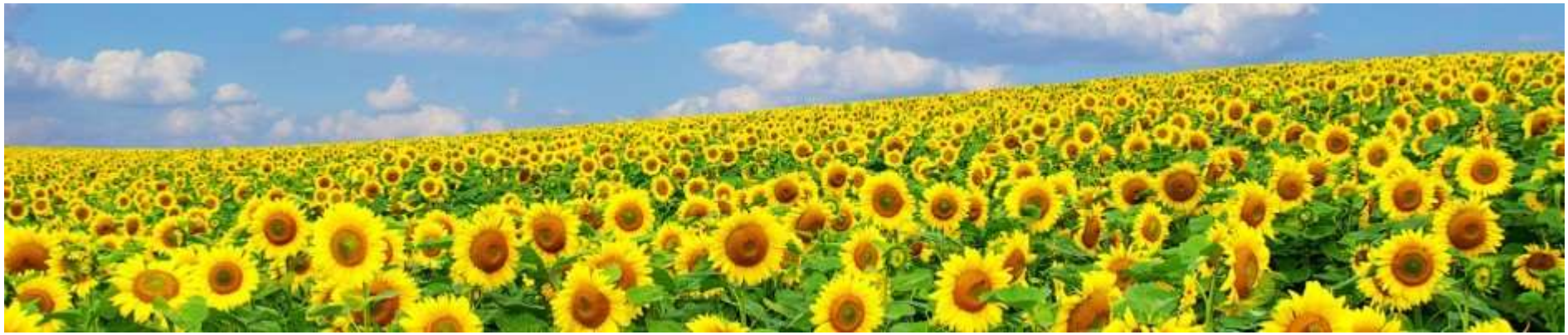

Proposals of the Technology of Fats and Fermentation Products department of NTU «KhPI»

The Department of Technology of Fats and Fermentation Products

- The head of the department:

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Graduate programs:

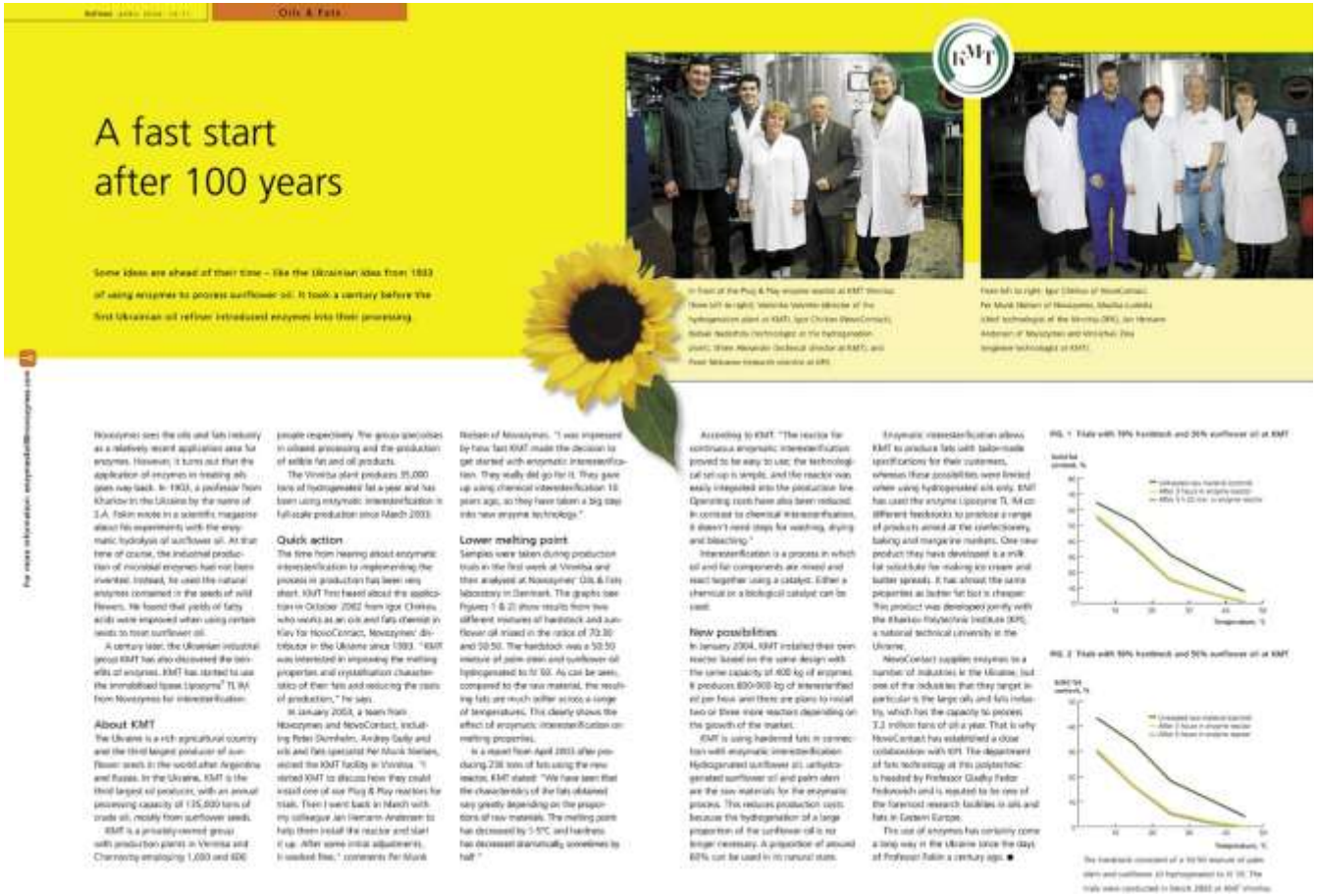
- ✓ Bachelor of Science in Food Technology
- ✓ Master of Science in Food technology
- ✓ Ph.D. in Food technology

The department deals with enzymatic energy-efficient production technologies of functional fats and food emulsions on their basis that have dietary and treatment-and-prophylactic properties

The scientific projects which have been fulfilled by the request of Ministry of Education and Science of Ukraine:

1. Acylglycerols conversions by applying enzymes.
2. The research of enzymatic acylglycerols modification involving ethyl esters of fatty acids.
3. The scientific basis and process development for the production of novel generation of confectionery and cooking functional fats.
4. The scientifically-practical bases of functional fats technology.

Our joint project with Novozymes (Denmark) devoted to the development of enzymatic fats interesterification technology



Oils & Fats

A fast start after 100 years

Some ideas are ahead of their time – like the Ukrainian idea from 1933 of using enzymes to process sunflower oil. It took a century before the first Ukrainian oil refiner introduced enzymes into their processing.

Novozymes sees the oils and fats industry as a relatively recent application area for enzymes. However, it turns out that the application of enzymes in treating oils goes way back. In 1903, a professor from Kharkov in the Ukraine by the name of S.A. Fokin wrote in a scientific magazine about his experiments with the enzymatic hydrolysis of sunflower oil. At the time of course, the industrial production of microbial enzymes had not been invented. Instead, he used the natural enzymes contained in the seeds of wild flowers. He found that yields of fatty acids were improved when using certain seeds to treat sunflower oil.

A century later, the Ukrainian industrial group KMT has also discovered the benefits of enzymes. KMT has started to use the immobilised lipase Lipozyme® TL IM from Novozymes for interesterification.

About KMT

The Ukraine is a rich agricultural country and the third largest producer of sunflower seeds in the world after Argentina and Russia. In the Ukraine, KMT is the third largest oil producer, with an annual processing capacity of 135,000 tons of crude oil, mostly from sunflower seeds.

KMT is a privately-owned group with production plants in Vinnitsa and Chernovtsy employing 1,000 and 600 people respectively. The group specialises in oilseed processing and the production of edible fat and oil products.

The Vinnitsa plant produces 35,000 tons of hydrogenated fat a year and has been using enzymatic interesterification in full-scale production since March 2003.

Quick action

The time from hearing about enzymatic interesterification to implementing the process in production has been very short. KMT first heard about the application in October 2002 from Igor Chirkov, who works as an oils and fats chemist in Kiev for NovoContact, Novozymes' distributor in the Ukraine since 1993. "KMT was interested in improving the melting properties and crystallisation characteristics of their fats and reducing the costs of production," he says.

In January 2003, a team from Novozymes and NovoContact, including Peter Dornheim, Andrey Sadly and oils and fats specialist Per Munk Nielsen, visited the KMT facility in Vinnitsa. "I started KMT to discuss how they could install one of our Plug & Play reactors for trials. Then I went back in March with my colleague Jan Hermann Andersen to help them install the reactor and start it up. After some initial adjustments, it worked fine," comments Per Munk Nielsen of Novozymes. "I was impressed by how fast KMT made the decision to get started with enzymatic interesterification. They really did go for it. They gave up using chemical interesterification 10 years ago, so they have taken a big step into new enzyme technology."

Lower melting point

Samples were taken during production trials in the first week at Vinnitsa and then analysed at Novozymes' Oils & Fats laboratory in Denmark. The graphs see Figures 1 & 2) show results from two different mixtures of hardstock and sunflower oil mixed in the ratios of 70:30 and 50:50. The hardstock was a 50:50 mixture of palm stein and sunflower oil hydrogenated to IV 60. As can be seen, compared to the raw material, the resulting fats are much softer across a range of temperatures. This clearly shows the effect of enzymatic interesterification on melting properties.

In a report from April 2003 after producing 230 tons of fats using the new reactor, KMT stated: "We have been that the characteristics of the fats obtained vary greatly depending on the proportions of raw materials. The melting point has decreased by 1-5°C and hardness has decreased dramatically, sometimes by half."

According to KMT: "The reactor for continuous enzymatic interesterification proved to be easy to use; the technological set-up is simple, and the reactor was easily integrated into the production line. Operating costs have also been reduced. In contrast to chemical interesterification, it doesn't need steps for washing, drying and bleaching."

Interesterification is a process in which oil and fat components are mixed and react together using a catalyst. Either a chemical or a biological catalyst can be used.

New possibilities

In January 2004, KMT installed their own reactor based on the same design with the same capacity of 400 kg of enzymes. It produces 800-900 kg of interesterified oil per hour, and there are plans to install two or three more reactors depending on the growth of the market.

KMT is using hardened fats in connection with enzymatic interesterification. Hydrogenated sunflower oil, carbohydrate-based sunflower oil and palm stein are the raw materials for the enzymatic process. This reduces production costs because the hydrogenation of a large proportion of the sunflower oil is no longer necessary. A proportion of around 80% can be used in its natural state.

Enzymatic interesterification allows KMT to produce fats with tailor-made specifications for their customers, whereas these possibilities were limited when using hydrogenated oils only. KMT has used the enzyme Lipozyme TL IM on different feedstocks to produce a range of products aimed at the confectionery, baking and margarine markets. One new product they have developed is a milk fat substitute for making ice cream and butter spreads. It has almost the same properties as butter fat but is cheaper. This product was developed jointly with the Kharkov Polytechnic Institute (KPI), a national technical university in the Ukraine.

NovoContact supplies enzymes to a number of industries in the Ukraine, but one of the industries that they target in particular is the large oils and fats industry, which has the capacity to process 3.2 million tons of oil a year. That is why NovoContact has established a close collaboration with KPI. The department of fats technology at this polytechnic is headed by Professor Dmitry Peter Fedkovich and is reputed to be one of the foremost research facilities in oils and fats in Eastern Europe.

The use of enzymes has certainly come a long way in the Ukraine since the days of Professor Fokin a century ago. ■

FIG. 1 Trials with 70% hardstock and 30% sunflower oil at KMT

FIG. 2 Trials with 50% hardstock and 50% sunflower oil at KMT

Our hardstock consisted of a 50:50 mixture of palm stein and sunflower oil hydrogenated to IV 60. The trials were conducted in March 2003 at KMT Vinnitsa.

<u>The results of the collaboration</u> are plant-scale production of milk fat substitutes and confectionary fats via enzymatic technology at two fat-and-oil factories of Ukraine

Scientific articles which have been published during 2016-2018 years in journals indexed by Scopus

1. Nekrasov, P. Optimization of formulation composition of health whey-based beverage / P. Nekrasov, N.Tkachenko, S. Vikul // Eastern-European Journal of Enterprise Technologies. –2016. – № 1/10 (79). – P. 49–57.

2. Gladkiy F. Technology of specialty fats based on palm stearin / F. Gladkiy, K.Kunitsa, O.Udovenko, E. Litvinenko, I. Levchuk // Eastern-European Journal of Enterprise Technologies. – 2016. – № 3/11(81). – P. 27–33.

3. Nekrasov, P. Optimization of formulation composition of the low–calorie emulsion fat systems / P. Nekrasov, N. Tkachenko, T. Makovska, L. Lanzhenko // Eastern-European Journal of Enterprise Technologies. – 2016. – № 3/11(81). – P. 20–27.

4. Nosenko, N. New vegetable oil blends to ensure high biological value and oxidate stability / N. Nosenko, E. Shemanskaya, V. Bakhmach, Sidorenko, A. Demydova, T. Berezka, T. Arutyunyan, D. Matukhov// Eastern-European Journal of Enterprise Technologies. – 2017. – №5/6 (89). – P. 42–47.

5. Nekrasov, P. Kinetics and thermodynamics of biocatalytic glycerolysis of triacylglycerols enriched with omega-3 polyunsaturated fatty acids / P. Nekrasov, O. Piven, O. Nekrasov, O. Gudz, N. Kryvonis // Questions of chemistry and chemical technology. - Dnepr: SHEI Ukrainian State University of Chemical Technology . – 2018. – №5. – P. 31-36.

Our proposal for the collaboration

The creation of scientifically-practical bases of enzymatic energy-efficient production technology of cocoa butter equivalents (CBE)

The novelty of the project is the suggestion about the application of ethyl esters of fatty acids, mostly stearic acid ethyl esters, as functional ingredients in food products which contain fat. This proposal makes it possible to significantly increase their digestibility and inhibit process of fat resynthesis in the human body. According to the expert council of the FAO / WHO «Fats and fatty acids in human nutrition» (2010) [http://www.fao.org/3/a-i1953e.pdf] fatty acids such as lauric, myristic, palmitic acids (in the food) increase the level of LDL cholesterol, while stearic acid doesn't have an affect on the content of LDL cholesterol in human blood plasma.

It is proposed to produce fat that contains acylglycerols which structure is similar to cocoa butter acyglycerols by interesterification of sunflower oil with fatty acids ethyl esters, preferably the ethyl esters of stearic acid. The obtained CBE will have dietary and treatment-and-prophylactic properties that can solve the problem of supplying the population with high-quality healthy food products.