

## Biotechnology

## Thermo Fisher Scientific supports Amyris to optimize the bioproduction of sustainable squalane

Squalane is a hydrocarbon compound found in human skin and some plant sources, and has gained prominence in the cosmetics and skincare industry for its excellent moisturizing and emollient properties. Traditionally, squalane for use in these products was obtained from shark liver oil, which raised significant ethical and environmental concerns. The overfishing of sharks for their squalene-rich livers has contributed to the decline of various shark species and disrupted marine ecosystems. In response to these challenges, there has been a growing shift towards sustainable sources of squalane.

### From sharks to sugarcane

Squalane is derived from squalene, which was originally harvested from sharks and hydrogenated to produce squalane, a practice that has left a lasting impact on marine ecosystems. Biotechnology company Amyris—originally founded in 2003 with a grant from the Bill & Melinda Gates Foundation to create a molecule to treat malaria—has developed an alternative method of producing squalane from sugarcane, providing a more sustainable, economical, and ethical source of this useful compound. Using engineered yeast strains in combination with a precision fermentation methodology, the company is able to produce synthetic farnesene from sugarcane biomass, which can be processed into squalane through dimerization and hydrogenation.

### Bioprocessing bites back

Amyris uses *Saccharomyces cerevisiae* to produce farnesene from sugarcane through a multi-step fermentation. This approach improves the stability of the yeast, allowing it to produce at the highest level possible to maximize yields and productivity. Carefully monitoring the reactor conditions at each stage is critical to ensure that the yeast is producing the farnesene efficiently.

A Thermo Scientific™ Prima PRO Process Mass Spectrometer provides online gas composition analysis for real-time monitoring, allowing alterations to the reaction conditions as needed. This is particularly important during the final 'master fermentation' step, where monitoring of ethanol, oxygen and carbon dioxide provides a close insight into the carbon balance. Any unexpected 'missing' carbon can indicate the production of unwanted molecules and impurities. Online monitoring of both sparge and outlet gases can be used to calculate the respiratory quotient (RQ)—the rate of oxygen consumption and carbon dioxide evolution. Knowing the RQ is essential to understand the health of the culture, indicating both the metabolic efficiency and the type of nutrients being consumed.

Precise evaluation of the concentrations of a bioreactor's inlet and outlet gases provides an ideal approach to accurately track a culture's growth kinetics and substrate consumption in a non-invasive manner, without compromising the sterility of the environment. Monitoring ethanol provides insights into whether the strain is in an aerobic or anaerobic state, allowing adjustments to the reaction as necessary, whereas measuring oxygen consumption—and keeping it as close to a target value as possible—ensures that the process is progressing as expected, ensuring uniformity of results.

### A sustainable future

Mass spectrometry provides a powerful analytical tool for monitoring and controlling yeast fermentation processes to optimize production of farnesene in squalane production. It ensures that the fermentation proceeds efficiently, yields a high-quality product, and minimizes the risk of process deviations or failures. Biofermentation has several advantages over traditional squalane extraction methods. First and foremost, it is more sustainable as it reduces the need for shark liver oil, a finite and ecologically problematic resource. Additionally, it offers greater control over the production process, resulting in a more consistent and reliable supply of squalane. Moreover, it aligns with the growing demand for environmentally responsible and cruelty-free beauty and skincare products, making it a preferred choice for manufacturers and consumers alike.



Prima PRO Process Mass Spectrometer.