Boosting palm oil extraction rates

Enzymes are nature's catalysts and global enzymes leader Novozymes is targeting the palm oil market with a new product it believes will help increase oil extraction yields for low capital investment. Serena Lim writes

PHOTO: ADOBE STOCK

Enzymes can be viewed as nature's catalysts, speeding up vital biological processes as well as chemical reactions.

Novozymes, which has a 48% market share of the global enzymes market, is turning its focus on Malaysia, Indonesia and the palm oil market, with an enzyme that it says will improve oil extraction rates (OERs).

"From cosmetics and biscuits, to soaps and fuels, palm oil is part of our everyday life," the company says. "As demand rises, so does the need to use resources more efficiently."

Palm and palm kernel oils comprise one-third of global oil production (*see Figure 1, below*) and palm is, by far, the most efficient oil crop, outmatching all others in terms of average yield per hectare (*see Figure 2, below*), Novozymes says.

"Yet palm oil milling concepts have not changed significantly since the 1950s and OER performance has stagnated in the 20-22% range for many years."

The company is now trialling its Palmora enzyme at several mills in Malaysia and Indonesia and says that full-scale plant operations are recording OER increases of at least 0.5 percentage points, accompanied by a reduction in effluent loads.

How it works

"Our enzyme-assisted oil extraction process is a game-changing technology that benefits both old and new palm oil mills and addresses the challenges the industry faces today," says Hong Wai Onn, technical service manager, oils and fats, Southeast Asia, for Novozymes Malaysia.

Speaking at the International Palm Oil Congress and Exhibition (PIPOC) in November 2017, Hong said that Palmora:

- Increases OERs
- Reduces viscosity, thereby enabling better oil separation
- Reduces hot dilution water, meaning less effluent.

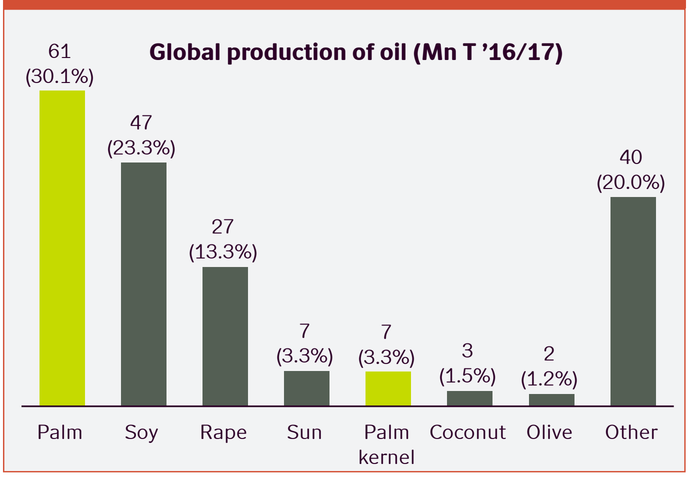
Describing the Novozymes process, Hong said that fresh fruit bunches (FFBs) are sterilised durinig palm oil milling and then stripped (*see Figure 3, following page*).

Water and Palmora are applied to the palm fruit before maceration, through a novel applicator system, to the mass passing digester.

The enzyme softens and breaks down the hemicellulose matrixes in the oil-bearing cell walls of the palm fruit mesocarp, enabling easier oil release.

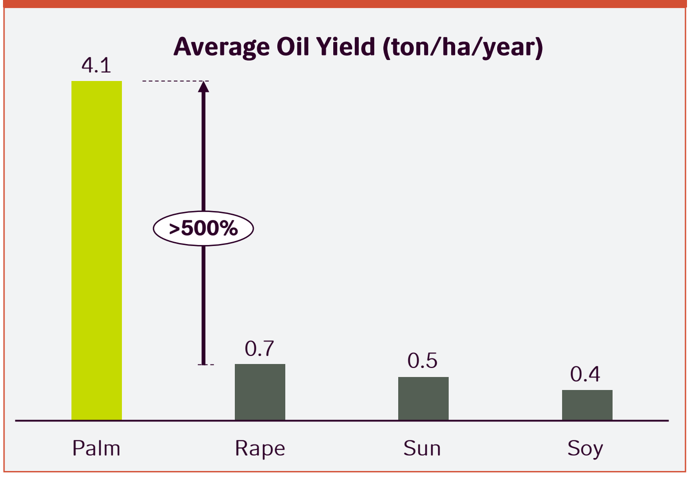
It increases cell wall rupture during digestion and screw pressing, resulting in less oil in the press ▶

FIGURE 1: OVERVIEW OF CURRENT VEGETABLE OIL PRODUCTION



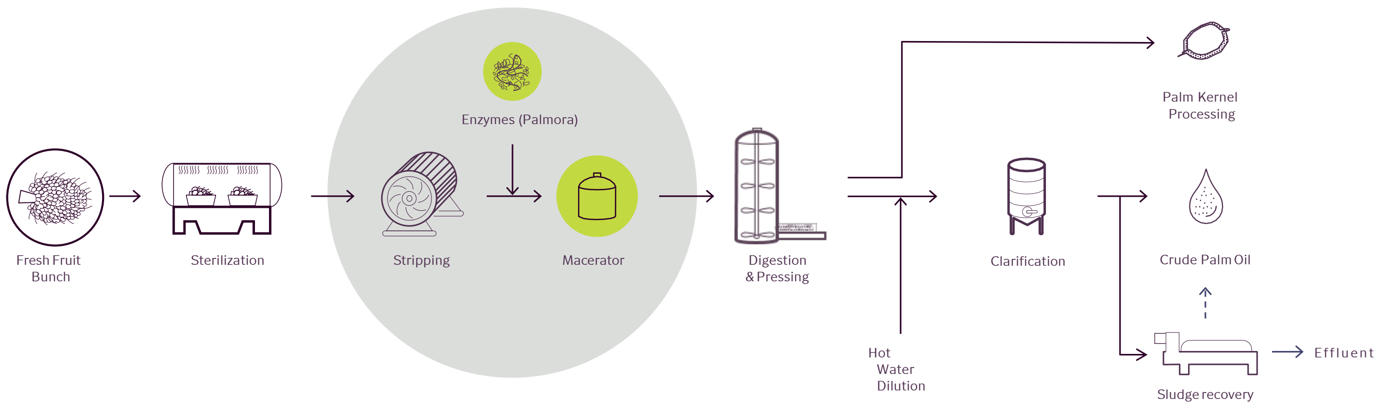
SOURCE: FAOSTAT 2016, GLOBAL PALM OIL PRODUCTION 2016, OIL WORLD, 2013

FIGURE 2: EFFICIENCY OF OIL CROPS (TONNE/HECTARE/YEAR)



SOURCE: NOVOZYMES

FIGURE 3: ENZYMATIC PALM OIL EXTRACTION PROCESS



- Water and Palmora are added through a novel applicator system to the mass passing digester at screw conveyor.
- Recommended process conditions are 300-350ppm of Palmora, 2.5-3.0% water, at temperatures of 65-85°C.

SOURCE: NOVOZYMES, INTERNATIONAL PALM OIL CONGRESS AND EXHIBITION (PIPOC) IN NOVEMBER 2017

fibre and less unbroken cells in the sludge waste.

In addition, it reduces the viscosity of undiluted crude oil. These benefits enable early oil harvesting prior to downstream clarification.

Hong says there is faster separation of the oil and water phases in the clarifier tank.

The system also reduces palm oil mill effluent generation in the clarifier tank.

In addition, there is also considerably less need for hot dilution water because of the lower viscosity in the undiluted crude palm oil, leading to significantly reduced water usage.

"These improvements can be obtained for low capital investment and with significant improvement to the bottom line," he says.

Equipment and costs

While Novozymes believes there are clear advantages to introducing Palmora, plantation companies will still need to weigh up the costs of introducing the enzyme system, which is compatible with existing facilities and equipment after minor retrofits.

There is the cost of the enzyme, at a rate of some 300-350 ppm, or around 0.33kg/tonne of FFB.

A plug-and-play enzyme applicator is needed to apply Palmora to the palm fruit. In addition, a macerator is needed to give the enzymes the right conditions, although some mills may already have one installed.

"The capital cost will depend on the mill layout and footprint but, by combining all the benefits of the system, there is the potential to downsize downstream equipment, such as a smaller capacity decanter, leading to a smaller footprint," according to Hong.

On top of this, Novozymes offers technical service and training along with the enzymes in the form of onsite specialists to support their customers.

Novozymes says that its solution has already been proven full-scale on a continuous basis.

"We continue to supply current partners and the expectations are that more and more oil millers will soon embrace this opportunity to continue to increase extraction rates and improve their bottom lines significantly." ●

What are enzymes?

Life would not exist without enzymes, but what exactly are they? Simply put, enzymes are proteins that act as catalysts.

When one substance needs to be transformed into another, nature uses enzymes to speed up the process. In our stomachs for example, enzymes break down food into tiny particles to be converted into energy.

Enzymes are present in all living cells. They are highly specific, allowing specific reactions and acting on specific substrates. They are fully biodegradable, breaking down into harmless amino acids. And they are nature's tools, speeding up vital biological processes.

Many industries use naturally-occurring enzymes as catalysts to speed up chemical reactions to produce a variety of everyday products, such as vegetable oils, cheese, beer, bread and ethanol.

Advances in science, including biotechnology, have also enabled the production of improved enzymes. Specific genes that tell a microorganism to produce a specific enzyme can be isolated, modified and improved. This gene can be transferred to a production microorganism – selectively bred by industry – that produces large quantities of the enzyme. Once fermentation is complete, the desired enzymes are recovered from the fermentation broth and the microorganisms are inactivated.

This process has enabled the development of enzymes which are more effective at the desired temperatures, pH or under manufacturing conditions that would inhibit enzyme activity (such as harsh chemicals), making them more efficient for home and industrial applications. These applications include:

Detergents

Enzymes have been used in many kinds of detergents for over 30 years to help remove stains. Most modern detergents contain a mix of several different enzymes, such as proteases (removes protein stains), amylases (removes starch stains), pectate lyases (removes fruit stains), mannanases (removes mannans, which are used as a thickening agent in cosmetics, toothpaste and in many processed foods such as dressings and ice creams), lipases (removes fats) and cellulases (clears colours and removes pills and fuzz on the fabric). These provide a sustainable and effective alternative to chemical ingredients, which enables consumers to wash their clothes at much lower temperatures and reduces water consumption.

Foods and beverages

Humans have been using enzymes for centuries to produce foods without really knowing it. For instance, it was our Bronze Age ancestors who discovered that an enzyme found in cows' stomachs could turn milk into cheese. Later, enzymes from yeasts and bacteria also made it possible to produce wine, beer and vinegar. Nowadays, it is possible to isolate the specific enzymes responsible for these processes, allowing for specialised strains that improve the flavour, quality and consistency of each product. Other enzymes reduce the length of time required for aging, help clarify or stabilise products, or help control alcohol and sugar content.

Textiles

Enzymes are widely used to prepare the fabrics for clothing, furniture and other household items. Increasing demands to reduce pollution caused by the textile industry has fuelled advances that have replaced harsh chemicals with enzymes in nearly all textile manufacturing. Enzymes are used to enhance the preparation of cotton for weaving, reduce impurities, or as a pre-treatment before dying to reduce rinsing time and improve colour quality.

Oils and fats

In edible oils and fats, enzymes are already used in various applications.

Enzymatic degumming is a well-established industrial process in vegetable oil refining.

During refining, each step to separate oil from impurities – such as phospholipids – results in a loss of yield.

In traditional refining, phospholipid removal is achieved by adding water to the crude oil, hydrating the phospholipids and causing an emulsion to form. The water and phospholipid will create a gum phase wherein a certain amount of oil will be trapped.

This viscous gum is then separated from the bulk oil by centrifugation, in a process termed 'water degumming'. Following centrifugation, neutral oil is entrained within the intact phospholipids in the gum, which represents a yield loss. Water degumming can be costly to producers and also uses high amounts of water, energy and raw materials.

In enzymatic degumming, phospholipases are used to break the phospholipids into water-soluble and oil-soluble fragments, disrupting emulsion formation and releasing entrained oil, making degumming easier. Gums are converted into water-soluble lysolecithin, which is removed after a one-step centrifugation stage. Benefits include higher yields, reduced chemical use and reduced formation of gums, which are virtually oil free.

Interesterification modifies the physical properties of oils by rearranging the fatty acid groups within and between different triglycerides.

It is used, for example, to modify the overall melting profile of oils and to improve the compatibility of oils in the solid state, with applications in margarine and confectionery fat production.

Both chemical or enzymatic catalysts can be used in interestification. Enzymatic interesterification offers selectivity, mild reaction conditions, low temperatures, uses 'natural' lipase catalysts, with no need to wash or bleach resulting fats.

Biofuels

Bioethanol can be produced from starchy plants such as corn and wheat, with enzymes efficiently making the conversion.

One of the greatest breakthoughs in enzyme technology for biofuels has come in the area of cellulosic ethanol, in which low-cost, non-food feedstocks such as corn stover, woody residues and municipal solid waste can be used. This kind of biomass has a more complex structure and is more difficult to convert into ethanol. Enzymes are vital in this conversion.

Biodiesel can also be produced enzymatically, without the need for harsh chemicals like sodium methoxide and sulphuric acid, even for biodiesel feedstocks with high free fatty acid (FFA) content, such as palm fatty acid distillate.

In fact, the higher the FFA content, the better for the enzymes, meaning that enzymatic producers can benefit from greater feedstock flexibility, higher yields and increased safety, on top of being able to utilise and increase the value of low value feedstock such as palm fatty acid distillate and palm acid oil, among others.

In addition, the process has fewer processing steps, produces higher quality glycerine by-product, uses less energy and generates less waste water. ●