



# Squalane (Olive)

## A Case Study on Use of Synthetic Biology Replacements

**Farmers Affected:** 30 million people make living from olive sector<sup>1</sup>

**Market Value:** \$93 million, \$141 million US by 2019

**Volume:** 2,500 metric tonnes / year

**Uses:** Cosmetics

**Syn Bio Companies:** Amyris

**Hotspots:** Spain, Greece, Italy and North Africa (Morocco, Tunisia)

**Also grown in:** France, Syria, Turkey

**Cultural Importance:** Olive-growing and use are closely woven into Mediterranean culture and Judeo-Christian religion.

**Biodiversity Benefits:** Older olive groves exhibit high biodiversity benefits and integrate with livestock farming. Newer intensive olive plantations raise agrochemical and erosion issues that can be mitigated with organic production.

**Patents:** US20120040396A1, WO2012024186A1, US20100267971A1, WO2010115097A3

**Products:** Cosmetics (Make-up removing cloths, face oil, cleansing oil, body moisturizer, hand cleaner)

**Method:** Synthetically engineered yeast

**Commercialization:** On the market

**Feedstock:** Sugarcane

**Brands, Identifiers:** Neossance™ Squalane, Biossance™ products<sup>2</sup>: “The Refresher”, “The Nourisher”, “The Purifier”, “The Revitalizer”, Peter Thomas Roth’s “Oilless Oil 100% Purified Squalane”, Elizabeth Arden, among others. “Muck Daddy” hand cleaner degreaser

### Overview

Squalane is a high-end, “oil-free” moisturizing ingredient, found in nature and used in many cosmetics. Until recently, it was extracted primarily from the livers of deep sea sharks. However, following demands from civil society campaigns, deep-sea shark harvesting became prohibited in many parts of the world and many brands removed shark-derived squalane from their cosmetics in favor of renewable plant-based sources.<sup>3</sup> Squalane is therefore today derived largely from botanical sources, mostly olive oil. Since 2010, leading synthetic biology firm Amyris Biotechnologies has been marketing its so-called “sugar-derived” squalane as Neossance™.<sup>4</sup> The Amyris squalane is produced by bioengineered yeast fed on Brazilian sugarcane, and has gained a significant hold in the cosmetics market, used today by a wide variety of brands. It is also sold by Amyris’ in-house cosmetics brand Biossance™.

**Status:** Syn bio squalane is already on the market



R&D

Scale Up

Commercialization

### What is Squalane?

Squalane is a high-end moisturizing ingredient used in many cosmetics. It is naturally found throughout the plant and animal kingdoms, even in human skin. Squalene (the shark-derived version of squalane) was discovered in 1906 by the Japanese oils and fats expert Dr. Mitsumaru Tsujimoto, when he investigated the part of shark liver oil that would not saponify (turn into soap)<sup>5</sup>.



For more info on Synthetic Biology please visit the ETC Group website: [www.etcgroup.org/synbio](http://www.etcgroup.org/synbio)

He named the substance after the shark family it came from (*Squalidae*); however it was later found to also exist in smaller quantities in other animal and vegetable sources, including amaranth and wheat germ. Besides moisturizing properties, squalane is a hydrocarbon and a triterpene, and is a natural and vital part of the synthesis of all plant and animal sterols, including cholesterol, steroid hormones, and vitamin D in the human body. Squalane has recently been used as an immunologic adjuvant in vaccines and as an antioxidant. Research suggests that squalane, as a part of the Mediterranean diet, may be a chemopreventive substance protecting people from cancer.

### Squalane as a Natural Product

Until recently, Squalane was commercially extracted from the livers of deep sea sharks. Livers of an estimated 3,000 sharks are required to produce just under 1 ton of squalane. Up to 2.7 million deep-sea sharks a year were thus killed to meet the global demand for squalane in the cosmetic industry alone.<sup>6</sup>

More recently, the majority of squalane on the market has been derived from botanical sources including rice bran, wheat germ, amaranth seeds and most importantly, olives.

In 2008, following campaigns by civil society, L'Oreal and Unilever announced that they would remove shark squalane from their cosmetic brands in favor of renewable plant-based sources; so deep-sea trawlers gave way to Mediterranean and North African farmers and exporters. Today, refined olive oil is the primary source. The first compression of olive oil contains about 400-450 mg per 100g of squalane, while refined oil contains about 25% less. In some cases, premium quality olive oil contains concentrations of up to 700 mg per 100g. Amaranth may also become an important vegetable source of squalane in time since it has higher concentrations than olive. The cosmetics industry is already the biggest consumer of the amaranth seed oil market buying a market share of above 60% in 2013.<sup>7</sup>

Global squalane production was 2,500 metric tonnes (MT) in 2013. Of that, 1,050 MT was produced from olive oil, 1,000 MT from shark liver, and 450 MT from Amyris' synthetic biology organisms. At current prices, the market represents \$93 million US in sales. A recent press release estimated the squalane market will be worth more than \$141 million US by 2019.<sup>8</sup> Global consumption of squalane is expected to be 4,028 tons by 2019. Amyris has been the most active company in the squalane market in recent years.<sup>9</sup>

Global olive oil production, to which squalane supply is now linked, is currently 2.9 million tonnes of which just over 2 million is produced within the European Union's Mediterranean region. Spain is the leading olive oil manufacturer at 1.3 million tonnes, along with Greece and Italy. Spain produces 46% of the world's olive oil, with this oil accounting for €1.8 billion of Spanish exports in 2011, making it the country's third most important agricultural commodity after wine and pork. Greece has 531,000 olive oil farms and Italy has more than one million farms. Other major producers are Syria, Turkey, Tunisia and Morocco.<sup>10</sup> Moroccan olive production is in a phase of notably rapid growth. The country doubled its olive oil production in recent years to 1.5 million tons, reducing unemployment for women in particular, by creating over 300 000 permanent jobs.<sup>11</sup>

### Biodiversity and Cultural Considerations

While large scale extraction of squalane from shark livers has been roundly condemned by marine protection organizations, the now more common sourcing of squalane from olive farms would seem to be an overall beneficial move for both agroecological landscapes and Mediterranean farming communities. When squalane is sourced from olive oil, it is actually a by-product of the refining process, and is considered a useful component of olive mill wastes.<sup>12</sup> Squalane is found in relatively high concentrations in olive-oil residues after the last production steps (deodorization), and is also a waste product of the refineries. As such, olive squalane production does not necessarily compete with food, or drive additional land use demands, while it does add to the value of the olive harvest.

Olive production in the Mediterranean region occurs in orchard systems with trees that may be many hundreds of years old. Older orchards, while less efficient, are recognized for their high biodiversity benefits - offering shade and habitat for owls and other birds and are integrated with livestock grazing (particularly sheep and goats), removing need for herbicide or fertilizers. Olive groves traditionally have low water needs and can support a high diversity of plant species. For example, there are reports of as many as 100 species of plant per hectare in the ground flora and over 500 species in the olive area of Cordoba province. Another survey refers to 120 plant species, 70 vertebrates and 160 invertebrates associated with olive plantations.<sup>13</sup> More modern, densely stocked and intensive olive plantations do raise concerns associated with use of agrochemicals as well as soil erosion. However, even in such intensive systems, organic production avoiding pesticides is becoming increasingly common. Older, traditional olive groves rarely require chemical applications.

Olive growing, olive groves and use of olive oil have been woven into the cultures of Mediterranean societies for thousands of years. The long life of olive trees have led to them being revered as signs of fertility and vitality, of purity and of culture. The ancient Greeks named their most important city after the goddess Athena because she gave the olive tree as a gift. Judeo-Christian religious tradition has many references to the olive and olive groves. The symbol of the olive branch, originally from the bible, became a universal sign of peace now incorporated into the flag of the United Nations.

### **Synthetic Biology Production**

In February 2010, the California-based synthetic biology company Amyris entered a partnership with Soliance, a provider of ingredients to the French cosmetic industry, to sell large quantities of its Neossance™ squalane to the cosmetic industry.<sup>14</sup>

In 2011, Amyris also entered into a multiyear agreement to provide “several hundred tons” of squalane to Nikko Chemicals Co. Ltd. for distribution in the Japanese market.<sup>15</sup> In 2015, Amyris announced a further partnership with Squalan Natural Health, a privately held personal care products company based in the Netherlands, for the production and marketing of “Neossance Squalane.” Finally, on February 18, 2016, Amyris launched its own in-house brand Biossance™ a collection of skin care products using its squalane and the closely related compound hemisqualane. This product line includes moisturizers, cleansing oils, make-up removing cloths, etc. They are being commercialized by the Home Shopping Network, an “interactive, multi-channel” fashion and beauty company. Another of Amyris’ own product lines, “Muck Daddy,” commercializes a moisturizing hand cleaner degreaser based on squalane.<sup>16</sup>

Amyris had previously engineered the metabolic pathway of yeast to produce a molecule called farnesene, an essential building block for a wide range of chemical products, including squalane. Their production of Neossance Squalane and hemisqualane builds on this core technology. Since Amyris bioengineered yeast feeds on Brazilian sugarcane, the company and brands that use it claim that Neossance squalane is “sugar-derived” or “sugar squalane,” with no mention of synthetic biology-created microorganisms. Amyris has presented Neossance as an ethical alternative to shark squalane, with company PR presenting their product as a synthetic biology breakthrough, saving the lives of thousands of sharks. The claim fails to adequately take into account the existing plant-based production of squalane via olives and other plants. They do, however, claim Neossance as a “sustainable” product, arguing that sugarcane production in Brazil is a far more efficient use of land than olive oil.<sup>17</sup> Besides the numerous heavy environmental and social costs that do accompany growing sugarcane in Brazil, this analysis overlooks the fact that when olive squalane is produced from waste streams its land impact is negligible.

Continually commercialized as “100% plant-based,” or “made from plant sugars,” Amyris’ squalane has successfully infiltrated the cosmetic market as a new renewable, responsible and healthy alternative. Brands such as Clarins, Revlon, The Face Shop, Aveeno, L’OCCITANE, Elizabeth Arden and Thomas Peter Roth presently commercialize at least one of Amyris’ syn bio ingredients.<sup>18</sup> Despite being from a clearly unnatural bioengineered source, Amyris market their syn bio squalane with “green” and “natural” branding. Neossance is certified by ECOCERT “in accordance with the Natural and Organic Cosmetics standards”<sup>19</sup> and has the “Natural Seal” certification from the Natural Products Association.<sup>20</sup> Additionally, the Environmental Working Group (EWG), a nonprofit who advocates for environmental health and nontoxic products, has just granted its “EWG VERIFIED™” seal to the Biossance™ moisturizer “The Revitalizer”. The EWG VERIFIED™ standard is said to have been “created to educate consumers, empower them to make smart choices and to change the market.” Their “skin deep database” has “strict guidelines of criteria” in order to “rate thousands of products to inform and educate consumers on what is in their products and why it matters.”<sup>21</sup>

Amyris even claims that their squalane is “GMO-free” because the squalene itself contains no engineered DNA though it is produced by a GMO yeast.<sup>22</sup> Biossance’s advertising plays on the fact that squalane is naturally found in the human body and focuses on women’s empowerment through beauty. Again, the unnatural, industrial source of the ingredient is not disclosed.

Neossance’s real advantage, beyond the marketing hype, might be its cost. While squalane from olive oil is 30% more expensive than that derived from sharks (8-12 euros/kg more expensive)<sup>23</sup>, Amyris’ biosynthetic squalane may be a cheaper non-shark option than olive squalane.

### Implications and the Future:

Neossance Squalane has been an important beachhead product for Amyris and for the use of syn bio-derived ingredients in cosmetics. Its appeal however rests on a mix of cost savings for manufacturers and misleading marketing in what consumers are told. Neossance™ may be cutting a little into the shark squalane market, but it is more significantly undercutting production of squalane from olives and other plants, which provide added value to olive producers and are more genuinely sustainable and ‘natural.’

## Endnotes

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  - 6 Smith, Theresa J (2000). “Squalene: potential chemopreventive agent,” *Expert Opinion on Investigational Drugs* 9 (8): 1841–8. doi:10.1517/13543784.9.8.1841. PMID 11060781; see also <https://en.wikipedia.org/wiki/Squalene>
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