

# Cocoa Butter & Synthetic Biology

## A Case Study

**PRODUCT:** Cocoa butter, the main ingredient in chocolate, comes from cocoa beans grown by smallholder farmers in 30 tropical countries. “Cocoa butter equivalents” are composed of vegetable fats derived from a variety of plant sources.

**STATUS:** Solazyme, a California-based synthetic biology\* company, is engineering oil-producing algae that are fueled by sugar feedstocks in giant fermentation tanks. In 2012, the company announced that it has developed a new high-value “tailored oil” with a fatty acid composition very similar to cocoa butter.<sup>1</sup> The company is developing the cocoa butter substitute for use in food and personal care (e.g. cosmetics, lotions) products.<sup>2</sup>

**AFFECTED COUNTRY/REGION:** Between five and six million smallholder farmers grow cocoa. West Africa accounts for over 71% of all cocoa bean production;<sup>3</sup> the world’s top 3 cocoa bean producers—Côte d’Ivoire, Ghana and Indonesia—account for over two-thirds (68.6%) of all cocoa bean production.

**MARKET:** The value of the worldwide cocoa butter market is about US\$6 billion.<sup>4</sup> The current market for *cocoa butter equivalents* is an estimated \$US600 million per annum.<sup>5</sup>

**COMMERCIALIZATION:** Not known. After agreeing to provide information via telephone interview, Solazyme abruptly declined to answer further questions about its work on the development of a cocoa butter-like engineered oil and directed us to the company’s website.<sup>6</sup>

*“Step  
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Cacao farmer in Costa Rica photo: Everjean

### Introduction

In late 2012, the CEO of California-based Solazyme announced that his company had developed a new high-value “tailored oil” with a fatty acid composition very similar to cocoa butter.<sup>10</sup> According to Solazyme: “We’ve also developed another first of its kind capability, the ability to control the specific position of specific fatty acids in the oil. Positioning the fatty acids plays a major role in creating the physical properties of cocoa butter like its sharp melting curve. The same melting properties of cocoa butter are ideally suited for a range of personal care products such as lotions, emollients and moisturizers.”<sup>11</sup>

In response, one Internet pundit brashly trumpeted, “Step aside cocoa farm, synthetic biology is on its way... It isn’t unrealistic to think that the company would eventually become a major supplier of sustainable cocoa

\*Note: With growing public awareness and concern about the use of synthetic biology to create synthetic food flavors/ fragrances/ingredients, the synthetic biology industry is in the midst of a strategic “makeover” and is seeking to distance itself from the “synthetic biology” label. Although Solazyme now insists that it is not a synthetic biology company, it is widely identified as a synthetic biology company and has previously self-identified as such in the past. The company uses techniques such as “directed evolution”<sup>7</sup> and “metabolic engineering”<sup>8</sup> that are generally recognized as synthetic biology. Solazyme’s filings with the US Securities & Exchange Commission refer to ‘targeted recombinant technology.’ A spokesperson for Solazyme confirms that the company is using the same technologies that it used previously when it described itself as ‘synthetic biology’ company.<sup>9</sup>

butter alternatives.”<sup>12</sup> Another observer speculated that Solazyme’s technology will enable the “de-regionalization” of cocoa butter production and thus eliminate constraints associated with the sourcing of natural cocoa beans from tropical countries: volatile prices, unpredictable supplies, long-distance shipping, possible geopolitical instability or variables associated with weather and crop pests.<sup>13</sup>

Founded in 2003, California-based Solazyme is a publicly-traded company that specializes in the development of engineered microalgae for the production of “tailored” oils for use in chemicals, foods, fuels and personal care/health products. The company boasts that its ability to tweak the molecular composition of oil-producing algae enables them to “go beyond anything that natural plant oils can do, with huge productivity and great yields.”<sup>14</sup>

Solazyme focuses on strains of single-cell microalgae that naturally produce oil. The company’s goal is to manipulate the cellular machinery of microalgae to produce specific kinds of lipids<sup>15</sup> (fatty acids) on demand, and to ramp up yields of the oil-bearing organism by feeding it sugar feedstocks (from corn or sugarcane) in industrial fermentation tanks. The company claims that it has successfully engineered microalgae to mimic the lipid (fatty acid) profile of naturally occurring oils such as cocoa butter.

Solazyme’s financial outlook appears shaky – the company is more than \$300 million in debt and has few product revenues to date. However the company has achieved commercial-scale production of several tailored oil products, and is partnering with high-profile, heavyweight corporations, including Unilever, Bunge, Dow, Archer Daniels Midland (ADM), Mitsui & Co and AkzoNobel, among others. Solazyme holds 20 issued US patents, six issued foreign patents and over 175 pending patent applications filed in the US and other jurisdictions.<sup>16</sup> In January 2014, Solazyme announced that it is producing commercial supplies of tailored oils at ADM’s facility in Clinton, Iowa and another facility operated by American Natural Products in Galva, Iowa.<sup>17</sup> In March 2014,

Solazyme launched a new product line: “Encapso,” an encapsulated lubricant for oil drilling and hydraulic fracturing (fracking).<sup>18</sup> In May 2014 Unilever announced that it is using Solazyme’s “Algal Oils” in the production of Lux brand soap.<sup>19</sup> Since 2011, Solazyme has sold microalgae-derived ingredients for the company’s commercial skin care products known as “Algenist.” Solazyme has a joint venture with agribusiness giant Bunge to build and operate a commercial-scale tailored oils production facility next to Bunge’s Moema sugarcane mill in Brazil.

### Background: Cocoa Production

Some 5-6 million farmers grow cocoa in hot, rainy and tropical areas of Africa, Asia and Latin America across a narrow belt within 10-20 degrees latitude of the Equator. An estimated 40-50 million people depend on cocoa for their livelihood.<sup>20</sup>

Cocoa is grown by farmers in more than 30 tropical countries.<sup>21</sup> **Smallholder farmers account for 80-90% of world cocoa production.** In Africa and Asia, a typical cocoa farm covers 2-4 hectares (4.9 -12.3 acres).<sup>22</sup>

- West Africa accounts for over 71% of all cocoa bean production worldwide.<sup>23</sup>
- The world’s top 3 cocoa bean producing countries, Côte d’Ivoire, Ghana and Indonesia accounted for over two-thirds (68.6%) of all cocoa bean production in 2012/13.<sup>24</sup>
- The top 5 cocoa producing countries accounted for 80% of the world supply:

### Leading Cocoa Bean Producer Countries

(based on 2012/13 estimates)

Country	Thousands of Tonnes	% Share of World Market (estimate)
Côte d’Ivoire	1449	36.7%
Ghana	835	21.2%
Indonesia	420	10.6%
Cameroon	225	5.7%
Nigeria	225	5.7%
<b>Top 5</b>	3154	80%
<b>Total World</b>	3942	100%

Source: International Cocoa Organization (ICCO)

The International Cocoa Organization (ICCO) forecasts that in 2013/14, West African producers will account for 72% of global cocoa bean production, followed by cocoa farmers in the Americas (16%) and Asia and Oceania (12%).

Like most tropical agricultural export commodities, cocoa is subject to boom and bust cycles. For example, cocoa prices plunged to a 27-year low of \$714 per tonne in November 2000, and soared to a 32-year high of \$3,775 per tonne in March 2011.<sup>25</sup> (With demand for cocoa currently exceeding supply, cocoa prices are rising. In March 2014 cocoa prices reached US\$3,031 per tonne in New York and £1,896 per tonne in London). Volatility in cocoa prices is due to many factors, including: extreme weather and climate change, pests and disease, political instability in producing countries and corporate concentration in the cocoa value chain.

### Cocoa Market Concentration

The huge number of farm families in the tropics who make their living growing cocoa stands in stark contrast to the increasingly consolidated control of industrial cocoa bean buyers and traders. The corporations that control the cocoa market are among the most powerful agro-industrial commodity trading firms in the world. **Today, just three global cocoa bean traders/processors** (Barry Callebaut – 26%; Cargill – 21%; ADM – 17%), **account for an estimated 64% of the world’s cocoa grindings.** (Based on global production of about 4.4 million tonnes.)<sup>26</sup>

In late 2013, Cargill was on the verge of acquiring ADM’s global cocoa & chocolate operations<sup>27</sup>, a deal that would have allowed just two firms to dominate the global market. The cocoa merger talks melted, however, and in April 2014 ADM announced that it would retain its cocoa buying/processing operations and sell its chocolate business.<sup>28</sup> However, ADM’s current partnership with Solazyme does not involve cocoa or cocoa butter equivalents.



Cocoa beans. *photo: Everjean*

Chocolate is big business, but small farmers who grow the main ingredient (cocoa) earn a tiny share of the estimated US\$125 billion spent per annum on chocolate products. According to Fairtrade Foundation, despite rising cocoa prices, in 2010 West African growers received just 3.5% to 6% of the average retail value of a chocolate bar compared to 18% in the 1980s.<sup>29</sup> By contrast, the manufacturers’ share shot up from 56% to 70% and the retailers’ from 12% to 17% over the same period.<sup>30</sup>

The global appetite for chocolate is huge, and the demand for cocoa butter (the main ingredient in chocolate) is growing, particularly in Asia. The vast majority of cocoa butter is used for confectionary (i.e. food) and drink products. The proportion of cocoa butter that is used for *non-edible* uses (i.e. personal care products such as cosmetics, lotions) is very small: only 1-2% of total production, and it depends largely on the price of cocoa butter.<sup>31</sup>

- The value of the world-wide cocoa butter market is about US\$6 billion.<sup>32</sup>
- The amount spent world-wide on retail purchases of chocolate products is in the neighborhood of US\$125 billion.<sup>33</sup>
- The current market for cocoa butter equivalents is an estimated \$US600 million per annum.

### Is there a market for a cocoa-butter-equivalent derived from engineered algae?

Solazyme’s quest to develop a cocoa-butter-like engineered algal oil will face steep competition from an established industry that already produces cocoa butter alternatives. The current market for **Cocoa Butter Equivalents (CBE)**<sup>34</sup> is in the neighborhood of US\$600 million per annum; the CBE market

varies from year to year depending on the price of cocoa butter, sometimes by 30% or more.<sup>35</sup> In the EU, for example, CBEs are sourced from cheaper plant-derived vegetable fats, including: illipé (*Shorea* spp.), palm oil (*Elaeis guineensis*, *Elaeis olifera*), sal (*Shorea robusta*), shea (*Butyrospermum parkii*), kokum gurgi (*Garcinia indica*), and mango kernel (*Mangifera indica*). The composition and price of CBEs depends on the supply of many different plant-based oils.<sup>36</sup>

The CBE market is used to “stretch” the cocoa butter supply – or to provide a cheaper raw material for lower-quality chocolate or chocolate-like products. Most countries have regulations governing the definition of cocoa/chocolate products and the minimum percentage of cocoa butter that must be used. In the EU, for example, a product can’t be called “chocolate” if the end product is made up of more than 5% vegetable fats other than cocoa butter; the labeling of chocolate products containing vegetable fats other than cocoa butter must bear the statement “contains vegetable fat in addition to cocoa butter.”<sup>37</sup>

## Conclusion

The potential of a biosynthesized cocoa butter alternative derived from modified algae does not currently threaten the livelihoods of smallholder farmers who grow naturally-sourced cocoa beans. However, if Solazyme is able to achieve low-cost, high-yielding customized oils and fats, the company could displace or disrupt markets for some tropical oils (such as coconut oil, palm oil, palm kernel oil, shea butter) that are typically used in cocoa butter equivalents.

Even if Solazyme is able to scale up production of modified algal oil to mimic cocoa butter-like properties, the end product must compete with cheaper sources of plant-derived vegetable fats that are currently used for cocoa butter equivalents. To date, the company has not announced a corporate partner to support the development of a cocoa butter alternative. Although Solazyme claims that its process is “sustainable”, the company’s large-scale fermentation process depends on access to large quantities of sugar feedstocks (maize or sugarcane). Solazyme has noted that prices of sugar feedstocks are volatile and supplies are not dependable.<sup>38</sup>

Some observers note that Solazyme’s engineered oil with cocoa-butter-like properties may be the answer to the current under-supply of cocoa on the world market. Although demand for cocoa beans currently outpaces supply, the boom and bust cycle in world cocoa markets is nothing new. Corporate cocoa giants are currently investing millions of dollars in new cocoa grinding operations and processing facilities. For example, with demand for chocolate surging in Asia, Indonesia expects to triple output of cocoa beans by 2020 and cocoa grinding capacity there is forecast to jump 85% by the end of 2014.<sup>39</sup> It is unlikely that corporate cocoa barons would be investing millions in expanded cocoa grinding/processing capacity if a cheaper, biosynthesized cocoa butter was capable of displacing naturally-derived cocoa butter.

**Finally, public resistance to synthetic biology’s engineered foods is real and growing.** A recent survey of public attitudes about synthetic biology indicates that one of the applications of synthetic biology that generates “a lot of criticism and concern” for consumers is the development of synthetic flavors to replace natural flavors and ingredients such as vanilla and citrus in foods that are intended for human consumption. According to the researchers: “The discussions reveal that participants are not so much concerned about developing synthetic ingredients for paint as they are about developing synthetic food additives that humans would ingest.<sup>40</sup> When it comes to vanilla, there is a sense that we have what we need and so a synthetic version is not needed – it would create a potential risk for no good reason.”<sup>41</sup>

If the public is concerned about synbio’s vanilla substitute, the notion of bio-synthesized cocoa would be equally unappetizing to chocolate lovers worldwide. The corporate cocoa barons won’t need a public relations firm to figure that out.

## References

For references, email [info@etcgroup.org](mailto:info@etcgroup.org).