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BioTimes®

The quarterly bioindustrial magazine from Novozymes



novozymes® 

Unlocking the magic of nature

Novozymes is the biotech-based world leader in enzymes and microorganisms. Using nature's own technologies, we continuously expand the frontiers of biological solutions to improve industrial performance everywhere.

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A breakthrough in oils and fats

The ninth in a series of short articles about how biological solutions have driven the evolution of industry forwards.

Consumers are watching more carefully what they eat and what is written on food labels. The new trans fat labelling introduced in the USA in January 2006 has created a big interest in enzymatic interesterification for the production of trans-free margarine fats. Similar labelling was introduced in parts of Latin America in August 2006.

In July 2002 ADM built the first commercial units in the USA for enzymatic interesterification using Lipozyme® TL IM from Novozymes (see *BioTimes* Sept. 2003 and Sept. 2005). They were pioneers in the production of trans-free margarines and shortenings.

This issue of *BioTimes* contains an article about another pioneer - an Argentine

company called Flora Dánica (see pages 8-9) that is the first in the world to produce trans-free fats using a new engineering solution developed jointly by Novozymes and Desmet Ballestra (see page 10). This is proof that a reliable and competitive process is available for large-scale enzymatic interesterification. It represents a breakthrough in the oils and fats industry. Now a real alternative to chemical interesterification is generally available. In comparison to the chemical process, enzymatic interesterification offers a clean technology that produces no effluents or unwanted by-products and requires little post-treatment of the interesterified oil.

Enzymes are biological catalysts that represent green technology. Being biological, they allow oils and fats to be processed in a more natural way. Time after time, in various industries, Novozymes has seen how enzymes can be used to replace harsh chemicals. Enzymes work under mild condi-

tions and are more specific than chemicals, so they give fewer unwanted by-products, if any. For example, enzymatic degumming of vegetable oils gives rise to no soap whatsoever, unlike the traditional chemical refining method.

One thing is certain: the environmental regulations around the world are likely to become tougher in future, and enzymes can help companies to meet them.

Enzymes are finding their way into vegetable oil refineries all over the world, as demonstrated by previous degumming case stories in *BioTimes* from Egypt, the Ukraine and the USA. Novozymes is currently helping companies in many other countries to reap the benefits of enzymatic solutions for oils and fats processing. These companies see how enzymes can save them money while allowing them to make products that live up to consumer demands for healthy food and environmental responsibility. ●

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Recaldent™ - made from milk to protect teeth



Chewing gum marketed in Mexico and Japan contains Recaldent™ (CPP-ACP).

Pancreatic trypsin from Novozymes is used in Australia in the manufacture of a casein phosphopeptide (CPP) complex from milk protein. The product is known as Recaldent™ and provides bioavailable minerals to tooth enamel to help prevent decay.

Dairy products like milk and cheese are known to prevent dental caries, or tooth decay, in humans and animals. Research has shown that the casein protein component of dairy products is responsible for this effect.

In nature, the enzymes in the mouth and stomach produce peptides from milk protein. There is a group of peptides called casein phosphopeptides that stabilise calcium and phosphate, maintaining them in an amorphous or soluble form known as ACP. Calcium and phosphate are the building blocks of tooth enamel. Normally they are highly insoluble, but in the presence of these peptides they remain soluble and bioavailable. When this peptide-calcium phosphate complex is delivered to the teeth in a chewing gum, paste or mouthwash, or even potentially in food, the peptides bind to the tooth surface and effectively provide a reservoir of soluble calcium and phosphate at the surface of the tooth.

Professor Eric Reynolds, head of the School of Dental Science at the University of Melbourne in Australia, undertook research to produce CPP-ACP complex in the laboratory using milk casein and

Pancreatic Trypsin Novo (PTN) concentrate. The research has been ongoing for many years and the university now holds patents relating to CPP-ACP in many countries.

The patents were licensed to the Australian dairy company Bonlac Foods Ltd, who built the first full-scale processing unit to manufacture the CPP-ACP complex, which is marketed under the trade mark Recaldent™.

Novozymes and its distributor in Australia, Oppenheimer, worked very closely with Bonlac Foods in 1999 during the development phase to optimise the production of Recaldent™ (CPP-ACP). A concentrated version of the enzyme PTN was made exclusively for this application. The trypsin activity as well as the side activities play an important role in obtaining good yields of Recaldent™ (CPP-ACP).

Success in Japan

The first company to use Recaldent™ (CPP-ACP) was the Adams confectionery business. They incorporated Recaldent™ (CPP-ACP) into sugar-free chewing gum that was marketed in the USA, Japan and four European countries.

Recaldent™ chewing gum has been very well received in Japan, where it has been sold over the counter and also through dental surgeries since 2000.

Recaldent™ (CPP-ACP) is also used in Trident White Gum, a leading whitening gum in the USA. Recaldent™ (CPP-ACP) gives an added benefit to this high-end oral care gum.

Apart from gums, Recaldent™ (CPP-ACP) is used in a paste that is recommended by dentists for a variety of dental indications. A global dental materials company based in Tokyo by the name of GC Corporation has developed a concentrated paste containing Recaldent™ (CPP-ACP) that is known as GC Tooth Mousse in most parts of the world and as MI (Minimum Intervention™) Paste in the USA and Japan.

“Unexplored opportunities”

In 2003 Cadbury Schweppes group acquired the Adams confectionery business and decided to purchase the Recaldent™ (CPP-ACP) business from Bonlac Foods at the same time. A new exclusive licence was entered into with the University of Melbourne, and the manufacturing of

Recaldent™ (CPP-ACP) was moved from the old Bonlac Foods site at Toora to a Cadbury Schweppes manufacturing site in Scoresby, a suburb of Melbourne. The technology and Recaldent™ (CPP-ACP) ingredient are now marketed internationally by Cadbury Schweppes.

According to Geoff Webster, the Commercial Manager of Recaldent™ (CPP-ACP) at Cadbury Schweppes in Melbourne: "The interest from my own organisation and from third parties is sure to grow. There are lots of unexplored opportunities for the Recaldent™ (CPP-ACP) technology in confectionery, food and drinks, and in the oral care area such as toothpaste and mouthwash."

He travels to different parts of the world explaining the virtues of Recaldent™ (CPP-ACP), often accompanied by Professor Eric Reynolds, who presents scientific data based



Siddique Samad (Business Development Manager at Novozymes covering Australia and New Zealand), Dr Ian Mitchell (Scientific Development Manager at Cadbury Schweppes), Vince Zappia (Operations Manager at Cadbury Schweppes in Melbourne) and Marnie Semmens (Sales Manager at Oppenheimer) in front of the only processing unit of its kind in the world producing the CPP-ACP complex trademarked Recaldent™

on numerous trials. For example, tests conducted by the University of Melbourne have shown that Recaldent™ (CPP-ACP) is capable of blocking the effects of sugars and acids on teeth.

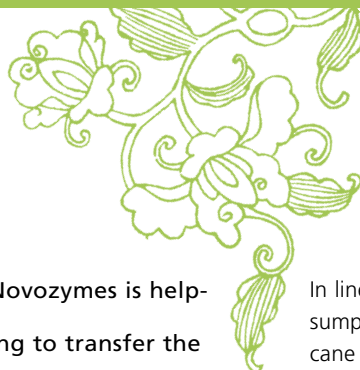
An acidic fizzy drink that doesn't attack your teeth? A chocolate bar or sweet that negates the effects of sugar on the teeth? These are interesting product concepts to be explored in future. ●

FOR MORE INFORMATION
www.recaldent.com

Helping China to make starch even sweeter



The raw material used in China for making a sweetener as sweet as sugar.



Novozymes is helping to transfer the enzyme technology for the production of high fructose corn syrup to China, where the interest in this sweetener is growing.

In line with China's economic development, the consumption of sugar has increased. China grows sugar cane but does not produce enough sugar to supply its domestic consumption, which was 11.5 million tons in 2005. Two million tons of sugar needed to be imported in 2005.

Agricultural land for growing sugar cane in China is limited due to the climate and urbanisation. One crop that is more abundant in China is maize (corn), and China is the second largest producer in the world. Maize is hardly renowned for its sweet taste but it is rich in starch. Using enzymes, the starch can be converted into a wide range of sweeteners, including glucose, maltose and fructose. In fact, 6 million tons of maize were converted by the Chinese sweetener industry in 2005.

Sugar substitute

High fructose corn syrup can be used as a substitute for sugar. It matches sugar in almost every respect, including quality, degree of sweetness and caloric value. But unlike sugar, HFCS is always supplied as a liquid. HFCS cannot therefore be used where a dry sweetener is required. Apart from this one exception, HFCS can replace sugar to a greater or lesser extent in a wide range of food and beverage applications.

The USA is the most significant producer of high fructose corn syrups and consumes about 75% of world production. Japan, the world's second largest importer of sugar, is another significant producer of HFCS.

Rising demand

Historically, HFCS production has been very small in China due to high production costs and old technology.

With the recent changes in the demand and supply situation for sugar in China, HFCS has become an economical alternative to sugar and Chinese producers of sweeteners from maize have started up or expanded production of HFCS. Production almost doubled in 2005 to 0.25 million tons from 0.14 million tons in 2004. The official estimate from the Starch Sugar Branch of the





HFCS is used as a sweetener for soft drinks in China.

WHAT IS SUGAR?

Glucose, fructose and galactose are the three basic monosaccharides (single sugar molecules). From these three units, other sugars are formed either naturally or by processing. The following disaccharides are composed of two monosaccharides joined together:

Sucrose < glucose
fructose

Lactose < galactose
glucose

Maltose < glucose
glucose



Chinese Fermentation Industry Association is that HFCS production will reach 0.6 million tons in 2006. China has 20 plants for producing HFCS and several new plants are under construction. In China it takes about one year to take an isomerisation plant from the design stage to commissioning. Most of these new plants are being installed by local Chinese starch processors that have no previous experience of high fructose production.

Strong support

"We have been very active in this market and have worked closely with the industry association to explain the technology and educate customers in how to use enzymes," says Jianbin Lu, industry sales manager for Grain Processing at Novozymes in China. "Our sales team has made a lot of effort to introduce this new application while our Customer Solutions team has worked hand in hand with new customers unfamiliar with fructose production. They give training seminars for the operators and production manager, and they are there when a new plant is commissioned. They have even helped to design some plants by making suggestions. We provide a lot of added value."

The local Customer Solutions experts for the starch industry in China are Jianming Hao, Zhong Pan and Xiangguo Zhao. When required, Customer Solutions colleagues from Europe and the USA have visited China to advise customers or give seminars. This means that Chinese customers can benefit from Novozymes' many years of experience of HFCS from other countries where the application is well established.

Sweetzyme® IT from Novozymes is sold worldwide for this application and sales are growing in China. This immobilised glucose isomerase is packed into columns, where it converts glucose into fructose in a continuous process.

A typical isomerisation column in China is filled with 300-500 kg of Sweetzyme IT, which will last about 300 days before the enzyme activity is exhausted and the packed bed needs to be changed.

The enzyme is sensitive to both temperature and pH, so these parameters must be carefully controlled to preserve the activity of the enzyme.

Soft drinks

So far the high fructose corn syrup produced in China has been primarily used as a sweetener for soft drinks. It is made in two grades: HFCS 42 (42% fructose) and HFCS 55 (55% fructose). However, there are other potential markets yet to be explored. Here too Novozymes can help by making customers aware of the opportunities for HFCS in other applications such as baking and confectionery.

"The production of fructose is a new thing for local starch processors in China," comments Novozymes' Chunshun Fang, regional marketing manager for the starch industry in Asia Pacific. "Our industry sales manager, account managers and Customer Solutions people have contributed a lot to the development of this application in China. When a new plant starts up, we are there." ●

GLUCOSE is the basic sugar unit of which many sugars are composed and to which most sugars and starches are broken down.

DEXTROSE is pure glucose.

FRUCTOSE or fruit sugar is present in most fruit, many vegetables, and honey. It is the sweetest of all common sugars.

SUCROSE is the sugar most of us are familiar with in our homes as white or brown sugar. It comes from cane or beet sugar and is composed of equal parts of glucose and fructose. (In the article, the term 'sugar' refers to sucrose.)

INVERT SUGAR is formed by the hydrolysis of sucrose to a mixture of fructose and glucose by the enzyme invertase.

HIGH FRUCTOSE SYRUP (also known as high fructose corn syrup, isosyrup, isoglucose or starch sugar) is chemically and physically the same as invert sugar. It is a mixture of glucose and fructose, the fructose being formed by isomerisation of glucose using a glucose isomerase.

LACTOSE is also known as milk sugar and is naturally present in milk.

MALTOSE is found in sprouting grains and malted cereals.

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Novozymes presents an enzyme solution that enables even greater cost efficiency on dough strengthening in straight-dough and Chorleywood processes. Lipopan Xtra is a new member of the Lipopan product range, pioneering lipases that dramatically improve cost efficiency when compared to chemical emulsifiers in baked products.

“ Lipopan® Xtra opens up additional market segments and gives value to bread improver manufacturers. ”

Strengthen your dough and your profit with Lipopan[®] Xtra



High-quality bread improver formulations rely on dough strengthening, and Novozymes' groundbreaking Lipopan F enzyme solution has proven to be a cost-effective dough strengthener, especially in Turkish-style and French-style bread and overnight fermented bread.

"Lipopan Xtra complements Lipopan F by offering even greater returns on the cost of dough strengthening in straight-dough and Chorleywood processes. Together they represent the most cost-efficient dough strengtheners for a broad range of baked products," says Anett Lund-Nielsen Colstrup, launch manager at Novozymes.

Innovative enzymes as a substitute for emulsifiers

Chemical emulsifiers such as DATEM and SSL/CSL are often added to bread improvers to improve overall bread quality and prevent the dough from collapsing during production.

Lipopan is a lipase that works on the lipids naturally present in the wheat flour and modifies non-polar as well as polar lipids such as lecithin. These modified polar lipids increase the stability of gas cells in the dough, improving dough stability.

"Bread improver manufacturers can use Lipopan to reduce the level of emulsifier used by 50-100%. One kilo of Lipopan can replace anywhere from 100 to 1,000 kilos of chemical emulsifier and have the same effect," says Anett Lund-Nielsen Colstrup.

Reducing the amount of emulsifier also translates into savings in terms of storage, transport and handling costs.

The Lipopan Xtra effect

Lipopan Xtra is most appealing for bread improver formulations for straight-dough and Chorleywood processes and it is the

most cost-competitive lipase in the market for its applications.

"Lipopan Xtra is ideal for these types of baking procedure and works nicely at low dosages. It is a robust enzyme solution and is less sensitive to variation in flour quality," says Luise Erlandsen, science manager at Novozymes. "Also, Lipopan Xtra is soluble in water-based liquid bread improvers, which is a problem for DATEM. And it is also highly stable in liquid bread improvers, thus increasing their storage life."

Lipopan Xtra is also more suitable for butter-containing recipes because other lipases cause malodorous fatty acids to be released.

"Butter-containing recipes also benefit from Lipopan Xtra," says Luise Erlandsen. "You can't use it in croissant dough with lots and lots of butter, but for regular straight-dough recipes with low levels of butter, Lipopan Xtra is less prone to cause off-flavour than other available lipases."

Dough strengthening at lower cost

Both Lipopan products offer good dough stability, improved loaf volume and an improved bread crumb structure.

"Bread improver manufacturers using Lipopan get loaves with very good volume and crumb appearance. This enzyme solution's broad substrate specificity differentiates it from the other lipases in the market," adds Luise Erlandsen.

Lipases also reduce, and in some cases eliminate, the acidic off-flavour associated with some emulsifiers.

Besides improved cost efficiency, there are other advantages of reducing the amount of emulsifiers, including the elimination of anti-caking agents. In hot and humid climates, emulsifiers based on lipids can give caking and lumping problems in

bread improvers. Traditionally, chemical anti-caking agents are used to counteract this problem, but with Lipopan the need is reduced or even eliminated. Lipopan is a free-flowing granulate that doesn't cake, which is a desirable trait.

Lipopan forever

Lipopan Xtra was developed to complement Lipopan F, the first enzymatic dough strengthener, launched in 2001.

"When it was launched, Lipopan F was revolutionary and people in the industry didn't think small amounts of an enzyme would replace chemical emulsifiers. Lipopan F proved that it could be done. It has been a great success and now we're expanding our market reach to accommodate straight-dough and Chorleywood processes with Lipopan Xtra," says Andrew Fordyce, marketing director for Cereal Food at Novozymes.

"Lipopan Xtra is the next and natural evolutionary step in lipases for us. It opens up additional market segments and gives value to bread improver manufacturers.

"We are working on developing lipases tailored for all bread-making processes that work synergistically with other ingredients in the dough. We want bread improver manufacturers around the world to use our lipase solutions to improve dough strengthening cost efficiency and at the same time improve the quality of their final product. Ultimately, our goal is to completely replace emulsifiers with Novozymes' lipases." ●

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READ MORE
www.novozymes.com/lipopan

0% trans fats, 4% increase in Argentine margarine market

The successful introduction of trans-free margarines by Flora Dánica in August 2005 followed the implementation of new enzyme technology and a new engineering solution for interesterification.



Carlos García (left) and Mercedes Larrain of Flora Dánica with Luis Alessandro of Novozymes. An immobilised lipase from Novozymes is used at the Llavallol plant near Buenos Aires, where Carlos is Production Manager and Mercedes is Research Manager.

In July 2005 Flora Dánica, Argentina's leading manufacturer of margarine, took a bold step. After 65 years in the Argentine market, they had built up a successful range of table margarines accounting for a 60% share of the consumer market. Then they changed everything! To avoid the formation of trans fatty acids (TFAs), they revised their production process and introduced a new enzymatic process to modify vegetable oils. Then they relaunched all of their margarines with new packaging and the 'nutriSystem' symbol to indicate that the products were now free of TFAs.

Mercedes Larrain is Manager of Quality Control and R&D at Flora Dánica. She and her team were responsible for developing the new products. "Overnight we completely changed our packaging and pack design to show that the margarines were different. There is a great risk in changing when you are the leader," she says. "However, the risk has paid off. Sales of margarine had been declining slowly in recent years, but in 2005 the total Argentine margarine market increased by 4%."

Mercedes Larrain attributes this primarily to the increasing sales of Flora Dánica's new products launched with a campaign to promote the health benefits of trans-free margarines.

Cholesterol risk

"It has recently been discovered that TFAs have at least the same impact on the cardiovascular system as saturated fatty acids," says Mercedes Larrain. "There is a correlation between the intake of TFAs and the

increase in cholesterol in the blood. TFAs have also been associated with an increased risk of coronary heart disease in epidemiological studies. Argentinians are becoming increasingly health-conscious. Women in particular are watching what they eat and what they give to their children."

Consumers are now well informed about TFAs. New labelling regulations from August 2006 under the Mercosur Trade Agreement covering Brazil, Paraguay, Uruguay and Argentina require the content of TFAs to be stated on the labels of packed foodstuffs.

At the time of writing, Flora Dánica is still the only company in Argentina making margarines, shortenings and other products free of trans fatty acids. The trans-free margarines fit in with Flora Dánica's aim to produce healthy, nutritious margarines.

In 2006 Flora Dánica has also introduced two new ranges of shortenings for industrial customers: Danlow, with up to 10% TFAs, and Danova, with zero TFAs.

First in the world

The margarines and shortenings are made with a blend of interesterified and non-interesterified oils. Interesterification changes the melting profile of blends of oils and fats to give them the desired solid fat content and melting point characteristics for table margarines and shortenings.

To perform the interesterification, the Novozymes enzyme Lipozyme® TL IM is used. In July 2004 Flora Dánica began testing this enzyme on a laboratory scale. Then they scaled up to a medium-sized

pilot plant with a Plug & Play reactor with a capacity of 100 kg of enzymes. Just one year later they began running the first industrial enzymatic interesterification plant in Latin America and the first such plant in the world to be sold by Desmet Ballestra, a well-known international supplier to the oils and fats industry. The plant has four 100 kg enzyme reactors in series, giving a capacity to produce 20 tons of interesterified fats per day. The enzyme is immobilised and packed into the reactor. The reactors work continuously 24 hours a day and each enzyme bed lasts about one month before the activity becomes low and the enzymes need changing.

Desmet Ballestra has an agreement with Novozymes to jointly promote this new technology. They supply the engineering know-how and equipment, while Novozymes supplies the enzymes.

"This has been a real joint development based on close technical cooperation. Flora Dánica was very quick to implement the new technology and it took just a year to go from lab-scale to full-scale production," says Luis Alessandro, who was closely involved as Novozymes' sales coordinator for the oils and fats industry in Latin America. He sees Flora Dánica as "the reference" for enzymatic interesterification, not just for Latin America, but for the rest of the world.

Reducing risks

One of the special features of the four reactors is that the incoming oils and fats come into contact with the oldest bed of



The term 'nutriSystem' is used by Flora Dánica to indicate that the margarine is free of trans fats.

enzymes first. In this way, the first reactor acts as a protective barrier.

Flora Dánica refines 200 tons of raw vegetable oil per day on-site to remove impurities. The purity of the oil has a distinct impact on yields from the enzyme reactors. By removing substances such as peroxides, yields from the reactors increase by up to 20%.

"The process has been working very smoothly. Our operators had no difficulty in learning how to use enzymes and manage the plant," says Carlos García, the Production Manager at Flora Dánica's Llavallol plant in Buenos Aires, where margarines are produced.

Better than chemicals

Flora Dánica previously made margarines from oils processed in the traditional way by partial hydrogenation. When they were planning to produce trans-free fats, they decided to switch to the interesterification process because using fully hydrogenated fats is not an option. These fats do not melt in the mouth and must therefore be blended with liquid oils and then interesterified. Flora Dánica had the choice between chemical and enzymatic interesterification. Both methods were assessed in the laboratory.

The main advantages of the enzymatic process are a mild temperature, no neutralisation or bleaching is needed, no liquid effluents are generated, and the enzymes are safer to handle than very reactive and unstable chemicals.

The enzymatic process takes place at 70°C, whereas chemical interesterification requires a temperature of 110°C and the

reaction releases even more heat. At such a high temperature, the oil becomes coloured and a bleaching step is required. Sodium soaps are also produced, requiring a water wash of the oil, which leads to wastewater and loss of oil. All this can be avoided. No waste products are produced apart from the enzymes themselves, which are proteins and therefore biological. Flora Dánica disposes of the waste enzymes along with other by-products by incineration.

Better taste

In consumer trials conducted by Flora Dánica, consumer panels found that the new margarines made by enzymatic interesterification actually tasted better and "fresher" than Flora Dánica's previous range of margarines.

"The enzymatic process is best not only for the consumer, but also for us in terms of ecological impact, safety and a clean process," says Mercedes Larrain of Flora Dánica.

An Argentine favourite

The latest innovation from Flora Dánica is fresh pastry sheets for *empanadas*. This favourite food has traditionally been prepared with bovine tallow-based margarine or with margarines based on partially hydrogenated oils. Flora Dánica's new product, called Tapas de Empanadas, is a puff pastry made using margarine based on enzymatically interesterified trans-free vegetable oils. Another new product was launched in June 2006 - trans-free spreads with salty flavours (Dánica Dorada Saborizadas).



"The process has been working very smoothly," says Carlos García, the Production Manager at Flora Dánica's Llavallol plant in Buenos Aires, pictured beside the series of four enzyme reactors.

The company has plans to expand the interesterification plant by adding a further four reactors to double the capacity. They anticipate that sales of their newly launched Danlow and Danova industrial shortenings will increase.

The success of Flora Dánica shows that enzymatic interesterification is a competitive and clean technology for manufacturers of margarines and shortenings. Flora Dánica made a sales success of the fact that they were first in the Argentine market with trans-free margarines. ●

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A cost-effective way to meet consumer demands

Desmet Ballestra and Novozymes have developed a four-stage reactor design suitable for producing the trans- free products requested by health-conscious consumers.

Novozymes is in the business of producing biological solutions to industrial problems. But when the company made a breakthrough in 2000 and developed a new lipase for oil modification called Lipozyme® TL IM, they suddenly found themselves having to deal with engineering problems and issues. This is no ordinary enzyme. It is immobilised and placed in a packed-bed reactor so that it can be used again and again. That's why Novozymes began talking to Desmet Ballestra, an engineering company specialising in the supply of equipment and services to the oils and fats industry. Desmet Ballestra has supplied small and large plants to some 1,500 oil millers around the world, including 30 chemical interesterification plants.

"We came up with the new technology together," says Marc Kellens, Technical Director of Desmet Ballestra. "Novozymes revealed their process know-how and we put our ideas for improving reactor design on the table. Then we ended up with a reliable and competitive technology for enzymatic interesterification that we can both confidently present to the oils and fats industry."

Four reactors

The principle is to have not just one but four reactors. They are connected in series with a countercurrent flow, with the oil coming into contact with the oldest bed of enzymes first.

The first reactor acts partly as a purification step. It has the lowest level of activity because the enzymes have been in contact with oil the longest. If there are any impurities in the oil that are harmful to enzymes, they will only affect this reactor and be absorbed by the enzymes. The most active reactor is the last one, which is also the best protected.

"There is a growing interest in enzymatic interesterification, but it is still a new technology and that means it is associated with a calculated risk," says Marc Kellens. "The calculated risk has to be minimised by assuring potential customers that they can make a commodity product at the same cost or lower than traditional chemical interesterification. I believe we can do this today."

The first customer to purchase an enzymatic interesterification plant from Desmet

Ballestra was the Argentinian company Flora Dánica, and they are very pleased with the results (see pages 8-9).

Three sizes

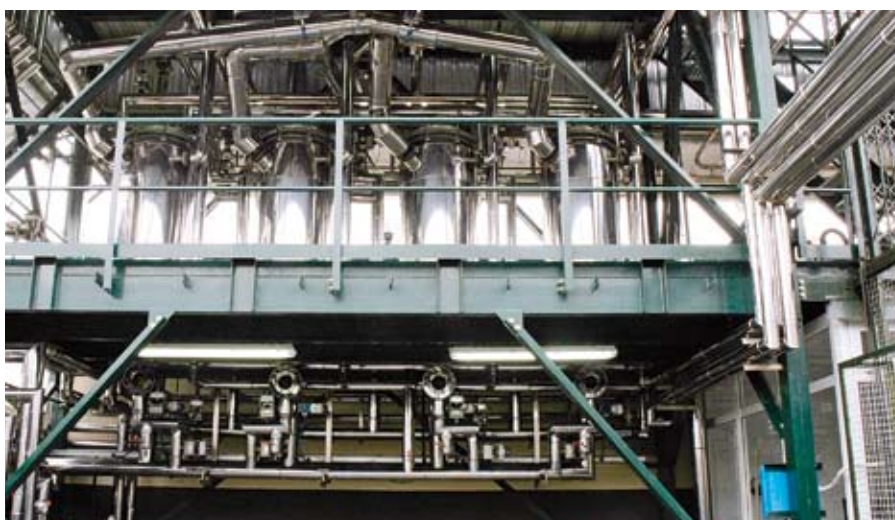
Three sizes of reactor are available from Desmet Ballestra, with enzyme capacities of 100 kg, 200 kg and 400 kg respectively. That means a total of 400 kg (4 x 100 kg), 800 kg (4 x 200 kg) and 1,600 kg (4 x 400 kg) of enzymes respectively, giving a capacity to produce 20-25 tons, 40-50 tons and 80-100 tons of fat per day respectively. In Desmet Ballestra's experience, this will cover the needs of 95% of the market.

For conducting trials on a pilot scale, individual Plug & Play reactors are available on loan, and Desmet Ballestra can supply 10 kg and 20 kg pilot reactors as well. If a company is ready to embark on large-scale industrial production, Desmet Ballestra can give a quote and supply a four-stage countercurrent reactor design that is state-of-the-art technology.

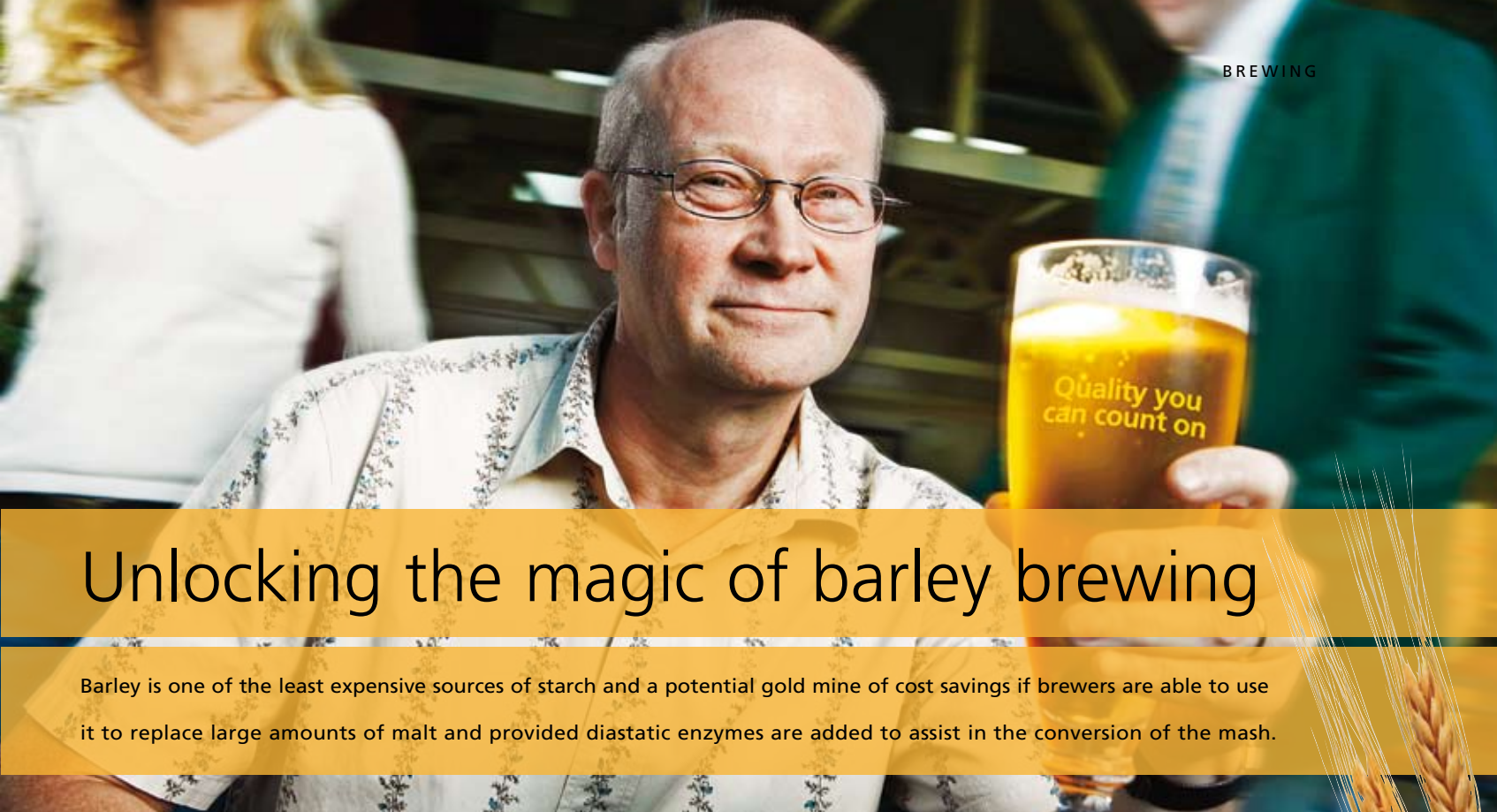
"The automation, process control and safeguards make our process design fail-safe. That is our competitive advantage," stresses Marc Kellens of Desmet Ballestra. "We know how to build a process that is reliable and efficient. That will save customers money in the long run."

Hans Christian Holm, senior manager for Oils & Fats Marketing at Novozymes, adds: "We are very satisfied with our work with Desmet Ballestra in this area as our joint team is now able to deliver a proven and reliable technological solution." ●

Four packed-bed enzyme reactors from Desmet Ballestra have been placed in series and produce 20 tons of interesterified oil a day at Flora Dánica in Argentina.



FOR MORE INFORMATION
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[visit www.desmetballestra.com](http://www.desmetballestra.com)



Unlocking the magic of barley brewing

Barley is one of the least expensive sources of starch and a potential gold mine of cost savings if brewers are able to use it to replace large amounts of malt and provided diastatic enzymes are added to assist in the conversion of the mash.

Traditionally, the main raw material for beer has been malt, which is 30-50% more expensive than adjuncts. In modern-day brewing, it is therefore popular to replace a portion of the malt with maize (corn) grits, barley, sorghum, rice and other starch sources.

“Since enzymes for fermentation became commercially viable in the 1960s, brewers and enzyme manufacturers have been developing ideas for substituting malt with unmalted raw materials and exogenous enzymes,” says Patrick Patterson, global marketing manager at Novozymes.

“In many popular beer brands, 20-40% of the malt is replaced with unmalted raw materials depending on the region and the needs of consumers, but the idea is to substitute even higher portions of the malt and maybe even replace the malt with 100% barley or other adjuncts plus a cocktail of enzymes.”

Standard malt is derived from barley; the main difference between the two is that malt contains more active enzymes. In addition, the barley grain is partly degraded, especially the cell walls and one third of the proteins, while most of the starch is unchanged.

“In principle, malt can be substituted with barley if sufficient enzymes are available during mashing to produce high-quality wort. This can be realised with barley brewing enzyme solutions,” says Sten Aastrup, customer solutions manager for brewing at Novozymes.

“With our latest enzyme solutions, we can now substitute up to 50% or more of the malt with barley, representing raw material cost savings in the range of 15-25% without compromising on wort or beer quality.”

And the use of barley as an adjunct has other advantages besides cost savings. The barley husk eases wort filtration, and the raw barley grains contribute useful amounts of beta-amylase to the mash as well as other enzymes such as peptidase and phosphatase.

“Barley also contributes to palatability and beer foam stability,” adds Patrick Patterson. “And there’s another benefit. Less malt means less CO₂ emissions, which supports the sustainability claims of the brewers.”

Brewing with barley and enzymes

Brewing adjuncts contain insufficient amounts of active enzymes or none at all.

“When brewing with barley, brewers must rely on highly active malt or exogenous enzymes to provide the necessary activity for starch conversion, formation of FAN and degradation of polymers such as glucans and arabinoxylans,” says Sten Aastrup.

Novozymes offers convenient blends, typically containing alpha-amylases, beta-glucanases, arabinoxylanase and proteases. These enzyme cocktails simplify the enzymatic mash treatment because several enzyme activities are dosed at once. The

enzymes are added in the brewhouse at mashing-in.

“Novozymes offers the Ceremix® product range, specially designed for barley brewing solutions. Ceremix can be used alone or in combination with other Novozymes products,” says Patrick Patterson. “Ceremix ensures enzymatic breakdown of the barley grain components, resulting in high-quality wort when substituting up to 50% or more of the malt with barley. The brewing process, however, can remain the same as with malt with no additional time needed.”

The brewhouse of the future

With the increased worldwide focus on cost-efficiency, the future development of barley brewing and the increased use of barley as a substitute for malt is inevitable.

“Through the development of new beer brands, barley shares will probably be further increased,” says Radivoj Glavardanov, brewing consultant for Novozymes. “I believe it is realistic to expect growth in the production of beer without malt. All this could happen with even better complex enzyme preparations.” ●

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The structured interview conducted with 178 customers was seen by many as an excellent opportunity to give feedback.



Customer survey opens up a new channel for dialogue

Customers who responded to this year's customer satisfaction survey have welcomed the opportunity to give feedback to Novozymes. In turn, Novozymes has not been slow in responding to their requests.

When Novozymes conducted a major worldwide survey between March and May 2006 to gauge customer satisfaction, the response rate was reasonably high and the level of satisfaction was well above average compared to similar surveys in other branches.

Emphasis on feedback

What made this different from previous customer satisfaction surveys conducted by Novozymes was the emphasis on feedback and follow-up. For example, one of the most important questions was: How can Novozymes change to add more value to your company?

"We had a goal for the account manager to quickly get back to customers with a response if they had raised any specific questions or issues," says Peter Schröder from Sales & Customer Solutions, the project manager for the Customer Satisfaction Management programme.

"Though our customers are generally satis-

fied with us, the survey has provided us with many ideas on what we can do to make them even more satisfied."

Anders Ohmann is director of Customer Solutions at Novozymes, a worldwide network of technical specialists serving customers. "Our follow-up falls into two separate actions. Firstly, a fast reaction to any specific requests made by customers and, secondly, consolidation of the information for an industry and region to see if there is more that we need to do. We are proud that Novozymes came out with a strong result in the survey, but that doesn't mean we can't do even better."

Overall, the identified improvement areas related mostly to issues that were relevant to certain regions or individual customers. For example, as regards technical documentation, some customers were missing information relevant to their particular applications.

Another example is requests for certain types of packaging, reflecting that there

may be specific needs in particular regions or countries.

Joachim Helms is sales director for Novozymes in North America, one of seven sales areas around the world. He and his sales team of 25 people have carefully studied the results for their particular area and customers.

"We are very happy about the overall results of this survey. And we now have concrete recommendations from customers on which to base our efforts."

One person who has followed up on the results of the survey with a selection of his customers is key account manager Steve Schnurrer in Franklinton, USA. He has found that customers have warmly welcomed the survey. "Obviously we're taking up some of their time, and so they must want to do it. In return, the customer gets a chance to give feedback outside the normal business channels," he says. "Customers are generally very specific about why they're a Novozymes customer and how they think things should work."

An annual survey

The next customer satisfaction survey will begin in January 2007 and is planned to be conducted every year. "We hope for an even higher response to the next survey," says Peter Schröder. "The experience from the first survey is that customers see the interview and questionnaire as a good supplement to their normal dialogue with Novozymes." ●

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A total of 439 customers took part in the survey. Of these, 178 were interviewed face-to-face, while the other 261 submitted a questionnaire via the Internet. Both groups were asked to answer the same questionnaire, which comprised around 80 questions on the products and services provided by Novozymes. However, the face-to-face interviews, which lasted about 90 minutes, also gave an opportunity for an open dialogue with a Novozymes representative from Quality Management. Importantly, this was a neutral person whom the customer does not normally meet.