World Nutrition

Volume 5, Number 3, March 2014

Journal of the World Public Health Nutrition Association
Published monthly at www.wphna.org

Processing. Breakfast food

Amazing tales of ready-to-eat breakfast cereals

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Introduction

There are products we all know or should know are bad for us, such as chips (crisps), sodas (soft drinks), hot dogs, cookies (biscuits), and a lot of fast food. Nobody has ever put these items on a healthy list, except perhaps industry people. Loaded up with sugar, salt and white flour, they offer about as much nutritional value as the packages they're sold in.

But that's just the tip of the iceberg, the obvious stuff. The reach of the processed food industry goes a lot deeper than we think, extending to products designed to look as if they're not really processed at all. Take, for instance, chains that sell what many people hope and believe are 'fresh' sandwiches. But since when does fresh food have a brew of preservatives like sodium benzoate and calcium disodium EDTA, meat fillers like soy protein, and manufactured flavourings like yeast extract and hydrolysed vegetable protein? Counting up the large number of ingredients in just one sandwich can make you cross-eyed.

I first became aware of the enormity of the complex field known as food science back in 2006 when I attended an industry trade show. That year IFT, which is for the Institute of Food Technologists, and is one of the food industry's biggest gatherings, was held in New

Orleans. Inside a massive exposition hall, people talked about food in a language I barely understood. Our meals were no longer from plants or animals, but were 'applications,' as if dinner were a software programme to be coded. I was told, 'This is an ingredient that can be used in a meat application.' Or, 'This is for a cheese application.' At another booth, I talked to a marketing director about 'texturing systems.' His company sold starches that could, among many other things, make a cheaper version of Greek yoghurt. Someone had prepared samples of this pseudo-Greek yoghurt thickened with modified cornstarch and protein concentrates, instead of being strained in expensive machines. The taste was not bad. I would have never known.

By the time I got over to the booth serving up blueberry muffins made with fake blueberry bits, concocted from (more) cornstarch, sugar, flour and a dash of pulverised blueberries but also seeming much like the real thing, I realised that food scientists and the processed food industry had completely rewritten the definition of 'food.' No longer does it need to resemble something once grown or raised on a farm. For the sake of both profits and shelf life, it's better if it doesn't. We consume all this stuff but we often don't know what it is we're eating.

The industry prefers to keep it this way. In the two years I spent travelling around the food industry for research on my book *Pandora's Lunchbox*, a chapter of which is below, I saw oodles of examples of this. Consider, for instance, the marketing of soybean oil and other vegetable oils as '100% natural.' Yet this is produced by drenching crushed soybeans with hexane, a neurotoxic, highly flammable petrochemical that you don't want to go anywhere near without protective gear. The oil is then subjected to several other chemical treatments, as well as bleaching and deodorising to get rid of the truly awful taste of oils like soybean and canola. Much of soybean oil's nutrition also disappears. None of this, from the crushing of GMO soybeans to the hydrogenation or interesterification process that happens at the end of the long vegetable oil production chain, is remotely 'natural.'

Nor is it healthy, as we've been told to think. Soybean oil, an unstable polyunsaturated fat, is shockingly ill suited to the job of being the dominant source of added fat in US diets over the past five or six decades. When heated, such as in the cooking of French fries, fried chicken products and potato chips (crisps) it breaks down, or oxidises, and forms toxic aldehydes. These have gained little attention but may be as troublesome as *trans* fats.

Another highly processed product that pretends it isn't is ready-to-eat breakfast cereal, whose story I tell below. Cereal companies have long insisted that their products are a healthy way to start the day. The box is there to refresh your memory: 'high in vitamin D,' 'antioxidants,' 'good source of fibre'. It's nearly impossible to find a box in the cereal aisle that doesn't contain an alphabet soup of added vitamins and minerals. But most of these claims – and indeed much of the nutrition in the products – come from manufactured synthetic nutrients added in, much as if someone were crushing a multivitamin and sprinkling it into your flakes. Much of whatever nutrition was present in the starting grains gets destroyed in the manufacturing process, or fades away over the course of shelf-life.

In countries like the US, where I come from, eating more of what nutrition experts, not marketing executives, say is genuinely healthy isn't so easy, especially when the food industry has spent at least six decades and billions of dollars telling us we don't have to. But the health benefits of spending a bit more time along the perimeters of grocery store and in our own kitchens are immense. As my mom once told me, while I was in college living on pizza and Pop-Tarts, 'What you put into your body matters, Melanie. Just because it's edible doesn't mean it's good for you'.

The Big Breakfast

The biggest breakfast in the world in Battle Creek, Michigan, attended by all the characters that make sugared ready-to-consume breakfast cereals attractive to children now all over the world

On a picture-perfect early morning in June, thousands of hungry people filed up Michigan Avenue in Battle Creek, Michigan, making their way toward a ribbon of tables lined up under small, white-topped tents. As a blinding sun rose, crowds gathered two and three deep around neatly assembled rows of free breakfast cereal portioned into bowls. A collection of people stood behind each table, filling bowls. Some of them looked frantic, as if they already knew what kind of pace was going to be required to keep a steady supply of Cocoa Pebbles, Corn Pops, Raisin Bran, and Corn Flakes coming. Just outside each tent, someone stood ready with an opened carton of low-fat milk.

At the far end of the block, a troupe gyrated to dancehall reggae on a covered stage. Below them, a lively swaying crowd gathered on the street, marking the first time I witnessed anyone attempting to dance while eating a bowl of Frosted Flakes. Every so often, someone appeared with a large, bulging bag. 'Pop-Tart?' they offered. Over a loudspeaker, barely drowning out the music, someone shouted, 'Wake up, America. Battle Creek is serving breakfast!'

Well, Battle Creek's version. The town's annual Cereal Festival, also known as 'The World's Longest Breakfast Table', is hosted by the three cereal companies with a presence in Battle Creek. Every year, Kellogg's, which has its global headquarters

there, Post Foods, and Ralston (a store-brand manufacturer) send representatives to hand out free cereal and greet the crowd. They donate thousands of boxes of some of their more popular varieties, much of it coming straight from their Battle Creek factories, making Cereal Fest a sort of celebration of local food. Which is to say, say, industrial-local food products.

Although I'd arrived on Michigan Avenue at the festival's 8:00 in the morning scheduled start time, some people were already into their second bowl. Kevin, a retired Kellogg's plant employee, had had some Raisin Bran and then went in search of his primary target, Fruity Pebbles. 'I was worried when I didn't see them at the first few tables, so I had to keep looking,' he grinned. He wasn't the only grown man I saw enjoying brightly coloured cereal. Scott, a middle-aged dad with long blond hair, a moustache, and a black Harley Davidson T-shirt, explained that he doesn't normally eat Froot Loops for breakfast. 'This is what I grew up on, so it's like being a kid again', he said, diving into a half-empty bowl.

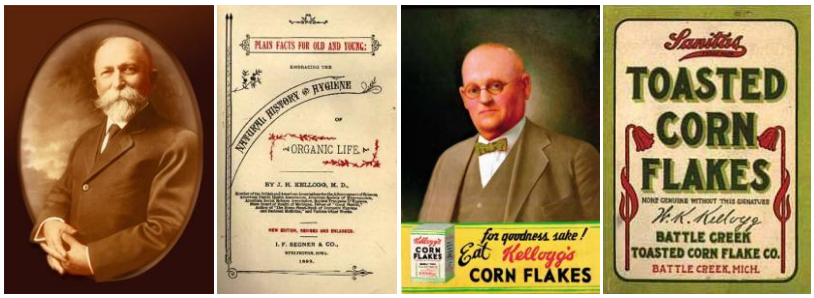
Many of the actual kids nearby were hovering around people dressed in plush cereal character suits, waiting to get their picture taken. (See above). The biggest masses of kids crowded around Tony the Tiger, Toucan Sam, and Post's Sugar Bear. Less in demand were the Keebler Elf, Corn Flakes's Cornelius Rooster, and the moustached Pringles guy. The kids were briefly interrupted in their quest for photos when the dozens of Kellogg employees in attendance gathered with their characters for a massive group snapshot.

If Battle Creek residents are like most people in the US, on any day that isn't Cereal Fest, one fifth of them (or one third, if they're kids) will eat some type of breakfast cereal, a habit that helps fuel a $10 billion annual US business and gives cereal its dominant place at the US breakfast table as well as an outsized share of space in the grocery cart. In the US, items from the cereal aisle are the eighth most popular supermarket product, after soda, milk, bread, salty snacks, beer, wine, and cheese.

But soda, milk, and bread have nothing on cereal when it comes to sheer numbers of choices. There are more cereal iterations in the supermarket than any other product. My local King Soopers, owned by Kroger, the country's biggest grocery chain after Walmart, displays a total of 215 different boxes – I counted them – spanning both the regular and 'natural' sections of the store. By contrast, the store sells 120 varieties of soda, 94 different sliced breads, 128 kinds of crackers, and a mere 34 types of peanut butter.

Our landscape of choices in the supermarket is not an undisturbed democracy. There's no point in deliberating too long over what kind of oranges or tomatoes to buy. The decision has all but been made for us: for oranges, navel or Valencia; for tomatoes, vine-ripened, cherry, or Roma. In the cereal aisle, though, we live in the land of boundless opportunity.

The Kellogg brothers



Health reformer John Harvey (JH) Kellogg (left, 1952-1943) with a later tract; and his brother, entrepreneur Will Keith (WK) Kellogg (right, 1860-1951) with an earlier corn flakes packet

Considering the vast cornucopia of things that snap, crackle, and pop, it's hard to imagine a time when Americans didn't participate in the morning ritual of pouring cereal into a bowl. But like most processed food, boxed breakfast cereal is a twentieth-century creation. And it's one that's still most relevant to America and its English-speaking allies. The United States, Canada, the United Kingdom, and Australia account for 6 percent of the world's population but more than half the world's breakfast cereal consumption, according to Cereal Partners Worldwide, a global venture between General Mills and Nestlé that's working on increasing consumption outside the English-speaking world.

Before the early 1900s, people did in fact consume quite a lot of cereal – just not the sort that could be eaten straight from the box. It came in the form of grains (typically whole) that had to be combined with water or milk and then cooked slowly. In the South, it was corn grits. In northern states, many Scottish and Irish immigrants didn't get through a day without oatmeal porridge. Around the world, many cultures still maintain these cereal traditions, eating *kasha* from wheat, barley, or oats in Eastern Europe; watery rice gruel called *congee* in China; *halim*, a sweetened wheat porridge flavoured with cinnamon, in Iran and Turkey; and *pap*, a corn gruel used in a variety of southern African meals.

In addition to simple, cooked grains, in the nineteenth century, Americans, especially the well-to-do, ate a variety of things for breakfast that you aren't likely ever to see on a Denny's menu – wild pigeons, oysters, and stewed veal, for instance. They also feasted on considerable amounts of eggs, bacon, sausages, and fried ham. It was this voracious morning consumption of animal products that inspired a Battle Creek physician and surgeon named John Harvey Kellogg (1852-1943) to create the first modern, precooked, ready-to-eat breakfast cereal.

A vegetarian since the age of fourteen, Kellogg ran the Battle Creek Sanitarium, housed in an Italian Renaissance Revival building that still looms over downtown. The San, as it was called, operated as a hospital, spa, country club, and religious

revival camp all at once. It attracted many of the elite of society, including President Warren Harding, Amelia Earhart, Henry Ford, Mary Todd Lincoln, and George Bernard Shaw.

Though he measured only 5 foot 4 inches tall, the cherubic doctor cultivated a larger-than-life presence, and the San's patients were drawn as much to Kellogg's outsized personality as his many novel ideas about health. An early adopter of preventive medicine, Kellogg espoused the benefits of sunlight and exercise, notions that were ahead of their time. Some of his other ideas, though, were flat-out bizarre, if not downright wrong. Kellogg believed, for instance, that vibrating chairs could improve circulation and cure constipation, and that coffee 'cripples the liver.'

Seventh Day Adventism was founded in Battle Creek in 1863, and he was a devour believer. He argued against both sex and masturbation, believing that the 'solitary vice' in particular led to everything from cancer of the womb and urinary diseases to impotence and epilepsy. He said that he and his wife, Ella, never consummated their forty-year marriage. Instead of conceiving their own children, the Kelloggs reared 42 orphans.

The good doctor also had many thoughts about food, most of them considerably less eccentric. He believed the excessive consumption of animal products, especially for breakfast, was causing an epidemic of upset stomachs and other digestion-related maladies among those who could afford to eat an abundance of stewed veal and bacon. He was determined to find a healthier, low-fat, high-fibre way for his patients to start the day. Already serving oatmeal and whole-wheat porridges in his sanitarium, Kellogg wanted something new and exciting, a breakfast people could continue eating once they left the San. Ideally, it would be something that could be sent by mail and didn't require cooking.

John Harvey and Ella spent many hours in the San's kitchen, experimenting with new breakfast creations. One of their first products was a biscuit made of whole-wheat flour, oats, and cornmeal that had been mixed together into a dough and baked. Called granula, and later renamed granola, it was coarse, brittle, and nearly impossible to chew. To improve the texture, the couple strove to get the grain pieces much flatter, into a sort of flake shape, but this proved to be a challenge.

Kellogg's breakthrough came by accident. One day Ella boiled a batch of wheat kernels and then forgot to drain the water, leaving it soaking overnight. When Kellogg awoke, he found that the wheat was quite soft and mushy. He ran it through a roller, and to his delight, each kernel of wheat stuck to the roller as a flattened flake. He scraped them off and baked them on a flat pan. The result was the first flaked cereal. The flakes were crispy and still somewhat leathery, but much less so than his earlier granola pucks. In 1897, Kellogg started the Sanitas Food

Company to sell the cereal by mail order to former San patients who craved foods adhering to what Kellogg called 'biologic eating.'

It probably would have remained a small, quiet enterprise had Kellogg not hired his younger brother to work with him at the San. In contrast to the exceptionally charismatic and gregarious John Harvey, Will Keith Kellogg (1860-1951) was taciturn and reclusive, with round glasses and an austere bearing. But he was infinitely more practical and business-savvy than his whimsical older brother. After years of 15 hour days, meagre wages, and living at his brother's beck and call (reportedly suffering the indignity of taking dictation while John Harvey was on the toilet), Will Keith began asserting himself.

The Sanitas Food Company was now selling corn flakes as a companion to the wheat variety, and while John Harvey was away on a trip in Europe, Will Keith seditiously added sugar to the recipe. When he found out, John Harvey was apoplectic. He demanded the sinful ingredient be removed, but WK, overwhelmed by positive customer feedback, wisely ignored this request. The younger Kellogg saw enormous potential in Sanitas Toasted Corn Flakes. In 1906 he bought out his brother's share of the company and founded what would eventually become the Kellogg Company, today's $US 13 billion breakfast and snack empire.

The brothers never reconciled. At one point, they sued each other over the use of the family name. WK ultimately prevailed. John Harvey continued to run the San, but made the ill-fated decision to finance an ambitious expansion, incurring large amounts of debt just before the stock market crash of 1929. When patients stopped showing up, he couldn't pay his bills, and in 1942 he was forced to sell the San building to the federal government, which today runs it as an office of the General Services Administration. JH moved to Miami for a number of years, and in the final years of his life devolved into an even more eccentric character than he already was, regularly exercising outside wearing nothing but white cotton underwear. Several years before he died, he wrote a heartfelt letter to his brother apologising for all the squabbles during their time together at the San. But WK didn't learn of the missive until too late. By this time he was blind from glaucoma, and his associates hadn't told him about the letter, thinking it would upset him. He became aware of it only after John Harvey died in his sleep in 1943 at the age of 91.

Although John Harvey's presence loomed over Battle Creek in its early days, it was Will Keith who created the enduring legacy. Today, the Kellogg name appearing on a Battle Creek auditorium, middle school, community college, airport, and large foundation building all refer to the younger brother. When WK died in 1951, also at the age of 91, the Kellogg Company laid his body in an open mahogany casket for a day in the main lobby of its Battle Creek headquarters.

Shelf-life, the name of the game

Kellogg's 'Sweet Heart of the Corn', which is to say the starch fit for long life on the shelf, and right, Quakers Puffed Wheat Sparkies, introduced in 1940, with endorsement from Gregory Peck

Walk down a cereal aisle today or go onto a cereal brand's website, and you will quickly be informed that breakfast cereal is one of the healthiest ways to start the day, chock-full of nutrients and containing minimal fat. 'Made with wholesome grains,' says Kellogg's on its website. 'Kellogg's cereals help your family start the morning with energy by delivering a number of vital, take-on-the-day nutrients – nutrients that many of us, especially children, otherwise might miss.' It sounds fantastic. But what you don't often hear is that most of these 'take-on-the-day' nutrients are synthetic versions added to the product, often sprayed on after processing. It's nearly impossible to find a box of cereal in the supermarket that doesn't have an alphabet soup of manufactured vitamins and minerals, unless you're in the natural section, where about half the boxes are 'fortified'.

But if packaged breakfast cereals are so nourishing, why do they need so much help? The answer can be found in cereal factories, where the making of this food has evolved dramatically from the early days in Battle Creek. Finding out was part of my quest.

Compared with today's breakfast cereals, the Kellogg brothers' early wheat and corn flakes were crudely-made, nutritious creations. They were crafted from whole grains, little if any sugar, and only a few other ingredients. They packed a lot of fibre, as John Harvey had intended, and were likely to boast naturally occurring B vitamins and, in the case of Corn Flakes, vitamin C, though no one at the time knew how to measure such things.

They wouldn't stay like this for long, though.

The emerging system of warehousing and centralised production dictated that packaged products like breakfast cereal be able to survive for several months. On this count, Corn Flakes didn't fare so well. After just a month, boxes could develop

a rancid odour due to the presence of oil from the germ portion of the corn. If Corn Flakes lovers ate their cereal within several weeks of it being produced, this wasn't a problem, but WK. knew he needed a product with better shelf life.

In 1905, he changed the Corn Flakes recipe in a critical way, eliminating the problematic corn germ, as well as the bran. He used only the starchy centre, what he referred to as 'the sweet heart of the corn', personified on boxes by a farm girl clutching a freshly picked sheaf. This significantly lengthened the amount of time Corn Flakes could sit in warehouses or on grocers' shelves, but depleted the vitamins in the germ and the fibre in the bran. Since vitamins and fibre were yet to be identified in food, it's likely WK. didn't realise he was making a nutritional trade-off. For all he knew, his customers were getting a much-improved product.

Food scientists have since figured out ways to use heat and preservatives to deactivate the enzymes that cause corn and wheat oil to go rancid, though Kellogg's never did return to using whole corn. WK's fix for the cereal's shelf-life problem stands as one of the earliest examples of what would become a central paradox of the food processing industry. This is the fact that nutrition and convenience are sometimes deeply at odds with one another.

As for the crudely processed part, that didn't last long either. The first transformative technology was something called gun puffing. In 1904 the Quaker Oats Company introduced new machinery at the World's Fair in St. Louis. It hauled in a row of bronze army-surplus cannons, filled them with white rice, and then applied heat. As the cannons got hot, large amounts of pressure built up inside their chambers. When the chambers opened, the resulting rapid drop in pressure forced the rice to explode, letting off a loud boom and launching a storm of airy puffs over the crowd. This was Puffed Rice, the company's first ready-to-eat breakfast cereal. A Quaker poster at the fair pronounced the new technology 'The Eighth Wonder of the World.'

Despite the awe-inspiring display, the exploded cereal failed to catch on with consumers and languished in the marketplace for nearly a decade until 1913, when the company began an advertising campaign featuring the tagline 'The Grains That Are Shot from Guns.' The campaign leveraged a growing sense of wonderment toward technological innovation. Quaker ran advertisements highlighting the scientific novelty of Puffed Rice, sometimes featuring the laboratory-coated former University of Minnesota chemical biologist who had created the product. On boxes, customers were informed that their cereal was 'steam exploded' to '8 times normal size.' Sales increased tenfold in five years, placing both Puffed Rice and Puffed Wheat in the breakfast mainstream.

Quaker's 'Guns' campaign reflected a broad sense of pride in the food industry about the ways science was being used to create what were billed as improved food products. In 1919, canned-food manufacturers declared their products 'The Miracle

at Your Table.' In one advertisement, six housewives gazed in admiration as a bespectacled scientist at the National Canners Association's laboratory stared intently into a beaker. Likewise, for several years, starting in 1905, boxes of CW Post's Grape-Nuts bore this invitation: 'Factory always open to visitors'.

Some hundred years later, none of the cereal companies I contacted for this book, including Post Holdings, the maker of Grape-Nuts, were able to offer tours of their factories, though several older residents of Battle Creek fondly told me about excursions through the Kellogg plant in the 1950s and 1960s.

The technical miracle of extrusion

A food extruder (left). Many now like this one are made in China. Some of the shapes made in extrusion machines (right). These extrude human ultra-processed human and pet product ingredients

Americans today know far less about how their breakfasts are made than did our less educated ancestors living in far less techno-savvy times. In 1913, most Americans knew more or less what a gun-puffing machine was, thanks to Quaker. Today, almost nobody does. Mention automatic single-shot guns, automatic multiple-shot, and continuous guns, the types of gun-puffing machinery in use today, and people are likely to think you're planning a Civil War re-enactment, or a wildlife massacre, rather than referring to the production of Sugar Smacks or Cheerios.

Instead of touting their technological prowess, modern food product companies seek to suggest the pastoral origins of their products. Images of amber waves of wheat, lush fruit, and happy farm animals beckon from packages, and advertisements tout 'natural goodness.' On the relationship if any between the charming farm scenes depicted and the actual products themselves, manufacturers are usually silent.

Customers of Bear River Valley all-natural cereals, for instance, could easily assume that these products are produced in a careful operation in a tiny, stream-studded town in northern Utah called Bear River City, population 853. Packages feature images of mountains and rivers. On the website, a map shows the exact location of this bucolic outpost. Bear River City is a real town, after all. It's just that Bear Valley all-natural cereals aren't produced there. They're made eight miles north in

Tremonton in a colossal $US 100 million cereal plant owned by MOM Brands (formerly Malt-O-Meal). It's a site of production for most of the company's other cereals as well—brands like Apple Zings, Muffin Tops, Coco Roos, and Honey Buzzers.

After gun puffers came extrusion machines. These were invented in the 1930s and more widely adapted and used as a way to process cereal products as from the 1960s. This breakthrough made everything before it seem antediluvian. Extrusion machines take multiple ingredients, mix them together rapidly and form cereal and all the other ingredients into a potentially endless array of fun-filled shapes. They ushered in an era of breakfast shaped as multicolour diamonds, clovers, and letters of the alphabet, capturing the attention of children.

The real beauty of these machines, though, is that they slash costs. Instead of the seven hours it took to cook and process grains, the whole operation could be done one continuous, twenty-minute step. Today, raw materials zip through extruders in more like 15-60 seconds. This meant not only a higher output, but fewer machines, less square footage, and reduced energy usage, resulting in lower production costs and greater profitability. As an extra bonus, extruders kill bacteria.

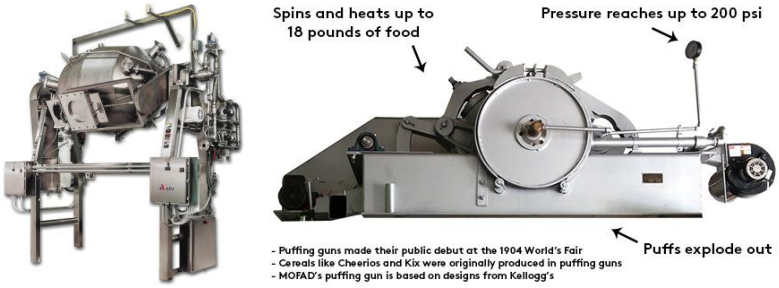
Some cereals, like MOM Brands Apple Zings and Honey Buzzers, and many lower-priced and store brands, are created almost entirely within the tubular confines of extrusion machines. The ingredients flow into one end, and crisp shapes emerge – extrude – from a die at the other. Other varieties are partially cooked into pellets in extruders and then further processed – either gun puffed (Cheerios, Froot Loops, and Cascadian Farms Fruitful O's) or flattened and toasted (some raisin brans).

Extrusion is the harshest and most nutritionally devastating way to process cereal. These are not gentle machines. They look a bit like oversized jackhammers turned on their sides. Inside the long, steel barrel, starch, sugar, and protein molecules are ripped apart by twisting screws that generate intense heat and pressure. Think of extrusion as a molecular melting pot. One food scientist likened starch molecules in an extruder to exploding water balloons. 'You swell the starch granule and then it breaks, spilling its guts into the solution it's in,' he told me. Such damage is quite intentional, since it's what allows ingredients to meld together quickly, forming a thick, homogenised mass. The process is referred to as 'plasticisation', which neatly sums up the nutritional gist of what happens inside an extruder.

According to a 2009 study done by Mian Riaz, a food science professor at Texas A&M and one of the country's leading extrusion experts, the nutrients most vulnerable to extrusion, which is also used for puffed snacks such as Cheetos and snack bars, are vitamins A, B1 (or thiamine), C, E, and folate, the natural form of folic acid. The loss of vitamin B1 is particularly unfortunate because cereal grains are one of our most important sources of this nutrient. The degree of damage varies

widely but can sometimes reach 100 percent. Naturally occurring fibre and phytochemicals such as the antioxidants present in oats, also fare poorly.

Creators of immortality



Modern steamers (left) and gun puffers (right) used to make breakfast cereals. Intense steaming, drying and toasting ensures that the products are much the same a year or more after manufacture

Beyond the extruder, steam cooking under pressure, drying, and toasting, which occurs at a fiery 525°F to 625°F, subject grains and other raw materials to much higher temperatures than anyone normally would at home. Home cooks generally don't need to evaporate every last drop of water from food in order to give it a long shelf life. Most commercial cereal has been dried so thoroughly that it is virtually immune to decomposition. This explains why the contents of the 6 year-old boxes sitting in my office look exactly the same as the day I bought them.

The assault on cereal nutrition doesn't end with processing. Surviving vitamins have to endure the box. Breakfast cereal can sit around for up to nine months before anyone buys it, and over time most vitamins naturally degrade and lose their potency. For insurance, manufacturers compensate by adding in synthetic vitamins at overages up to two and a half times what's listed on the package. In other words, if the label says you'll get 30 percent of the recommended daily allowance of vitamin C, there might have been 105 percent added, just to ensure that by the time you spoon the crunchy squares into your mouth, 30 percent is there. Minerals like iron, calcium, and zinc aren't delicate, so they don't need to be added in at such high levels.

All this nutrient loss is a collateral damage of high-output industrial production. So, too, with naturally occurring flavour. What little flavour develops in a sixty-second extrusion-cooking process tends to 'flash off,' along with the superhot moisture in the dough. And so, the only foolproof way to ensure that cereal doesn't taste like the box it's sold in, is to use more durable, manufactured flavourings. The same goes for colourings. Pellets and cereal bits sometimes emerge from extruders appearing gray or unappealingly dull, which accounts for the yellow #5 used in Kellogg's Smart Start cereal, even though the product doesn't look very yellow.

Box 1

Vitamins made in China

Every day at the kinetic Port of Melbourne, Australia, a container vessel the length of an average strip mall sets sail. Stacked high in its belly inside steel boxes are all sorts of things you'd expect to be exported out of Australia—natural materials like timber and pulp; agricultural commodities like barley and cotton; bottles of Australian wine; and that most enduring of Australian exports, sheep wool. Sailing steadily, the ship makes its way northward, skirting Australia's eastern coast, winding through the islands of Papua New Guinea, and charting a course into the open waters of the Pacific.

After two and a half weeks, it arrives within China's nautical borders and lands at the port of Shanghai. Until recently, most of what was shorn from the backs of Australia's 73 million sheep went to Europe and North America. Today most of it finds its way to China. Firms there buy between 70 per cent and 80 per cent of the wool Australia produces, up from less than 25 percent in 1999.

This is about more than the manufacture of sweaters. Much of the wool China buys is equally valued for the grease embedded in it as for the wool itself. Just as ducks secrete oil to make their feathers waterproof, sheep produce a similar fatty substance that helps protect them from harsh weather. Australia's wool is particularly greasy, and this grease—or various derivatives of it—is useful for making a whole slew of industrial and consumer products. Some portions go to produce lubricants for machinery and waterproofing for boats. Others, like lanolin, become lip gloss, moisturizer, and sunscreens.

And there's another end point for this grease—something hardly anyone would ever associate with wool. At a factory in Dongyang, a burgeoning industrial center on China's eastern coast, the grease's cholesterol component is used to make vitamin D. Zhejiang Garden Biochemical is the world's largest maker of this vitamin—one that goes into nearly all the milk Americans consume (including organic varieties), as well as many of our breakfast cereals, breads, margarine, bars, and other dairy products. And so it is that our milk doesn't come entirely from cows. For some small part of it, we're indebted to the greasy backs of Australia's sheep.

Synthesising vitamins

The initial means for accessing these vitamins was to get them from the foods in which they were found abundantly. D and A came from cod liver oil, C from oranges, B1 from rice, and B2 from liver. But in the 1930s, mostly in Europe, chemists figured out how to synthesise these compounds in laboratories, bypassing food sources entirely. Companies like Roche in Switzerland and the German chemical firm BASF established what would eventually become hundred-million-dollar vitamin manufacturing businesses. Not long after, food companies began experimenting with these newfangled health boosters. In 1938, Kellogg's Pep became one of the first breakfast cereals to be fortified with vitamins.

The new, high-tech additions also started showing up in hot dogs, puddings, and soda. In 1941, the Doughnut Corporation, which at the time had a near-monopoly on the sale of donuts in the United States (it would be another decade before the nation's first Dunkin Donuts opened its doors), ran an eye-catching ad campaign for 'Vitamin Donuts.' Fortified with ample amounts of Casimir Funk's thiamine and smaller amounts of B3 and iron, the donuts promised 'pep and vigor' to a wartime population.

For the most part, though, these initial forays into fortification were dry runs. As the Canadian food historian Harvey Levenstein writes in his book *Paradox of Plenty*, many manufacturers remained hesitant about fortification, fearing it would amount to an acknowledgment 'that their critics had been right, that processing often did deprive food of nutrients.'

When, at the urging of the US government, flour millers started adding the B vitamins and iron to white flour in 1941, it seemed exactly this sort of concession—a confirmation that white flour is a nutritional vacuum. For six decades, since the dawn of steel roller mills, milling companies had been casting off nearly all of wheat's nutrients to make fine, silken flour. No one could have proved it in the second half of the nineteenth century, but by the 1940s the subject of white flour's nutritional inferiority was no longer in dispute.

Synthetic vitamins are everywhere

Vitamins and minerals are now a celebrated addition to many food products. Companies need not declare why the nutrients are in there; often just the simple fact of their presence is enough. 'Marshmallow Pebbles is a wholesome, sweetened rice cereal,' Post declares on its website. 'It is low in fat, gluten free, cholesterol free, and provides 10 essential vitamins and minerals. It is also an 'Excellent Source of Vitamin D'!' Kraft's MilkBite Bars boast that they have 'the calcium of an 8 oz glass of milk,' without clarifying that some of the calcium comes from calcium phosphate and calcium caseinate, not entirely from the milk in the product, which makes an appearance on the ingredient list in the form of cream and skim milk.

As one glance at World War II Vitamin Donut posters tells you, this is an old trick but one more prevalent than ever. That the marketability of added nutrients is at an all-time high is evidenced by the fact that artificial sweeteners now contain them. Packets of Splenda Essentials have B1, B5, and B6 'to help support a healthy metabolism.' Vitamins and minerals are the only synthetic ingredients with carte blanche approval for inclusion in certified organic products, even when those vitamins and minerals are produced with genetically modified (GM) bacteria or have been synthesised from noxious petrochemicals. GM technology and toxic chemicals are otherwise banned from organics.

Vitamins and minerals form such ubiquitous background music in the supermarket that we no longer think about how they got there or whether they're actually the same thing as the food substances they were modelled on. Even people you'd assume would know something about how vitamins come to be aren't necessarily aware. At a conference called SupplySide West in Las Vegas, I asked the retired founder of a company selling specialised mixes of vitamins how his products are made. 'I don't know and I don't care,' he bellowed, cradling a late afternoon beer and seemingly not in the mood for serious questions.

Some months later, when I e-mailed Marius Cuming, media manager at Australian Wool Innovation, an organisation of the country's wool growers, to ask him about wool's path through China and into our vitamins, he responded that he was pretty sure wool didn't have anything to do with vitamin D. I forwarded him some information and he replied, 'The experienced wool scientists at AWI are certainly raising eyebrows. . . . I didn't know that D3 was manufactured from wool lanolin—what a great health claim!'

Marius Cuming understands intuitively: health claims are exactly what make vitamins a $US multi-billion worldwide business.

Enhancing the crunch

National Lampoon's Clark Griswold, played by Chevy Chase, in his food scientist role invents the breakfast cereal crunch enhancer varnish (all above). Real-life boffins are still working on this

In the movie *National Lampoon's Vegas Vacation*, Clark Griswold, Hollywood's only leading food scientist character, finances a week of temptation and misadventure in Sin City with a generous bonus he received from inventing the 'Crunch Enhancer.' A game-changing 'non-nutritive cereal varnish,' it ensures that flakes, squares, and Os won't ever get soggy. 'It's semi-permeable,' Clark tells a co-worker. 'It's not osmotic. What it does is coat and seal the flake, prevents the milk from penetrating it.'

Real food scientists would be envious of Clark. They have yet to arrive at any such foolproof solution for what they call 'short bowl life.' All but the most exceptionally fast eaters know that once in contact with milk or some other liquid, cereal soon dissolves into a pile of soggy mush. This is especially true for varieties that have gone through an extruder. The damaged starches simply fall apart, leaving behind a bowl of glop. Manufacturers do their best to lengthen the amount of time that can pass before this happens: they toast at high temperatures and spray the cereal with a fine coating of sugar to serve as a moisture barrier. But the ultimate 'crunch enhancer' remains elusive.

While the idea of soft, pre-digested food may sound like a good thing – the work of breaking it down has already been done for us! – this turns out not to be the case. The human gastrointestinal tract has spent many tens of thousands of years digesting crunchy, fibrous foods, and along the way it's come to appreciate the challenge. Depriving our stomachs of this function by giving them disassembled food products. appears profoundly to alter energy metabolism and the dynamics of hunger and satiety. When starches arrive in our stomachs already broken down, they enter our bloodstream rapidly, causing a spike in insulin and potentially fostering a dynamic that can lead to the condition known insulin resistance, a precursor of diabetes.

A little bit of starch damage is actually a good thing. Humans can't effectively digest uncooked grains. No one eats raw corn on the cob or gnaws on wheat kernels. Crushing, flour milling, and normal cooking, all start the breakdown process in a helpful way, allowing our bodies to access a grain's nutrients. But industrial processes

like extrusion and gun puffing are extreme; they dismantle foods to the point where there's not much left for our digestive systems to do.

Since 8 percent of the US population suffers from diabetes and 35 percent of us have some degree of metabolic syndrome, a sort of pre-diabetes, the issue isn't simply academic. It's thought there's a link between intensive food processing and weight gain, since one of the ways we burn calories is by the process of digestion. Anywhere between 5 and 15 percent of our daily energy expenditure comes simply from the act of eating. Ultra-processed products require considerably fewer calories to assimilate.

Ample research supports this notion, which runs counter to the theory that a calorie is just a calorie regardless of whether it comes from orange slices or a bottle of orange Gatorade.

Thus for 22 weeks, a team of Japanese researchers fed two groups of young rats a diet of rat chow that was nutritionally identical, except that one ration contained the standard hard-to-chew pellets and the other contained pellets that had been puffed up with air, making them softer and requiring about half as much force to chew. If all calories are equal, then both groups should have grown at roughly the same rate and to the same eventual size. But that didn't happen. The rats that consumed the airy pellets gained more weight than their brethren. The weight gain was gradual at first, but by the end of the experiment the rats eating soft pellets weighed about 6 per cent more and had 30 per cent more abdominal fat, enough to be classified as obese. The reason for this appeared to be that the soft pellets induced lower post-meal metabolic rates and diminished levels of thermogenesis, the production of heat by our bodies.

A California study that evaluated human responses to a 'whole' meal versus a 'processed' meal, yielded similar findings. Eighteen people were given two different meals consisting of the same number of calories on different days. The 'whole' meal was made up from cheddar cheese; '100 percent natural' multigrain bread made with stone-ground whole-wheat flour (which is generally coarser); and sunflower seeds, oats, barley, corn, and millet. The 'processed' meal was white bread and slices of ultra-processed cheese-type product. Although the participants said they found both meals equally satiating, their metabolic rates after the two meals were quite different: almost 50 percent higher for the whole-food meal. If you extrapolate that over many meals and many months, it's not hard to see how losing as much as half of that 5 to 15 per cent digestion-related calorie burning could lead to slow, creeping weight gain, the sort you don't even realise is happening because it is related entirely to the kind of food you eat, not the quantity.

So how do you find out how much, if any, of your cereal's vitamins come from Mother Nature? Good luck. The nutrition label on the side panel will be of no help; labeling rules don't require manufacturers to distinguish the source of the nutrient. All you can do is wonder.

Empty calories, or better than donuts

In the 1960s Robert Choate (left) led the attack on sweetened breakfast cereals aimed at children as being largely empty calories. In the 2000s Eileen Kennedy (right) resurrected the 'donut defence'

This is exactly what Robert Choate (1924-2009) did. Before nutrition information of any sort was required on packaging, Choate, a senior staff member in the Nixon White House, rang the alarm about the deluge of nutritionally suspect, sweetened cereals that had flooded the market during the previous fifteen years, thanks to new technology for sugar coating.

In the 1950s, General Mills introduced Jets, Frosty Os, and Cocoa Puffs; Kellogg's came out with Corn Pops, Frosted Flakes, Sugar Smacks, and Cocoa Krispies, following it up in the 1960s with Froot Loops, Apple Jacks, and Frosted Sugar Stars. 'Watch the TV commercials on Saturday morning and get really mad,' Choate said in 1970. 'The industry brainwashes children into demanding the least worthwhile products . . . Nutrition doesn't snap crackle, or pop.'

Handsome, with a deep voice and dark mane of slicked hair, Choate was born into a blueblood New England family (a relative founded the Choate Rosemary Hall prep school in Connecticut). He attended Phillips Exeter Academy in New Hampshire and served in the Navy during World War II. Following that, he earned a civil engineering degree from the University of California at Berkeley and started a construction business in Phoenix, earning a small fortune in real estate and adding to the windfall he'd inherited from his father, a successful Boston newspaper publisher.

His life took an unexpected turn when he contracted hepatitis in the late 1950s and spent a year recovering from it. While bedridden, he read the autobiography of Walter White, an early leader of the National Association for the Advancement of Colored People (NAACP) who had African ancestry but looked Caucasian, with blond hair and blue eyes. This and other books about racial justice inspired Choate to re-evaluate his life. He decided to pursue a new career working to alleviate poverty. As part of that, he initiated a national study on malnutrition, which sparked his interest in food and helped land him in the Nixon White House.

Taking note of the central position that boxed cereal had assumed at the American breakfast table, Choate hired a laboratory to calculate the amounts of nine important nutrients contained in sixty different breakfast cereals. On 23 July 1970, he presented his findings to the Senate Commerce Committee chaired by Senator Frank Moss of Utah. The results were not encouraging for cereal companies: On a scale from 0 to 700, with 700 being the most nutritious, two-thirds of the tested products ranked below 100, including popular varieties such as Corn Flakes, Rice Krispies, Sugar Frosted Flakes, Cheerios, Wheaties, and Shredded Wheat. Many cereals, Choate told the committee, 'fatten but do little to prevent malnutrition.' They were, he said, 'empty calories.'

His testimony was widely reported in the media. Cereal makers were both embarrassed and enraged, but they lacked solid counter-arguments with which to defend themselves. Kellogg's led a personal attack on his credentials but never disputed the specifics of his findings. 'Civil engineer Choate's theories and so-called formula might be meaningful for digging a mine shaft,' the company's director of research told the Associated Press. 'But they are completely valueless as a yardstick for measuring the nutritional value of any type of food.' Other companies charged that he had failed to take into account the nutrients from milk, cereal's trusted partner. Choate had also neglected to compare the nutritional value of cereal, they said, with other breakfast foods, such as donuts.

This marked the first use of the better-than-a-donut defence, though it wouldn't be the last. The argument surfaced four decades later in a doomed attempt to explain why Froot Loops is a healthy product. In 2009, the food industry created a nutrition ratings programme called Smart Choices that was to give 'better-for-you' products a green check mark on their packages. Froot Loops and Apple Jacks, it turned out, were among those products. In an interview with the *New York Times*, Eileen Kennedy, then the dean of Tufts University's nutrition school and head of the Smart Choices board, offered up this explanation: 'You're rushing around [at the supermarket], you're trying to think about healthy eating for your kids and you have a choice between a donut and a cereal. So Froot Loops is a better choice.' Several months later, the programme, having made some more un-smart choices, was history. The food industry quietly walked away from it.

General Foods, the maker of Post cereals, took a different tack in its response to Choate's 1970 Senate assault. The company disagreed with the notion that its sweetened cereals like Honeycomb, Crispy Critters, and Super Sugar Crisp, now named Golden Crisp, would lead to excess sugar consumption among children. 'In our opinion, exactly the opposite is true,' the company said at the time. 'Pre-sweetened cereals provide a measure of control over sugar intake that is not present when the young consumer sweetens his own.'

General Foods's intimation that children might dump the entire contents of a sugar bowl into their morning meals failed to gain much traction in the public imagination.

Choate's testimony, on the other hand, stirred outrage, and cereal manufacturers felt compelled to take action. They did this by adding vitamins and minerals to their formulas. Some cereals already included some, so manufacturers added more; others had none and welcomed fortification for the first time. The breakfast cereal aisle was transformed into the most heavily fortified real estate in the supermarket. Two years later, more than half of the forty cereals Choate had execrated had been fortified and returned to the shelves as new and improved.

But Choate wasn't finished. He hired two leading nutrition professors, one at the University of Nebraska and the other at the University of Georgia, to conduct a series of cereal feeding tests with juvenile rats. There was more bad news for cereal companies. Rats on a diet of all but 6 of 40 cereals showed little or no growth, even when their food was supplemented with a separate vitamin and mineral mixture. Armed with these latest results, Choate returned to the Senate for another newsworthy appearance. At one point he poured the heaping amount of sugar contained in a box of Post Pebbles onto a table. He railed against prioritising profits over the nation's health. 'The temptation of the dollar is greater than the will to nourish the population,' he warned.

A few years later, *Consumer Reports* sought to replicate Choate's tests, putting groups of rats on 44 brands of cereal, most of them fortified, for at least twelve weeks. The magazine reported that half the cereals proved nutritionally 'deficient' in the experiments and the other half were 'adequate,' although rats eating some of this latter category still displayed minor symptoms of nutritional deficiency, such as graying or browning of the hair and nervousness.

The authors acknowledged that it might seem strange to readers that a cereal like Product 19, which was fortified with 100 percent of the RDA for vitamins and minerals, appeared at the bottom of the rankings. But human and rat bodies require a complex web of nutrients beyond what had been added, they explained. The magazine referred to this web of then-unknown substances as 'intrinsic factors.' Scientists today identify these as for example carotenoids, flavonols, and polyphenols, members of an enormous universe of beneficial plant chemicals, the likes of which companies are still trying to figure out how to incorporate into their products.

No one has since done these sorts of comprehensive feeding tests on breakfast cereal, or any other processed food for that matter. So we don't know how cereals would fare today. To some degree, nutrition in the category has improved since the s1970s. Many cereals still list sugar as a primary ingredient, but there tends to be less of it per serving than there was three decades ago. All of General Mills kids' cereals (Cookie Crisp, Trix, Boo Berry, and so on and on) now contain no more than 10 grams of sugar per serving and include some amount of whole grains, mirroring a broader industry effort to replace some of the stripped-down wheat and corn with more intact varieties. But whole grains are useful only if the good stuff in them, such

as the vitamins, minerals, phytochemicals, and fibre, survives both processing and shelf life, and figuring out to what extent that has happened isn't easy.

When I inquired, Kellogg's, General Mills, and Quaker (owned by Pepsi-Co) said they weren't interested in discussing the subject. However, Post Foods, the nation's third-largest cereal company, was willing to provide a chart showing the levels of naturally occurring B vitamins, those most abundant in wheat, in its Great Grains cereal. What it showed, not surprisingly, is that most of the vitamins you get by eating this cereal come from what's been added. According to the box, one serving of Great Grains gives you between 25 and 35 percent of the RDA for thiamine (B1), riboflavin (B2), niacin (B3), B6, and folic acid. Without synthetic additions, the numbers would be much lower – 10 percent, 2 percent, 8 percent, 4 percent, and zero, respectively. And these levels represent what you'll get from a freshly made cereal, not one that's been hanging around for six months.

The case for and against

Some of the hundreds of varieties of breakfast cereal aimed at US children. Manufacturers now plan to penetrate countries throughout the global South whose children now eat traditional breakfast food

For most commercial cereals, this may be as good as it gets. If you can get beyond its relatively high sugar content, Great Grains stands out as one of the healthier offerings on the market, having been recently reformulated into, as Post puts it, 'less processed nutrition you can see.' Mark Izzo, Post's director of research and development, explained to me how the company now uses whole, intact wheat berries to make its flakes, not just an amalgamation of various forms of ground-up flour. 'We get the wheat kernels in via rail car and then we batch-cook them with a

gentle steaming process, no different than what you could do at home with a pressure cooker. Then we roll them and bake them,' he said. No extrusion and no gun puffing (both of which the company still uses for many of its other products, like Honeycomb and Alpha-Bits). The result is large quantities of whole grains – 32 to 40 grams per serving, depending on the variety, and a lot more than in Cheerios (14 grams), Kellogg's Raisin Bran (15 grams), and Special K (9 grams). Great Grains still contains the chemical preservative BHT. 'We have very active programmes working on replacing that,' assured Izzo.

Post learned the value of cereals made from gently processed whole grains several years ago when it did testing to see if there were naturally occurring antioxidants in its products. The cereals registering significant levels were those getting an antioxidant boost from raisins (which, of course, aren't cereal) and those that were minimally processed, at least relatively speaking – Shredded Wheat and Grape Nuts. Post did this testing in 2009, before the re-launch of Great Grains, so that brand wasn't tested.

Yet still, much like Great Grains, Shredded Wheat and Grape Nuts – products at the cereal aisle's nutritional pinnacle – offer far fewer intrinsic vitamins that what you'd find in an equivalent amount of whole-wheat flour. It's hardly a ringing endorsement for a category often touted as a bastion of wholesome and nutritious choices.

Dairy industry people are generally big fans of breakfast cereal; it helps boost milk consumption. During a presentation at IFT 12, held in Las Vegas, Nancy Auestad, a vice president at the Dairy Research Institute, highlighted ready-to-consume breakfast cereal (once milk is added) as a 'critically important source of nutrients for the American population.' And in a sense, she is right.

Conclusion

What I have learned during the years of researching and writing my book *Pandora's Lunchbox*, now available in paperback, and since first publication too, is that what people in the US and many other countries now eat, would be completely baffling to a person living a century ago.

The food industry has successfully encouraged people to stop doing their own cooking, to snack constantly throughout the day, to have meals inside a car, and to consume a steady supply of food products that bear little resemblance to things grown or raised on a farm. In all fairness, too, the ways of life especially of people living in higher-income industrialised countries have changed dramatically over the past century, now commonly with two-wage households and a round-the-clock workday, making processed products responsive to a felt need for convenience.

As a culture, we in the US and people in other countries too, have come to a point where we blindly entrust transnational corporations with one of our most intimate and important acts as human beings – that of nourishing ourselves and our children. We eat what Kraft, Tyson and Taco Bell decide to put on the menu without ever thinking about where all this food came from and what's really in it. The Big Food giants aren't evil, but they have to care about sales and profits. Health is not their business. Our physical and emotional well-being matters, and we should not be so willing to outsource our diets to them.

As well as this, though, it's best not to get too strident about all this. Processed food products can have their role in our lives, and there's nothing wrong with occasional junk food indulgences, though it's best to steer clear of products that are designed to be intensely palatable and some would say addictive. Food is meant to be enjoyed. My hope is that we move toward a place where more and more populations, communities, families and people retain or regain the profound pleasures of acquiring, preparing, cooking and enjoying fresh, healthy food.

Status

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