



Shea, Cocoa Butter & Other Cocoa Butter Equivalents (CBEs)

A Case Study on Use of Synthetic Biology Replacements

Farmers Affected: Cocoa: 5-6 million¹
Shea Butter: 3 million African women²
Market Value: Cocoa: \$6 billion US³.
Cocoa butter equivalents: \$600 million US⁴ Including **Shea:** Between \$90-\$200 US million/year

Volume: Cocoa: 4.2 million tonnes (2014)⁵
Shea: 65,000 metric tonnes exported to Europe and North America annually (2015)⁶

Uses: Food products (edible fats, confectionery, bakery), animal feed, cosmetics

Syn Bio companies: TerraVia (previously Solazyme)

Hotspots: Cocoa: Cote d'Ivoire, Ghana, Indonesia⁷, **Shea:** West Africa including Mali, Burkina Faso, Benin, Senegal, Ivory Coast, Ghana, Gambia, Nigeria

Also Grown In: Nigeria, Cameroon, Brazil, Ecuador, Mexico, Dominican Republic, Peru
Other Butters: Indonesia, India, Brazil, Myanmar

Cultural Importance: Cocoa: Millennial tradition; a beverage of the Aztec gods, warriors and upper classes; was considered an invigorating and healthful drink also in Europe. **Shea:** Collected by women. Usage traditions date back to ancient Egypt.

Biodiversity Considerations: Cocoa: Shade crops provide habitat and food for plants and animals normally dependent upon tropical forest. **Shea:** Conservation of shea trees on fields and fallow land form part of a complex indigenous biodiverse farming system.

Overview

Cocoa butter and shea butter are vegetable fats used both for food and cosmetics applications. They are often described respectively as “cocoa butter” and “cocoa butter equivalents” (CBEs). CBEs include shea and other less common butters such as illipe, kokum, mowrah, murumuru, mango and palm butters. Cocoa butter is made from the beans of the cacao tree, grown across the tropics, while shea butter is made mostly from the oilseeds of the African shea tree.

Status: Syn bio shea / cocoa may be available 2016



R&D

Scale Up

Commercialization

At least 8-9 million smallholder famers and their families depend on growing and harvesting shea seeds and cacao beans, particularly in West and Sub-Saharan Africa.

Patents:

US20110293785A1:
Food Compositions
Comprising Tailored Oil

Products: Algal Butter

Method: Synthetically manipulated algae plants

Commercialization: 2016

Feedstock: Sugar cane or corn

Brands, Identifiers:

“AlgaWise algae butter”⁸



For more info on Synthetic Biology please visit the ETC Group website:
www.etcgroup.org/synbio

Cocoa butter use is particularly targeted towards the manufacture of chocolate, while Shea and other butters tend to either stretch food uses of cocoa butter or are even more commonly used in cosmetics as moisturizers.

In 2012, the synthetic biology firm Solazyme (later renamed TerraVia), announced that it had developed a new high-value “tailored oil” with a fatty acid composition very similar to cocoa butter.¹⁰ One investor site brashly trumpeted: “Step aside cocoa farm, synthetic biology is on its way...” Solazyme, which genetically modifies sugar-fed algae to produce oils in giant vats, explained that its new algae butter is “ideally suited for a range of personal care products such as lotions, emollients and moisturizers.”¹¹ In October 2015 Solazyme/TerraVia announced that AlgaWise butter will be on sale commercially in early 2016 and identified clearly that it was an alternative to shea noting that the algae butter “has a composition and functionality mirroring high value structuring fats such as shea stearin.”¹²

What are Shea, Cocoa Butter and Cocoa Butter Equivalents (CBE)?

Cocoa butter is derived from cocoa beans, grown by 5-6 million smallholder farmers in 30 tropical countries.¹³ It is best known as the main ingredient in chocolate and the vast majority of cocoa butter is used for confectionery (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 that amount depends largely on the price of cocoa butter.¹⁴ West Africa accounts for over 71% of all cocoa bean production, and Indonesia is also a major producer.

“Cocoa butter equivalents” (CBE), of which shea butter is one, are composed of vegetable fats derived from a variety of plant sources. CBEs are sourced from cheaper plant-derived vegetable fats, including: illipé (*Shorea stenoptera*), palm oil (*Elaeis guineensis*, *Elaeis olifera*), sal (*Shorea robusta*), shea (*Vitellaria paradoxa*), kokum gurgi (*Garcinia indica*), and mango kernel (*Mangifera indica*). The composition and price of CBEs depends on the current supply of many of these different plant-based oils.¹⁵

The CBE market is especially used to “stretch” the cocoa butter supply—or to provide a cheaper raw material for lower-quality chocolate or for cosmetic products.

The CBE market therefore varies from year to year depending on the price of cocoa butter, sometimes by 30% or more.¹⁶

Shea Butter is made from the seed of the fruit of the shea tree, *Vitellaria paradoxa* (syn. *Butyrospermum parkii*, *Butyrospermum paradoxum*). This tree is indigenous to a band of vegetation extending over 5,000 km from Senegal to Ethiopia and Uganda. It thrives in savanna areas where oil palm cannot grow due to low rainfall. Shea is not only overwhelmingly harvested by women (90%) but all stages from extraction to commercialization are controlled by women, making it an important crop for basic African livelihoods. Shea butter is a useful base for local pharmaceutical preparations, cosmetics and as a cocoa butter equivalent.¹⁷

“We can dislocate the production of that oil from a tropical climate to the middle of Iowa in winter and make an oil that is more nutritious and more stable.” “It is truly revolutionary, that we can take what is a normal crop cycle and compress that into three days”, Senior VP of Solazyme/TerraVia Mark Brooks.⁹

Shea and Cocoa Butter as Natural Products

Cocoa farms are located in hot, rainy and tropical areas of Africa, Asia and Latin America, across a narrow belt falling within 10-20 degrees latitude of the equator. An estimated 4-5 million people in these often poor tropical areas depend on cocoa for their livelihoods.¹⁸

Smallholder farmers account for 80-90% of world cocoa production. In Africa and Asia, a typical cocoa farm covers 2-4 hectares.¹⁹

The major producing countries for Shea are in West Africa: Mali, Burkina Faso, Benin, Senegal, Ivory Coast, Ghana, Gambia, Nigeria.²⁰ In recent decades, shea butter has become a valued ingredient in the finest natural cosmetics. The cosmetic and pharmaceutical industries consume an estimated 2-8,000 tonnes of shea butter each year, and this figure is expected to rise with growing demand in new markets.²¹

Processing of shea butter is often carried out by informal groups of women who pool their labour. Thus, in every producer country, rural women's groups and marketing associations have an important role in the shea butter industry. The UN Development Programme (UNDP) estimates that an average of three million women in Africa²² and 16 million women²³ worldwide work directly or indirectly with shea butter. Moreover, it is estimated that 12% of poorest household total income comes from shea. A 2011 study by US Aid found that for every 1 MT shea nuts purchased from farmers at \$220/MT, 128\$ of additional household income is created in the regional economy.²⁴ Shea butter production offers jobs and higher income; improved family nutrition; better housing; and money to pay for school fees. Higher income in communities means improved access to potable water and construction of schools and medical centers.²⁵

Cocoa butter prices normally determine shea butter prices for export values.²⁶ Like most tropical agricultural export commodities, cocoa and shea are subject to boom and bust cycles. 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.

Shea and Cocoa Biodiversity and Cultural Considerations

Shade crops, such as cocoa and shea trees, provide habitat for plants and animals normally dependent upon tropical forest. It is also believed that shade plantations such as cacao may play a particularly critical conservation role for migratory organisms.²⁷

The shea tree grows very slowly, yielding its first fruit harvest after 15 to 20 years. Mature trees are preserved during land clearance for farming and thus form part of the indigenous farming system, naturally maintaining a rich biodiversity and ecological preservation.²⁸

Both cacao and shea have important cultural histories. Cocoa uses date back 4 millennia, to pre-Colombian cultures of Mesoamerica. It was made in a drink and was used as a monetary unit. A symbol of abundance, it was also used in religious rituals honoring the gods, in funerals and as a symbol of nobility and for soldiers during battles.²⁹ Ancient accounts tell of large caravans carrying clay jars of shea butter to queen Cleopatra of Egypt. African women have long used shea as a cosmetic, to ease child birth pains (northeast Ghana) and to cover newborn babies from head to toe to prevent infection (Gambia).³⁰

Cocoa has become a focus of international consternation because of the discovery of fairly widespread use of child and slave labour in six of the 74 producing countries (all of them in West Africa). While industry promises, US legislation and UN targets are trying to end these practices by 2020, their efforts have so far produced disappointing results. Nonetheless, replacing cocoa butter altogether seems unlikely to be a relevant means of ending cocoa slavery. Arguably, undercutting prices with synthetic alternatives could have the effect of worsening prices and labour conditions, just as much as possibly benefitting them. Overall, in terms of this being a profitable and culturally important product that benefits poor families, cocoa is still a desirable crop.³¹

Synthetic Biology Production

California-based TerraVia (formerly Solazyme) develops engineered microalgae (pond scum) which secrete “tailored” oils (altered algae oil that mimics other vegetable oil profiles) for use in chemicals, foods, fuels and personal care/health products. Solazyme/TerraVia believes the food and cosmetics business provide tremendous opportunities for these products to develop into large and profitable entities.³²

In 2012, TerraVia announced that it had developed a new high-value “tailored oil” with a fatty acid composition very similar to cocoa butter.³³ The company explained that its new algae butter is “ideally suited for a range of personal care products such as lotions, emollients and moisturizers.”³⁴ One investor site brashly trumpeted: “Step aside cocoa farm, synthetic biology is on its way...” In 2014 CEO Jonathan Wolfson reiterated that “Looking forward, a number of the high-value oils we’re working on have important application potential in nutrition, and these include [...] cocoa butter equivalents.”³⁵ Then, in 2015, TerraVia announced that its “AlgaWise Butter” was going through the GRAS (Generally Recognized As Safe) process and should be available on the US market in early 2016.³⁶ They identified more clearly that it mimics shea stearin – which is the fatty part of shea butter and that as such it will also be incorporated into foods. This AlgaWise Butter is currently being tested by manufacturers in spreads, bakery and confectionary applications, and could be used in any type of food where the fats are solid at room temperature. Solazyme has confirmed that its high oleic oil and structured fats (butter) are genetically engineered in order to make a precisely tailored oil with unique functionality.³⁷

AlgaWise Butter Customers may include Hormel, Utz, Enjoy Life Foods, So Delicious, SoyLent and Follow Your Heart. Manufacturers are likely to be allowed to describe it as “algal butter” on the ingredients list, according to Mark Brooks, senior vice-president. “I don’t think we are precluded from calling it algae butter, just as you are allowed to say ‘cocoa butter’ and ‘shea butter’, which are not dairy-derived either,” Brooks told Food Navigator-USA in November 2015.³⁸

This syn bio butter is part of a line of oils for cooking, baking and dressing that TerraVia is producing in a partnership with grain giant Bunge. They include AlgaWise Algae Oil and a consumer brand called Thrive Algae Oil already on the market. Bunge is in charge of marketing the oils and butter, and handles the oil processing and supply chain aspects of commercialization. Manufacturing takes place at the joint venture’s facility in São Paulo, Brazil, that is adjacent to Bunge’s Moema sugarcane mill, the feedstock for the syn bio algae.³⁹

Implications for the Future

For quality reasons, cocoa butter equivalents do not normally impact the chocolate market very much, so there is lower potential for a biosynthesized cocoa butter alternative to impact that larger part of the cocoa market that goes to chocolate makers. Demand for cocoa beans currently outpaces supply, and corporate cocoa giants are currently investing millions of dollars in new cocoa-grinding operations and processing facilities. They would probably not be doing so if they were looking towards using a cheaper, biosynthesized cocoa butter equivalent in the near future. However, if TerraVia is able to offer low-cost and high-yields of their algal cocoa butter equivalent, then it might prove significantly disruptive to the parallel markets for cocoa butter equivalents such as shea.

Observers have speculated that Solazyme’s technology will enable the “de-regionalization” of cocoa butter equivalent production, eliminating constraints associated with the sourcing of natural cocoa beans from tropical countries: volatile prices, unpredictable supplies, long-distance shipping and geopolitical instability.⁴⁰ In an interview given on the occasion of the IFT 2015 show in Chicago in the summer, TerraVia Senior VP Mark Brooks touts this disruption as a benefit: “It is truly revolutionary, that we can take what is a normal crop cycle and compress that into three days... We can dislocate the production of that oil from a tropical climate to the middle of Iowa in winter and make an oil that is more nutritious and more stable.”⁴¹

However, moving production from the land to the vats could have wide-reaching negative effects on the lands and the 5-6 million farmers who produce cocoa beans, and especially on the 16 million women involved in the shea butter industry worldwide.⁴² It could also displace or disrupt markets and farming communities around the world for other tropical oils and butter equivalents such as coconut oil, palm oil, palm kernel oil, shea butter and other smaller sources of butter such as illipe, kokum, mowrah and murumuru which are typically used as cocoa butter equivalents.

Beyond Shea: Other Cocoa Butter Equivalents (CBE)

In the food and cosmetic industry, some butters are considered substitutes for cocoa butter - the most important for Western cosmetics are illipe, mowrah, kokum, murumuru and mango butters. Others include: sal, palm, tucuma, cupuacu butters. Illipe butter is considered the best substitute for cocoa butter because of its similar melting points and fatty acid profiles. Mowrah butter is used as a substitute for shea butter. Illipe and mowrah butter are often sold as the “other butters” on the ingredient list (they can also be called Borneo tallow or Tengkaway).

Illipe (or Tengkawang) butter: Derived from seeds of *Shorea stenoptera*, an Asian tree that is native to Borneo forests. The Borneo Dayaks (indigenous to the area) have been making a butter from Illipe nuts for countless centuries. Today, Indonesia is the main producer and exporter of the tree's tengkawang nuts. Almost all production is exported and account for a value of roughly \$7.75 million US⁴³.

Mowrah: The fruit of the mahua (*Madhuca longifolia*) tree grown in India. Used for both edible (chocolate) and cosmetic applications, it is also utilized in the manufacturing of laundry soaps and lubricants as well as creams, lotions, and balms.



Tengkawang nuts

Murumuru butter: The *Astrocaryum murumuru* palm grows in Brazil and around the Amazon and is one of the dominant trees in this region. It is used in small amounts in shampoos (0.5% to 1%) and formulas for conditioners, creams, soaps, lipsticks and deodorants.

Sal butter: In India, *Shorea robusta* or sal forests occur over a wide area: 114,379 sq. km. Production data are unknown as most is consumed domestically.

Kokum butter: Fruit of the *Garcinia Indica* tree of India, it is used in cosmetics, especially lip balms; little market information is available..

Cupuacu butter: *Theobroma grandiflorum* is related to cacao and is native to the northern Amazon.

Palm butter: Comes from the fruit the African oil palm *Elaeis guineensis*. It is widely used in food and cosmetics in Africa.

Mango butter: Used in baby creams, sun care balms, hair products, and other moisturizing products. India has 57% of total production. Myanmar and southern Asia also make it.

Endnotes

- 1 World Cocoa Foundation, April 2014. *Cocoa Market Update*, April 1, 2014.
 - 2 Rebecca Moudio. "Shea butter nourishes opportunities for African women," *Africa Renewal Magazine*. August 2013. www.un.org/africarenewal/magazine/august-2013/shea-butter-nourishes-opportunities-africanwomen#sthash.QfA4Cvei.dpuf
 - 3 Personal communication with Steven Haws, Commodities Risk Analysis, 14 May 2014.
 - 4 *Ibid.*
 - 5 <http://www.unitedcacao.com/index.php/en/corporate-profile/global-cocoa-market>
 - 6 I.O. Graba, S.A. Sami and C.O. Adebago, "Analyzing the Structure and Performance of Shea Butter Market in Bosso and Borgu Local Government Areas of Niger State, Nigeria," *International Journal of u- and e- Service, Science and Technology* Vol.8, No.2 (2015), pp.321-336 <http://dx.doi.org/10.14257/ijunesst.2015.8.2.31>, accessed at www.sersc.org/journals/IJUNESST/vol8_no2/31.pdf See also: "Demand for shea butter produced in West Africa has increased by over 1200% over the last 10 years. In 2012, an estimated 350,000 metric tonnes of kernels were exported from Africa, with a market value of approximately US\$120 million." Industry Overview, Global Shea Alliance. <http://www.globalshea.com/work/14/Industry-overview>
 - 7 *ICCO Quarterly Bulletin of Cocoa Statistics*, Vol XL, No. 1, Cocoa Year 2013-14. 28 February 2014. www.icco.org
 - 8 Elaine Watson, "Solazyme expands algae oils JV with Bunge," *Food Navigator*. 30th October 2015. www.foodnavigator-usa.com/Manufacturers/Solazyme-expands-algae-oils-JV-with-Bunge
 - 9 Elaine Watson, "Solazyme launches Thrive culinary oil from algae," *Food Navigator*. 1st October 2015. www.foodnavigator-usa.com/Markets/Solazyme-launches-Thrive-culinary-oil-from-algae
 - 10 Solazyme's CEO Discusses Q3 2012 Results - Earnings Call Transcript, Nov. 14, 2012
 - 11 *Ibid.*
 - 12 Solazyme News Release, Bunge and Solazyme Expand Joint Venture - October 30th 2015. Online at <http://investors.solazyme.com/releasedetail.cfm?releaseid=939490>
 - 13 www.worldagroforestry.org/treesandmarkets/inaforesta/documents/cocoa%20and%20chocolate/cocoa%20and%20chocolate.pdf
 - 14 Personal communication with Michael Segal, Information & Media Officer, ICCO, 14 May 2014. See also: *The International Cocoa Trade*, 3rd Edition, by Robin Dand, Woodhead Publishing, 2011, p. 190.
 - 15 Directive 2000/36/EC of the European Parliament and of the Council of 23 June 2000.
 - 16 Personal communication with Steven Haws, Commodities Risk Analysis. 14 May 2014.
 - 17 Minor Oil Crops. FAO Corporate Document Repository. Forestry Department. www.fao.org/docrep/x5043e/x5043e0b.htm
 - 18 World Cocoa Foundation, April 2014. *Cocoa Market Update*, April 1, 2014.
 - 19 *Ibid.*
 - 20 E. T. Masters, J. A. Yidana et P. N. Lovett. *Reinforcing sound management through trade: shea tree products in Africa*. www.fao.org/docrep/008/y5918e/y5918e11.htm
 - 21 *Ibid.*
 - 22 Moudio, "Shea butter nourishes opportunities for African women" www.un.org/africarenewal/magazine/august-2013/shea-butter-nourishes-opportunities-african-women#sthash.QfA4Cvei.dpuf
 - 23 Oliver Nieburg, "Cocoa butter equivalent demand rising rapidly, says Global Shea Alliance", *Confectionary News.com*, May 27th 2013. www.confectionerynews.com/Ingredients/CocoabutterequivalentdemandrisingrapidlysaysGlobalSheaAlliance
 - 24 *Ibid.*
 - 25 Dr. Peter Lovett, "The Shea Industry's Economic Impact in Africa." Global Shea Alliance. 2013. www.globalshea.com/uploads/files/nyc_shea_trade_and_industry_conference_presentations/lovet_t_nyc_global_shea_may_2013_75.pdf
 - 26 *Ibid.*
 - 27 <https://nationalzoo.si.edu/scbi/migratorybirds/research/cacao/greenberg.cfm>
 - 28 E.T. Masters, J.A. Yidana and P.N. Lovett. www.fao.org/docrep/008/y5918e/y5918e11.htm
 - 29 www.worldagroforestry.org/treesandmarkets/inaforesta/history.htm
 - 30 Traditional uses of shea butter in Africa - <http://sheabutter.com/blog/traditional-uses-of-shea-butter-in-africa/>
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- 31 See https://en.wikipedia.org/wiki/Children_in_cocoa_production; and especially Payson Center for International Development and Technology Transfer of Tulane University (31 October 2007). "First annual report: Oversight of public and private initiatives to eliminate the worst forms of child labor in the cocoa sector in Cote d'Ivoire and Ghana" (PDF; 'The bitter taste of slavery,' 28 September 2000, Liz Blunt, *BBC*, retrieved at 30 March 2016
- 32 www.altenergystocks.com/archives/2016/03/solazymes_otsopuzzling_rebranding.html
- 33 Solazyme's CEO Discusses Q3 2012 Results - Earnings Call Transcript, Nov. 14, 2012
- 34 *Ibid.*
- 35 Elaine Watson, "First wave of products containing Solazyme's microalgae-based food ingredients hits shelves", 7 novembre 2014. www.foodnavigatorusa.com/Suppliers2/SolazymeAlgaViaalgalingredientsin8products
- 36 Elaine Watson, "Solazyme to launch alge butter in early 2016," 12th Novembre 2015. www.foodnavigator-usa.com/Suppliers2/Solazyme-to-launch-algae-butter-in-early-2016
- 37 Elaine Watson, "Solazyme AlgaVia algal ingredients in 8 products," 7th November 2014. www.foodnavigator-usa.com/Suppliers2/Solazyme-AlgaVia-algal-ingredients-in-8-products
- 38 *Ibid.*
- 39 Jeff Gelski. Bunge to market algae oil. 30th October 2015. www.bakingbusiness.com/articles/news_home/Business/2015/10/Bunge_to_market_algae_oil.aspx?ID=%7B331040F4-3696-45D9-8A9A-700E63A7A0C9%7D&cck=1
- 40 Note: The author owns stock in Solazyme. Kevin Quon, "Rising Cocoa Bean Prices Find An Unlikely Hero In Algae," *Seeking Alpha*. Mar. 4, 2013 <http://seekingalpha.com/article/124>
- 41 Elaine Watson, "Solazyme launches Thrive culinary oil from algae," 1st October 2015. www.foodnavigator-usa.com/Markets/Solazyme-launches-Thrive-culinary-oil-from-algae
- 42 Nieburg, "Cocoa butter equivalent demand rising rapidly" <http://www.confectionerynews.com/Ingredients/Cocoa-butter-equivalent-demand-rising-rapidly-says-Global-Shea-Alliance>
- 43 "International trade in non-wood forest products: An overview," FAO Corporate Document Repository. Forestry Department. www.fao.org/docrep/x5326e/x5326e06.htm
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