

Squalane & Synthetic Biology

A Case Study



Most squalane is currently produced from olives. *photo: Marco Bernardini*

Product: Squalene is a high-end, oil-free moisturizing ingredient used in many cosmetics that, until recently, was extracted primarily from the liver of deep sea sharks.

Status: California-based synthetic biology company, Amyris, Inc., has engineered the metabolic pathway of yeast to produce a molecule called farnesene – an essential building block for a wide range of chemical products – including squalene.

Affected Country/Region: Deep-sea trawlers are losing out to Spain and other Mediterranean area exporters who, in turn, may lose out to Brazil's sugarcane industry. Instead of sourcing squalene from shark liver oil, the moisturizer can be extracted from botanical sources, including rice bran, wheat germ, amaranth seeds and olives. Refined olive oil is now the primary botanical source for squalene but synthetic biology may allow the market to shift to sugarcane in Brazil.

Market: The squalane market has shrunk to just one third of its size by volume in the last decade. Global squalane production was 2,500 metric tonnes (MT) in 2013. Of that, 1,050 MT is produced from olive oil, 1,000 MT from shark liver, and 450 MT from Amyris. At current prices, the market represents \$93 million in sales.

Commercialization: Amyris, Inc. is selling commercial quantities of squalene to cosmetic ingredient buyer Soliance (France). Engineered microbes in Amyris' Brazil-based fermentation facility produce farnesene and byproducts such as squalene from up to two million tons of crushed sugarcane per annum. Amyris has selected Dowell C&I Co., Ltd., a supplier of ingredients for the personal care industry, as its exclusive distributor of Neossance™ Squalane in the Republic of Korea. The company is planning to double its sugar-based squalene sales in 2014.

About Squalane

Squalene is a high-end, oil-free moisturizing ingredient used in a wide variety of cosmetics that, until recently, was extracted primarily from the liver of deep-sea sharks. The livers of an estimated 3,000 sharks are required to produce just 1 ton of squalene.¹ Up to 6 million deep-sea sharks a year were thus killed to meet the global demand of between 1,000-2,000 tons per annum.² Squalene is also used in the manufacture of vaccines.

As a result of civil society campaigns deep-sea shark harvesting is now prohibited in many parts of the world and, remove shark squalene from their cosmetic brands in favor of renewable plant-based sources.³ Recent advances in the purification of squalene have allowed perennial botanical sources like olives to become a viable commercial alternative to sharks.⁴

Refined olive oil is now the primary botanical source of squalane.⁵ In 2008, L'Oreal and Unilever announced that they would remove shark squalene from their cosmetic brands in favor of renewable plant-based sources.

Olive oil, received from the first compression,



Ingredients, Flavours, Fragrances and Synthetic Biology A New and Emerging Issue for CBD

New developments in synthetic biology could have far-reaching impacts on the market for biodiversity-derived natural products and the livelihoods of those who produce them. Cosmetic giants like Unilever and L'Oréal can source squalene from plant sources (olive oil, amaranth seeds, wheat germ, etc.) instead of harvesting the livers of 6 million deep sea sharks per year. This is a positive development. Now, Amyris is producing squalene from engineered microbes in fermentation tanks that are fueled by biomass – up to two million tons of crushed sugarcane annually. Who decides what is the most sustainable and socially just use of biomass and farmland? The Convention on Biodiversity is the only intergovernmental body that addressing the potential impacts of synthetic biology on the conservation and use of biodiversity and on the livelihoods of those who depend on agricultural exports (including high-value flavors, fragrances, cosmetics, essential oils, etc). The Convention on Biological Diversity is the appropriate forum to address this new and emerging issue.

holds about 400-450 mg per 100g of squalene, while refined oil contains about 25% less. In some cases, premium quality olive oil contains concentrations of up to 700 mg per 100g.

Current R&D:

Amyris has used synthetic biology to engineer the metabolic pathway of yeast to produce a molecule called farnesene, an essential building block for a wide range of chemical products which can then be processed into large amounts of high-quality squalene. In February 2010 Amyris announced

that it was selling its 100% bio-based Neossance™ Squalane – the company's first commercial product – to Soliance, a provider of ingredients to the French cosmetic industry.⁶

According to the company's plan, the Brotas facility in Brazil is capable of producing their synthetic farnesene – they call it Biofene – from up to two million tons of crushed sugarcane annually.⁷ The Brotas facility is also producing patchouli oil. Amyris is reportedly scaling-up production of microbial-derived farnesene at production facilities in Brazil, US and Europe.⁸ The company has not disclosed production costs or capacity related to squalene.

Intellectual Property related to Biosynthesis of Squalane:

[US20120040396A1: Methods for Purifying Bio-Organic Compounds. Assignee: Amyris, Inc. Published: 16 Feb 2012.

WO2012024186A1: Method for Purifying Bio-Organic Compounds from Fermentation Broth. Assignee: Amyris, Inc. Published: 23 Feb 2012

US20100267971A1: Stabilization And Hydrogenation Methods For Microbial-Derived Olefins. Assignee: Amyris, Inc. Published: 21 Oct 2010.

WO2010115097A3: Stabilization And Hydrogenation Methods For Microbial-Derived Olefins. Assignee: Amyris, Inc. Published: 29 Sept 2011.

References

- 1 Deep Sea Conservation Coalition. <http://savethedeepsea.blogspot.com/2011/08/save-deep-sea-sharks-squalene-and-trade.html>
- 2 Deep Sea Conservation Coalition. <http://savethedeepsea.blogspot.com/2011/08/save-deep-sea-sharks-squalene-and-trade.html>
- 3 January 30, 2008. <http://www.cosmeticsandtoiletries.com/networking/news/company/15040046.html?page=1>
- 4 Luis A. Brito, et al. An alternative renewable source of squalene for use in emulsion adjuvants. *Vaccine*, Vol 29, Issue 37, 26 August 2011.
- 5 Personal communication with Rebecca Greenberg, staff scientist, Oceana, 4 April 2007.
- 6 <http://www.amyris.com/en/newsroom/198-amyris-sells-first-renewable-product>
- 7 Anonymous, 2010. "Amyris: Farnesene and the pursuit of value, valuations, validation and vroom," *Biofuels Digest*, June 25, 2010.
- 8 Andrew McDougall, Amyris receives multi-million dollar approval for first industrial-scale production facility in Brazil, *CosmeticDesign.com*, 28 November 2011. <http://www.cosmeticsdesign.com>