Aroma Chemicals From the Tropics

Shao Quan Liu on Singapore's role in the F&F industry and the future of biotech aroma chemicals

Palm kernel oils can be converted into methyl ketones via fermentation.

"All the major flavor and fragrance houses are operating here," says Shao Quan Liu of the Food Science and Technology Program of the National University of Singapore's Department of Chemistry. Liu, who will speak as part of the International Federation of Essential Oils and Aroma Trades in Singapore (*http://ifeat.org/*), notes that Singapore's well-educated population, proximity to many crucial Asian economies and government investments in biomedical-life science areas have made it a hot spot for innovation.

Recently, Takasago International (Singapore) Pte. Ltd. made a $33.67 million investment in a new Singapore facility as part of its regional expansion strategy.

"As a company rooted in Asia, Takasago is deeply committed to developing high quality and innovative products in Singapore to meet the rapid rise in demand from India to Southeast Asia and Australia," said Ritaro Igaki, Takasago International president and CEO. "This new investment will be the first of several commitments we will make in the near future."

Meanwhile, Symrise's Asia-Pacific division opened a new Singapore facility as part of a $40 million investment program. "[O]ur business has strongly grown and Asia-Pacific has become our second largest market," said Declan MacFadden, president of Asia-Pacific at Symrise. "Another key factor for maintaining a strong presence in Singapore is that we see the country being at the forefront of the food manufacturing industry, constantly expanding and growing organically but never compromising on intellectual property standards."

And next year Givaudan plans to unveil its new Singapore-based creative and commercial center and high volume production center.

Growing F&F investments in the country, paired with its biotech research priorities have made Singapore a hub of innovation in aroma chemical production.

New Routes for Aroma Chemical Production

Liu notes that the challenges associated with traditional aroma chemical production via plant material extraction include the use of solvents and relatively low yields at the end of the process. For example, he says, yields of 2-phenyl ethanol from the extraction of rose flowers are quite small, while the cost is high. (Liu is quick to note that biotech production of aroma chemicals is higher-yield only in comparison to natural extraction; chemical production processes, he says, are generally more yield-efficient than biotech.)

"Companies need to grow a large amount [of plants] on a large land area, which brings up the issue of competition with [food] agriculture," he adds.

In this context, Liu notes, biotechnology solutions offer milder conditions, do not require a large land area and generally don't compete with agricultural land. These operations require equipment such as fermentation tanks, similar to those used in breweries, "so the barrier is not that high."

"My personal view is that the main cost barrier is enzymes," Liu says. "At the same time, many of the enzymes offered by enzyme manufacturers are produced in a crude form. In other words, the costs will be significantly down. And many of the enzymes produced in an immobilized form on silica supporting material can be reused five to 10 times. These technical advantages will help reduce the costs."

The issue, Liu stresses, is cost and sustainability relative to the product. "The [traditional] chemical processes very often involve high temperatures, high pressure, which means high energy consumption as well as acids, alkali or catalysts that could be hazardous," he says. "Enzyme processes involve much lower temperatures (even room or ambient temperatures), milder conditions, normal pressure and no acids/alkali. Currently, many of the enzymes used, like lipase or protease, don't require addition of heavy metals as a "cofactor." Chemical processes often use raw materials from petrochemicals; of course, there are renewable and sustainability issues."

Key Ingredients

"Biotech processes by and large use natural, renewable materials," says Liu. "Agricultural byproducts like rice or maize brans, which contain ferulic acid, are cheap, readily available raw materials that can be converted into vanillin." He adds, "A lot of research has been done on L-phenylalanine, which can be converted into 2-phenylethanol by fermentation." This material, which is found in essential oils such as rose, ylang-ylang, neroli and many others, has practical application in formulations.

Meanwhile, biotech may face its own feedstock challenges. In the long-term, says Liu, the use of corn, a staple food crop, in biotech may become a "tricky" issue. "The amount of flavor and fragrance materials consumed will be much smaller [compared to biofuel production and consumption], therefore, the amount of corn used for this purpose will be much, much smaller. Still, there's always a dilemma there," he says. One partial solution he points to is the use of coconut and palm kernel oil.

"Depending on the method used and the context of biotechnological method, a number of ingredients can be produced, including fatty acids," says Liu. These medium-chain fatty acids, according to him, "can be converted into a raft of aroma-active bio-esters in the presence of bio-produced short-chain alcohols and an appropriate biocatalyst." By Liu's estimation, more than 30 aroma-active bio-esters can be produced in this manner. "These esters impart a broad range of fruity notes with subtle nuances," Liu's presentation abstract states. "With a consumer trend toward naturalness, naturally produced bio-esters would command a price premium." He adds that coconut and palm kernel oils could also be converted into methyl ketones via fermentation.

As consumer trends point increasingly to natural products and sustainability and supply concerns grow, the role of biotech may expand to meet evolving needs.