THE BITTERSWEET HISTORY OF SUGAR

From a rare treat to the crop that changed the modern world

Sugarcane plantation in Thailand —Photoongraphy/Shutterstock

Queen Elizabeth I (1538–1603) reigned from 1558 until 1603 and was the most influential trend-setter of her era. She is a pivotal figure in European history, a shrewd and pragmatic monarch who bridged the transition between the medieval and modern world, setting England on a path to global prominence. In later centuries, the Elizabethan period would be recalled as a sort of golden age, with the fluorescence of literature (Shakespeare and Spenser wrote in her time) and the emergence of the modern British nation.

Queen Elizabeth had famously decayed and blackened teeth, the result of her equally famous love for sugar in all its forms. Wherever she went, she was lavished with ostentatious displays of sugar sculpted into every form, all edible. In her time, the Queen dominated the social and political worlds of Europe. Paul Hentzner (1558–1623), a German emissary, described her as stately, commanding, and consummately refined. In the winter of 1598, she greeted a group of continental dignitaries: "As she went along in all this state and magnificence, she spoke very graciously, first to one, then to another, whether foreign Ministers, or those who attended for different reasons, in English, French, and Italian; for, besides being well skilled in Greek, Latin, and the languages I have mentioned, she is mistress of Spanish, Scotch, and Dutch." Hentzner describes her as "very majestic; her face oblong, fair, but wrinkled; her eyes small, yet black and pleasant; her nose a little hooked; her lips narrow, and her teeth black (a defect the English seem subject to, from their too great use of sugar)."

Blackened or missing teeth are hardly a look we associate with great wealth and power today, but in her era, sugar was a rare and precious luxury item, and dental medicine nonexistent, so many in the upper classes had similar teeth. Lesser folk reportedly blackened their teeth with pitch and charcoal to achieve this affluent look. It was not long after Elizabeth I's time that sugar became accessible to all socioeconomic classes in Britain, and the Queen's bad teeth became much more commonplace.

SUGARCANE was domesticated in the highlands of Papua New Guinea beginning about 10,000 years ago. The plant's sweet properties were known to scholars and herbalists across Asia and the Mediterranean for thousands of years. Believed to have magical properties, especially in enticing lovers, it figures in the myths and histories of New Guinea, Austronesia, south Asia, and the Middle East. In the *Atharva Veda*, one of the oldest of the Sanskrit *vedas*, or records of priestly knowledge from around 1000 BCE, the author mentions sugar as instrumental in a young man's courting of a woman: He sang, "This plant is born of honey, with honey do we dig for thee . . . May she long for me alone, like a bee for a branch full of honey! I have surrounded thee with a clinging sugarcane, to make you long for me!" In northern India sugarcane stalks hold up the wedding canopy to

symbolize sweetness, fertility, and long life for the wedding couple.

During Alexander the Great (356–323 BCE)'s conquests in southwest Asia, his people came into contact with this rare delicacy and news of it made its way back to the Mediterranean. The Greek philosopher/botanist, Theophrastus (ca. 371–ca. 287 BCE), described, "a kind of reed in India that brings forth honey without bees; it solidifies, and is like gum, and the people use it instead of honey." Other classical scholars mention it, and in Pliny the Elder (23–79 CE)'s *Natural History* he says, "Arabia, too, produces sugar, but that of India is the most esteemed. This substance is a kind of honey, which collects in reeds, white, like gum, and brittle to the teeth. The larger pieces are about the size of a filbert [less than an inch]; it is only employed, however, in medicine." Similarly, sugar from sugarcane shows up in listings of medicinal plants in China from about the same time, called by one early source, "sweet bamboo." The Indian methods for extracting sugar from cane were learned by Persian and Arabic producers and brought along with the Islamic expansion of the seventh and eighth centuries. Muslim entrepreneurs grew sugarcane on Sicily and in al-Andalus in the 800s CE, and from there it became known in Europe. Our word sugar comes from the Sanskrit word *śárkarā* by way of the Arabic word *sukkar*. Other words came into European speech along with "sugar," such as "candy," from the Arabic *qandi*.

Although crystalline sugar from sugarcane was known far back into antiquity, it was not until the last few hundred years that sugar changed the world. Until 1500 CE, only a few of the richest people had ever tasted refined sugar. After that date, a combination of several factors led to sugar transforming human society. Today, sugar is the largest crop on Earth, with growers producing 1.9 billion metric tons per year. That works out to about 50 lbs. of refined sugar a year for every person in the world (this figure includes beet sugar and high-fructose corn syrup). People in some parts of the world consume less sugar but in the United States people consume about 80 lbs. of sugar each. (It is also notable that about 85 percent of Americans surveyed were trying to reduce their sugar intake.)

A portrait of Queen Elizabeth I painted to commemorate the defeat of the Spanish Armada in 1588. —public domain/Wikipedia

WHAT HAPPENED TO TAKE sugar from being a rare medicine and expensive delicacy to being the crop that changed the global economy? The answer lies in the confluence of several historic trends, all involving new ways to deal with the great difficulties of making sugar. First, sugarcane is a demanding crop, very difficult to grow in northern latitudes. It requires rich soils with lots of nitrogen, potassium, and phosphorus, and every year's crop sucks up these micronutrients. Second, it takes a lot of water to grow, about 60–100 inches of rainfall per year. It can only be grown in a few spots on the southern fringes of Europe, and then only with irrigation. Third, it is very difficult to turn fields of cane into crystalized sugar. It requires squeezing the sweet liquid from its fibrous stalks, boiling it to concentrate its flavors, and then allowing it to cool and crystalize. It requires a lot of cane to produce sugar—about 12-14 tons of sugarcane per ton of crystalized sugar using preindustrial technologies. The fresh cane is heavy, and the equipment to process it is even heavier, so the fields and processing plants have to be close to each other. And the labor requirements for the process are enormous. Making sugar for a European market involved finding solutions to these problems, and doing so changed the world.

Europe's colonial expansion brought ways around these difficulties. After the successful trips around the southern tip of Africa into the Indian Ocean in 1488 and the Columbian voyages to the Americas beginning in 1492, Europeans came to know a great deal more about the tropical parts of the world. Columbus himself had seen sugar production being practiced in the Madeira and Cape Verde Islands by the Portuguese. It had started in the early 1400s, following

The sweet side of sugar: a joyful toddler with her birthday cake —stockcake.com/i/joyful-cake-mess_1184827_844378

Arabic practices. In his second voyage, Columbus took cuttings of sugarcane to plant in what is now northern Haiti. An account by contemporary colonist and historian, Gonzalo Fernández de Oviedo y Valdés (1478–1557), reads: "The Admiral first caused canes to be planted which were brought from the Canaries, and they grew as well here as in their native soil." In Africa, sugarcane was either already known or adopted by local people as part of their normal suite of domesticates, and in India sugar was already being produced, so the Europeans just bought it there for export European markets.

What it took for sugar to become much more common as a commodity was a labor force. First, this was made up of enslaved indigenous Americans and soon after, enslaved Africans. It also required more complex industrial equipment than had been used with sugarcane to this point. Wind and water mills were adapted to turn massive millstones to press the juice from the cane. Ultimately, it became more profitable to ship heavy iron processing equipment to the places where sugar was grown to process it there. Industrial complexes were built all over sugar-producing areas in the Caribbean and Brazil. This demand helped fuel the industrial revolution in the 1700s, and by the late 1700s steam power was used to drive heavier rollers, capable of extracting more juice from cane.

The human cost of slavery could hardly be more horrifying. People were enslaved and taken from Africa to the Americas for over 300 years, with millions of people dying enslaved on plantations. The Trans-Atlantic Slave Trade Database documents that about 12.5 million people were kidnapped and shipped across the Atlantic, most bound for Brazil and the Caribbean. The environmental toll was also shocking, as whole islands and large areas of the mainland were stripped of native plants and animals to be planted with a single species. This practice exhausted the soil of nutrients and caused massive erosion. On the islands, sediments from the land flowed out to sea and choked the reefs.

Another world-changing impact of industrial-scale sugar production was in finance. Establishing plantations, building processing facilities, and equipping an endless stream of trans-Atlantic cargo ships required enormous amounts of money, and it was needed at the beginning of any venture, long before any profits could be realized. Loans of large amounts of capital were needed. Each of these undertakings, moreover, was at risk of complete failure at the hands of pirates, hurricanes, foreign governments, incompetent crews, and a hundred other contingencies. Few were rich enough to fund such ventures themselves, so collectives were formed, each sharing in the investment and proportionally in the profits. Even then, they required insurance. In the 1680s, businessmen got together at Edward Lloyds' coffee shop in London and developed financial instruments to raise the capital needed for sugar ventures, and to underwrite them to manage the financial risk. Financial protections akin to insurance had historical precedents going back to ancient Babylon but were never used at the scale and frequency as they were in the sugar trade.

Sugar imports to England went from almost nothing in 1600 to 21,000 tons in 1700, to over 150,000 tons in 1800. Similarly, the amount of total credit extended went from under a million pounds sterling in 1600 to 12 million in 1700, to 60 million in 1770. This environment of ample credit brought about an evolution in London's financial institutions, which soon

The bitter side of sugar: Environmental conditions on Dominica made large-scale sugar production a short-lived venture, leaving behind abandoned prime farm land, ruined infrastructure, such as this sugar mill, and enslaved people. —Janos/AdobeStockImage

went to work supporting the capital needs of the industrial revolution of the later 1700s and after.

THERE IS LITTLE DOUBT that sugar has its appeal, but even so the size of the economic engine it set in motion is remarkable. Part of the reason for our demand for sugar relates to the way it interacts with our brains. When we have a dose of sugar, say a small candy bar, the refined carbohydrates in its sugar are converted to glucose and quickly absorbed into the bloodstream. Our blood glucose level rises over the course of the next hour. We immediately experience a surge of dopamine, signaling pleasure and a sort of "feel good" response that reinforces the behavior that produced it. (Some recreational drugs produce the same effect, though stronger: Nicotine and alcohol trigger roughly twice the dopamine release that sugar does, and cocaine or methamphetamines even more.) With our brains full of glucose, its main fuel, we perform cognitive tasks more quickly. But the spike in glucose triggers the pancreas to release insulin, a hormone that begins shuttling those glucose molecules into cells for use or storage. This causes a sharp drop in blood glucose levels—the "sugar crash" we sometimes feel about an hour after eating the sweet. Glucose levels in the brain drop and we feel "brain fog," a measurable drop in cognitive function. The drop is often accompanied with mood swings and feelings of irritability, anxiety, or lethargy. Anyone who has taken small children to a birthday party would be able to spot the moment when the sugar crash hits.

With time, the amount of sugar required to produce the same dopamine response increases. This occurs with all chemicals that trigger dopamine responses: the dopamine system "downregulates" and releases less dopamine each time. In this sense, sugar is addictive in the same way that heroin is—we like it because it causes a release of dopamine, but it requires a bigger hit each time to have the same response.

Only in the last few centuries have we seen a big impact of sugar on our health. Very wealthy people in India, China, or the Mediterranean could have tasted sugar, but it was not until 1600, or so, that common folk had access to it. The appearance of widely available sugar shows up conspicuously in the archaeological record because of a surge of dental caries, or cavities, that it produced. For pre-agricultural hunter-gatherer populations, tooth decay was very rare, with typically less than 5 percent of individuals experiencing it.

Agricultural populations whose diets relied heavily on starchy grains, such as wheat, rice, or corn, experienced higher rates of tooth decay. This occurred because the complex carbohydrates (polysaccharides) in grains are broken down into simpler sugars, which can adhere to the surface and crevices of teeth. These sugars feed oral bacteria that produce acids, which in turn erode enamel and cause cavities. Grains also stimulate the mouth to produce a kind of saliva that begins to break them down, but also promotes fermentation in the mouth. Not only were hunter-gatherers healthier than agriculturalists, with better teeth, but they likely had better breath as well. With agriculture, the incidence of cavities increases to about 30–50 percent of the population. When refined sugar is available around 90 percent of the population experiences some tooth decay. As Queen Elizabeth's sugar-blackened teeth showed, sugar came with consequences.

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