, parabens in cosmetics bypass the metabolic process and enter the blood stream and body organs intact. It has been estimated that women are exposed to 50 mg per day of parabens from cosmetics.[130] A recent study showed that parabens may have more activity at lower doses than previously thought and questions the adequacy of current safety testing methods which, by focusing on single substances, may not accurately predict the true potency of tested substances in real world situation and, as a result, underestimate their potential toxic effect on human health.[131]

The use of parabens in cosmetics is not restricted in the U.S. or in Canada. International regulations are stronger; the European Union restricts the concentration of parabens in cosmetics, and The European Commission on Endocrine Disruption[132] has listed parabens as Category 1 priority substances, based on evidence that these substances interfere with hormone function.[133,134]

PEGs (polyethylene glycols) and Propylene Glycol

Polyethylene is the most common form of plastic and, when combined with glycol, it becomes a thick and sticky liquid. Polyethylene Glycol (PEG) is a mixture of polymers that have been bonded together. On the ingredient list, PEGs are almost always followed by a number after their name, such as PEG 100, denoting the molecular weight, which varies with the number of polymer units forming the PEG molecule. The lower the molecular weight, the easier it is for the compound to penetrate the skin or mucosa (oral products). PEG is a humectant (it prevents the toothpaste from drying by retaining moisture) and is also used as an emulsifier or solvent (helps water-based and oil-based ingredients mix properly). It is classified by Environment Canada as expected to be toxic or harmful, and the Environmental Working Group mentions moderate concerns of toxicity on non-reproductive organs.[135] As with Sodium Laureth Sulfate, there is a potential risk for PEGs to be contaminated with ethylene oxide and 1,4-dioxane, due to the manufacturing process.

PEGs facilitate the penetration of the skin or mucosa. If a toothpaste contains other undesirable ingredients, PEGs will make it easier for these ingredients to get into the bloodstream and, thus, increase the user's exposure. And, if PEGs are contaminated with 1,4-dioxane or ethylene oxide, then there will be higher chances for these cancer-causing compounds to get into the bloodstream of the toothpaste user. Even if the amount of the dioxane contamination is very small, somebody who brushes normally, that is two times a day, will be exposed twice a day, every day, to this toxic compound, which amounts to a chronic exposure.

PROPYLENE GLYCOL (PG): A small organic alcohol, related in structure to Polyethylene glycol, Propylene glycol is a skin-conditioning agent in cosmetics and is used in toothpastes as a humectant and solvent. It also enhances absorption. Of note, among various other industrial uses, it is the active ingredient in engine coolants and antifreeze.

Even though cancer might not be a concern, according to the Environmental Working Group (EWG),[136] studies have shown that PG is a sensitizer and an irritant that can induce skin and mucous membrane irritation and skin rashes when taken orally. It also induces skin sensitization reactions and allergic reactions in patients with eczema and other skin allergies as well as contact urticaria in humans even with formulations containing PG concentrations as low as 2%.[137] PG can have a concentration-dependent systemic toxicity to liver and kidneys, a moderate concern according to EWG.[138] However, EWG has ranked propylene glycol at the highest level of concern with regard to its effects on blood at high doses.[139]

Propylene glycol has been classified as "generally regarded as safe" (GRAS) by the FDA, and metabolizes relatively quickly in the body (within 48 hours); however, because it is available in many over-the-counter products (e.g., processed foods, cosmetics, drugs, and toothpastes), there is no way to accurately estimate one's daily intake or exposure to this substance. Indeed, considering that its potential toxic effects are dose-dependent, it is important, particularly for children, to limit exposure and avoid ingestion. According to the Agency for Toxic Substances and Disease Registry (ATSDR), a 2 year-old boy developed central nervous system depression and metabolic acidosis following accidental ingestion of about three ounces of hair gel which contained about 1.75 – 2.25% of propylene glycol (2.25% of 3 oz. is less than half a teaspoon). He became unresponsive and taken to the hospital; after gastric lavage and treatment to reduce the acidosis, he eventually recovered.[140]

PEGs facilitate the penetration of the skin or mucosa. If a toothpaste contains other undesirable ingredients, PEGs will make it easier for these ingredients to get into the bloodstream and, thus, increase the user's exposure.

Propylene glycol has limited toxicity but it penetrates easily through the skin and mouth mucosa and functions as a penetration enhancer, thereby facilitating the absorption of other ingredients. It is best to avoid toothpastes containing this ingredient.

Sodium Lauryl Sulfate (SLS) and Sodium Laureth Sulfate (SLES)

Sodium Lauryl Sulfate (commonly known as SLS) along with Sodium Laureth Sulfate (SLES), Ammonium Lauryl Sulfate (ALS) and Ammonium Laureth Sulfate (ALES) are inexpensive chemicals used as surfactants, detergents, emulsifiers, and foaming agents. They are found in many mainstream personal hygiene products such as shampoos, toothpastes, mouthwashes, body wash, soaps, and detergents as well as in industrial cleaners. They are all considered potential eye and skin irritants[141] by the Cosmetic Ingredient Review (CIR), an independent organization that review and assesses the safety of ingredients used in cosmetics.

SODIUM LAURYL SULFATE (SLS): According to the Environmental Working Group's Skin Deep cosmetics database,[142] SLS is a skin, eye, and respiratory tract irritant, with a moderate toxicity to organs, and is classified by Environment Canada as inherently toxic to aquatic organisms. Studies have shown that SLS breaks down the protective lining of the mouth, leaving the underlying tissues irritated and prone to break out with aphthous ulcers (canker sores), or if canker sores are present, lengthening the healing process.[143,144]

SODIUM LAURETH SULFATE (SLES) – an abbreviation of Sodium Lauryl Ether Sulfate – is a gentler surfactant and a very effective foaming agent. It is related to and presents similar potential risks as SLS.

The manufacture of SLES involves a chemical process called ethoxylation,[145] in which ethylene oxide, an irritant and a developmental and organ system toxicant,[146] as well as a known breast carcinogen,[147,148] is reacted with detergents (such as SLS) to create softer surfactants. In addition to the potential contamination of the final product with ethylene oxide, this process generates 1,4-dioxane as a by-product. Besides exhibiting organ toxicity,[149]

1,4-dioxane is a known carcinogen[150,151,152] that is prohibited in cosmetic products.[153] However, 1,4-dioxane contamination has been found in SLES, Ammonium Lauryl Ether Sulfate (ALES) and many other similarly manufactured ingredients commonly found in toothpastes and other cosmetics. Presence of 1,4-dioxane in cosmetics is of special concern since it can be absorbed through the skin, and the mouth mucosa, in toxic amounts.

Ethylene oxide and 1,4-dioxane will not be included on a product's ingredient list as they are impurities resulting from the manufacturing process. Therefore, concerned consumers should look for ethoxylated ingredients, indicated by ingredients containing the syllable "-eth-" in their name, such as "myreth," "oleth," "laureth," "ceteareth," polyethylene glycol (PEG), polyoxyethylene, and ingredients with names ending in "-oxynol," which all have the potential to be contaminated with 1,4-dioxane or ethylene oxide.[154]

In addition, 1,4-dioxane is also persistent in the environment. In other words, it doesn't easily degrade and can remain in the environment long after it is rinsed down the drain; it has been found in groundwater at sites throughout the United States.[155] The FDA encourages manufacturers to remove 1,4-dioxane from their products, a relatively inexpensive process, but it is not required by federal law. Removal would be voluntary on the part of the industry[156,157]

Triclosan

Triclosan (TCS) is commonly used as a preservative and an antimicrobial agent. It is found in a wide range of household products, including garbage bags, toys, linens, mattresses, toilet fixtures clothing, furniture fabric, paints, laundry detergent, and facial tissues, as well as in cosmetics such as antiperspirants/deodorants, shaving products, creams, antibacterial soaps and detergents, cleansers and hand sanitizers, toothpastes, and tooth whitening products.

Endocrine Disruption:

Animal studies have shown triclosan can interfere with hormones critical for normal development, as well as brain and reproductive system functioning. In addition, triclosan has been associated with lower levels of thyroid hormone and testosterone, which could result in altered behavior, learning disabilities, or infertility.[158,159]

Triclosan-resistant Bacteria:

The extensive use of triclosan in consumer products may contribute to the development of triclosan-resistant bacteria,[160] and mounting evidence links the use of triclosan with the promotion of bacteria that are resistant to both antibiotic medications and antibacterial products.[161,162] For instance, triclosan-resistant strains of microorganisms such as E. coli and Salmonella have been identified. Studies indicate that use of triclosan provides a suitable environment for the emergence of antimicrobial, drug-resistant bacteria even at the low concentrations found in products and cosmetics.

Because triclosan's mode of action and target site in bacteria are similar to those of antibiotics, there are concerns that bacteria that become resistant to triclosan will also become resistant to antibiotics.[163] A 2010 report by the European Commission's Scientific Committee on Consumer Safety determined that even low concentrations of triclosan can trigger antibiotic resistance in bacteria.[164]

Bioaccumulation/Environmental Toxicity:

Triclosan can pass through the skin and has been found in the urine of 75% of people tested.[165] In addition, triclosan is lipophilic, meaning that it accumulates in fatty tissues. Studies have found concentrations of triclosan in three out of five human milk samples.[166] Triclosan has also been found in the umbilical cord blood of infants,[167] which raises concerns for the well-being of the fetus during vulnerable periods of development and questions the long lasting effects on exposed individuals after birth.

Although touted as an effective microbe-killing agent (active against bacteria, not viruses), triclosan is actually many times more likely to kill algae, crustaceans, and fish in waterways.[168] Because of its proliferative use and persistence, large quantities of this chemical often end up in sewage systems, persisting in forested and non-agricultural settings, leading to decades long exposure of plants, soil-dwelling biota, and their predators over multiple generations. Furthermore, there is evidence that triclosan bioaccumulates in the aquatic food chain, especially in plants and the internal organs of fish, and may impact survival and reproduction in aquatic animals, as well as interfere with normal endocrine system functions in fish. In the environment, triclosan can be transformed into potentially harmful products as it breaks down, such as chlorinated dioxins, which are persistent toxic compounds that bioaccumulate.[169,170] Finally, triclosan is registered by the EPA as a pesticide.

In spite of all the scientific evidences as to its potential as an endocrine disruptor, its environmental persistence and aquatic toxicity, triclosan is present in almost half of all supermarket liquid hand soaps and in some toothpastes such as Colgate's Total brand series.[213]

Triclosan is restricted in cosmetics in Canada and Japan. It is also on Whole Foods Market's list of unacceptable ingredients in its premium body care products.[171]

Other Compounds to Avoid

As discussed in the previous section, there are many questionable ingredients in toothpaste. The savvy consumer may question the necessity of these compounds as toothpaste ingredients and may opt to do without them when choosing a toothpaste. Below are some additional classes of toothpaste ingredients to avoid.

ABRASIVES INGREDIENTS. Hydrated silica (a component of sand) and various silicates (Alumina Magnesium Metasilicate, Aluminum Calcium Sodium Silicate, Aluminum Iron Silicates, and Sodium Potassium Aluminum Silicate) are used in toothpaste as abrasive agents to help remove plaque and whiten teeth. There are some claims that hydrated silica may negatively impact dental health over time. By scratching the surface of the tooth, silica damages the enamel and may prevent tooth remineralization by altering the acidic balance of the mouth.[172]

ALLERGENS, IRRITANTS, AND SUBSTANCES THAT MAY CAUSE CONTACT SENSITIVITIES. Allergies to oral hygiene ingredients are rare but do occur. Although any substance may cause an allergic reaction, studies point to some that are most common in toothpastes. Below are toothpaste ingredients that often show up as allergens in patch tests.[173,174,175]

- Toothpaste flavorings, including cinnamon (cinnamal), menthol, mint, spearmint, carvone, peppermint, and anethole;
- Papain;
- Preservatives and humectants, such as parabens, sodium benzoate, and propylene glycol;
- Surfactants/foaming agents, including cocamidopropyl betaine and sodium lauryl sulfate;
- Essential oils can be irritants or sensitizers (such as tea tree oil) or may interact with some substances and act as allergens especially in sensitive people. For instance, lavender oils forms a potential allergen called hydro peroxide when mixed with oxygen in the air. A reaction between skin enzymes and geranial oil forms geranial. Geranial is an allergic substance that irritates the skin surface. Some essential oils that are potential mucous membrane irritants are obtained from cinnamon bark or leaf, clove bud or leaf, lemongrass, peppermint.[176]
- Other plant-based antibacterials or fragrance ingredients, including limonene, linalool, eugenol, propolis, and,
- Fluoride

FLAVORING AGENTS. The savvy customer will stay away from synthetic flavors and look for flavors derived from botanical essential oils or extracts and prioritize organic botanical-based flavors.

SURFACTANTS/DETERGENTS. Added to toothpastes to enhance foaming and cleansing power, there are many surfactants in addition to Sodium Lauryl Sulfate (SLS). Most are synthetically derived, either from coconut oil or petroleum. Some may produce nitrosamines under certain conditions or be contaminated with 1,4-dioxane and ethylene oxide (known carcinogens).[177,178,179,180,181] For a comprehensive list of cosmetic ingredients potentially contaminated with these toxic chemicals, check the Environmental Working Group's Skin Deep cosmetics database.[182]

TARTAR AND PLAQUE CONTROL. Tartar, or calcified bacterial plaque, is best controlled by regular flossing and brushing. In addition, there are some chemicals additives, such as pyrophosphates, that can help reduce or prevent plaque. However, they provide plaque/tartar control by demineralizing saliva, which prevents natural tooth remineralization and may affect dental health over time.[183]

WHITENERS. Beside abrasives, which are considered whitening additives, various peroxide compounds can be added to toothpastes as bleaching aids. Peroxides are strong oxidizers and concerns exist as to the safety of their use on a routine basis. They are restricted in cosmetics in Canada.[184]

Are there Organic Toothpastes?

THERE ARE ALMOST NO ORGANIC TOOTHPASTES because the organic standards regulate food and food ingredients, not cosmetics. Cosmetics may, by necessity, contain substances obtained by processes forbidden under organic regulations.

According to the USDA:

> *"The FDA does not define or regulate the term 'organic,' as it applies to cosmetics, body care, or personal care products. USDA regulates the term "organic" as it applies to agricultural products through its National Organic Program (NOP) regulation, 7 CFR Part 205."*[185]

In effect, when it comes to food, the term "organic" is defined by the USDA's National Organic Program (NOP) standards, the Federal regulation that determines how organic food is grown, raised, processed, and sold and by the enabling legislation, the Organic Foods Production Act of 1990. However, the USDA doesn't have the same control over personal care products as it does over food. While many personal care products, including a few toothpastes, are certified under the USDA organic standards, and display the USDA organic seal, the USDA does not currently have the authority to police organic claims on personal care products that are not certified. Which means that while any food with "organic" on the label is subject to strict standards and enforcement by the Federal government, personal care products are not subject to such federal oversight.

Toothpastes or other cosmetics can contain certified organic ingredients. In addition, in order to ensure that the best ingredients are used or that cosmetics do not contain GMO-derived ingredients, other certifications exist, which can be confusing to the consumer. According to the USDA:

> *"Cosmetics, body care products, and personal care products may be certified to other, private standards and be marketed to those private standards in the United States. These standards might include foreign organic standards, eco-labels, earth friendly, etc. USDA's NOP does not regulate these labels at this time."*[186]

In order to ascertain which claims or certifications can be trusted, the following guidelines should be used. Products regulated by foreign organic standards, or with eco-labels or earth friendly claims are not discussed.[187]

While many personal care products, including a few toothpastes, are certified under the USDA organic standards, and display the USDA organic seal, the USDA does not currently have the authority to police organic claims on personal care products that are not certified.

- "100% Organic" – Products must contain (excluding water and salt) only organically produced ingredients. Products may display the USDA Organic Seal and must display the certifying agent's name and address.
- Products claiming to be "organic" – e.g. "organic toothpaste" – must be certified according to the USDA/NOP standards, the same standards which apply to organic food. This standard requires 95% certified organic ingredients (excluding salt and water) and the remaining 5% can only contain carefully vetted substances from a short list of non-organic approved additives. Products may display the USDA organic seal and must also display the certifying agent's name and address. All organic ingredients must be identi-

fied (e.g., organic glycerin) or via an asterisk or other mark.

- Products claiming to be "made with" organic – must be certified according to the USDA/NOP "made with organic" standard, which requires at least 70% organic ingredients and, as above, places strict restrictions on the substances that can be used in the remaining 30%. May state "made with organic (insert up to three ingredients or ingredient categories)," e.g. "made with organic essential oils and extracts." In this category products may not display the USDA organic seal and must display the certifying agent's name and address. The organic ingredients must also be identified by name (e.g., organic glycerin) or via an asterisk or other mark.
- Products containing less than 70% organic ingredients cannot use the term "organic" anywhere on the main display panel, but the specific ingredients that are USDA-certified "organically produced" may be identified on the ingredient statement on the information panel. Products may not display the USDA organic seal and may not display a certifying agent's name and address.[188,189]
- Products certified to the NSF/ANSI 305 (National Sanitation Foundation/American National Standards Institute) standards can claim "contains organic ingredients" – e.g. "contains organic rosemary, clove, and thyme oils" – and are required to contain at least 70% organic ingredients. Like the USDA/NOP standards, NSF/ANSI 305 products are subject to strict restrictions regarding substances that can be used in the remaining, non-organic, 30% of ingredients. However, this standard allows for a small number of substances and processes that are not allowed in the USDA/NOP standards for food. These substances and processes have been reviewed by the NSF International Joint Committee on Organic Personal Care, which is made up of manufacturers, retailers, regulators, certifiers, consumer groups, and other stakeholders. Products must display the certifying agent's name and address.[190,191]
- The "Non-GMO Project Verified" seal ensures that the product does not contain GMO-derived ingredients.[192,193]

TOOTHPASTES THAT ARE ORGANIC OR CONTAIN ORGANIC INGREDIENTS:

- **Face Naturals Tooth Cleanser** by Face Naturals. 95% organic ingredients.
- **Happy Teeth Toothpaste** and **Poofy Organic Toddler Toothpaste** by Poofy Organics. 95% organic ingredients, certified USDA organic by Baystate Organic Certifiers.
- **Herbal Choice Mari Natural Tooth-Gel** by Nature's Brands. 95% organic ingredients.
- Peppermint or cinnamon toothpaste by **Krista's Natural Products**. 95% organic ingredients.
- **Miessence** toothpaste by Organic and Natural Enterprise Group (ONE Group). 90% organic ingredients, certified by Biological Farmers of Australia (BFA).
- **Mint Sweet Orange Toothpaste** from Made Simple Skin Care. 95% organic ingredients, certified USDA organic by CCOF.
- **Dr. Bronner's All-One Toothpaste**, NSF/ANSI 305 certified, contains 70% organic ingredients, which are certified by OTCO.
- **Green People** toothpaste, based in the UK. Contains 30% certified organic ingredients. Certified organic by EcoCert, which has its own standards for natural and organic cosmetics.[194]
- **Jack N' Jill Natural Toothpaste**, for children, based in Australia. Contains some organic ingredients, notably organic flavors which are certified USDA Organic.

Homemade Toothpastes

IN ADDITION TO REGULAR BRUSHING AND FLOSSING, optimal dental health is dependent, to a large extent, upon proper nutrition: avoid processed foods, minimize sugar intake, and eat nutrient-dense whole foods, preferably organic, locally, and seasonally grown.[195]

Beyond seeking out the exemplary commercial toothpastes listed previously, which would ensure that the toothpaste you and your family are using is effective and safe, you also have the option of making your own toothpaste. Many problems, such as oral mucosa irritation, canker sores, and exposure to potentially toxic compounds can be avoided by doing so.

In effect, making your own toothpaste gives you complete control over what ingredients are contained therein, as well as the quality of those ingredients. An additional advantage is that you will save money, with a modest investment of time.

There are many do-it-yourself (DIY) toothpaste recipes to be found on the Internet, and high quality ingredients are commonly available at your local food co-op or independent health food store, as well as online. Organic and high-quality herbs, essential oils, and cosmetic ingredients can be found at From Nature with Love,[196] New Directions Aromatics,197 and Mountain Rose Herbs[198] among many others.

What to emphasize in a homemade toothpaste:

- Provide minerals to help teeth re-mineralize
  - Bentonite clay not only provides many trace minerals, but it also binds to and draws out heavy metals and toxins.[199] In addition, a recent study found that clay has antibacterial properties and is effective against E. coli as well as antibiotic resistant bacteria such as MRSA (Methicillin-resistant Staphylococcus aureus).[200,201]
- Help protect from cavities by preventing plaque formation
  - Sodium bicarbonate is a mild abrasive that also raises the mouth's pH. An alkaline pH helps prevent plaque formation.
  - Coconut oil has antiviral, antibacterial, and antifungal properties, and is effective against antibiotic resistant bacteria.[202,203] It is also a good texturizer.
  - Myrrh, cinnamon, clove, tea tree, oregano, rosemary, and peppermint essential oils all have natural antibacterial properties, and invigorate and stimulate healthy gums (see disclaimer).
- Have an acceptable taste (after all, we should use it at least two times a day)
  - Sweeteners such as erythritol, Stevia, or xylitol204 will sweeten the toothpaste and will not promote bacterial growth. Xylitol can help protect teeth from cavities;[205] however, it is toxic to dogs, so if you use it in your toothpaste, keep it stored safely away from pets.
  - Essential oils such as peppermint, orange, etc. (see disclaimer).
- Help whiten teeth, without damaging the enamel
  - Sodium bicarbonate, a mild abrasive
  - Calcium carbonate, a mild abrasive
  - Activated charcoal, binds and removes staining compounds from teeth
  - Lemon essential oil (see disclaimer)

This ingredient list is by no mean definitive. Do some research, experiment and enjoy your own DIY toothpaste!

Homemade toothpaste recipes

The recipes below are either clay-based or calcium carbonate-based. Clay has a particular mouth feel that not all may appreciate.

Calcium carbonate-based toothpaste

- 5 parts calcium carbonate powder
- 2-3 parts baking soda
- Trace minerals (e.g., ConcenTrace®) – *optional*
- 3 parts xylitol powder (or other sweetener of choice)
- 3-5 parts coconut oil (warmed to liquid)
- Essential oils of your choice (see disclaimer)
- Filtered or otherwise pure water, as needed

INSTRUCTIONS:

1. Place all powdered ingredients (i.e., calcium, baking soda, and/or xylitol) in a food processor and pulse until well-mixed (a few seconds).
2. In a liquid measuring cup, combine the essential oils (if using, see disclaimer) and the trace minerals with the liquid coconut oil, and slowly add to the food processor while continuing to pulse. Mix until smooth, add water (not much) as needed to reach desired consistency and texture.

Clay-based toothpaste

- 6-8 parts bentonite clay
- 3 parts xylitol powder (or sweetener of choice)
- 4 parts coconut oil, warmed to liquid
- Trace minerals (optional)
- Essential oils of your choice (if using, see disclaimer)
- Filtered or otherwise pure water as needed

INSTRUCTIONS:

1. Place all powdered ingredients (clay, Xylitol) in a food processor and pulse until well mixed (few seconds).
2. In a liquid measuring cup, add the essential oils (if using, see disclaimer) and the trace minerals to the liquid coconut oil and slowly add to the food processor while continuing to pulse. Mix until smooth, add water (not much) as needed to reach desired consistency and texture.

DISCLAIMER: *The recipes here are given as examples and we do not intend to infer any health claims nor health outcomes. The ingredients listed are suggestions only; keep in mind that children and some people can be sensitive to essential oils. Undiluted essential oils should never be ingested unless under the guidance of a naturopath or similar expert.*

To each of these recipes, you can add 4 parts of raw, unsweetened cocoa powder, which contains theobromine. Purified theobromine has been shown to be more effective than fluoride at protecting teeth.[206,207] By including whole cocoa powder, your teeth may benefit from the theobromine as well as the many other minerals and beneficial compounds found in cocoa. This will also impart a great taste and perhaps add effectiveness to your DIY toothpaste.

You can keep this toothpaste in a half pint jar or use refillable toothpaste tubes, which are available online. Homemade pastes will store well in your medicine cabinet, although may dry out over time, in which case water can be added.

Many other DIY toothpaste recipes can be found on the internet.[208,209,210,211] If you prefer a dry toothpowder, you can create it out of the same ingredients, while withholding the coconut oil.[212]

Conclusion

THE INTERESTS OF THE COSMETICS INDUSTRY are rooted in profitability, while the long-term safety of its products and the health of its customers are often taken for granted. As a result of toothless federal regulations, the most common ways a company will act to modify or remove problematic ingredients in its products are in reaction to consumers voicing concerns, if sales are impacted, and whether legal actions have been initiated.

As a result, toothpaste, *a product we put in one of the most absorbent areas of our body*—our mouths—contains many questionable ingredients that are potentially toxic. Most of these ingredients have not been thoroughly tested by manufacturers and governing agencies, or they were tested in a way that did not account for the potential chronic toxicity likely to occur from long-term exposure (most commonly, people brush two or more times a day over a lifetime). Furthermore, synergistic effects, which are the potential toxic effects of chemical mixtures resulting from the combination of two or more chemical ingredients together, are generally not evaluated. And finally, the total cumulative chemical exposure resulting from the food we eat, the air we breathe, the water we drink, and the toothpastes, as well as the other personal care products we use, is never considered.

It is crucial for every consumer to adopt a proactive stance to protect their wellbeing, and that of their children, by learning to recognize problematic and potentially toxic ingredients. Consumers can then avoid purchasing questionable toothpastes that may significantly add to their overall cumulative and chronic chemical exposure.

The Cornucopia Institute's toothpaste scorecard, available at cornucopia.org, can help you choose the safest and most effective products for you and your family.

It is crucial for every consumer to adopt a proactive stance to protect their wellbeing, and that of their children, by learning to recognize problematic and potentially toxic ingredients. Consumers can then avoid purchasing questionable toothpastes that may significantly add to their overall cumulative and chronic chemical exposure.

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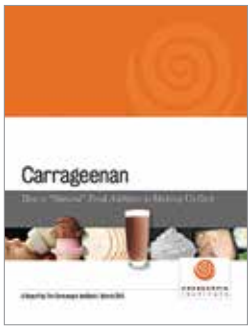

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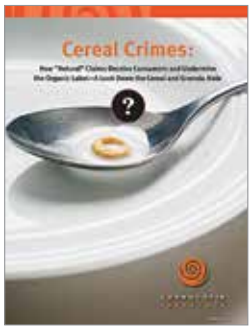

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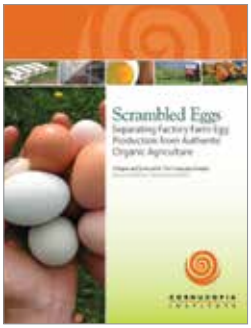

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