PRESS RELEASE

Rapeseed makes more than just oil – it's a source of proteins too

At the Fraunhofer Center for Chemical-Biotechnological Processes CBP in Leuna, Germany, representatives from politics, research and industry opened a novel pilot plant for the mild processing of rapeseed to increase the added-value potential of rape as a raw material. Based on a biorefinery, the plant not only delivers high-grade, pre-raffinate-quality rapeseed oil, but also a high-grade, protein-rich rapeseed kernel concentrate, secondary plant substances dissolved in ethanol and rapeseed hulls, which represent further products. The plant was built as part of the joint research project EthaNa, which has been funded by the German Federal Ministry of Food and Agriculture (BMEL).

Alongside soybean, rapeseed is the most important oil globally, and rapeseed oil is also the most popular cooking oil in Germany. As well as the oil, which makes up approximately 40 percent of the content, the rapeseed – like soybean – also contains high-grade proteins. These are similar to milk proteins and could therefore be used as a valuable source of plant-based protein for food and animal feed.

However, the conventional hot-pressing process used in industrial oil mills requires high temperatures and pressures. These change the protein structures and reduce their quality and that of the resulting rapeseed meal. These high temperatures are required again after pressing, to evaporate the hexane used as a solvent. This process extracts the oil that remains in the press cakes in order to increase the oil yield. A second factor that reduces quality in the conventional oil-extraction process is the bitter substances that enter into the extraction meal, for example, from the hulls that also go through the press.

Because rapeseed can be used not only for the popular oil, but also to generate increasingly in-demand, high-quality plant-based proteins, 11 partners from research and industry have been working together for the last five years on the EthaNa joint research project. Together, they have investigated a new approach for a mild processing of rapeseed on a large scale, and designed and built the first pilot plant. The EthaNa® pilot plant at the Fraunhofer Center for Chemical-Biotechnological Processes CBP, in Leuna, can process up to 50 kilograms of rapeseed per day. The project has been funded by the German Federal Ministry of Food and Agriculture (BMEL) and coordinated by Fraunhofer CBP and Magdeburg-based firm, B+B Engineering GmbH.

EthaNa® pilot plant enables complete utilization of rapeseed

The pilot plant consists of a de-hulling and an extraction plant. Upon conclusion of the EthaNa project, the plant was put into operation for the first time in 2022 and was

officially opened on May 3, 2023, as part of the ten-year anniversary celebrations at Fraunhofer CBP.

The patented EthaNa process is based on an approach that had so far only been used on a laboratory-scale – using ethanol to extract oil. The challenge for this project was scaling the process and implementing it in a pilot plant. "During the project, we investigated how and with which equipment and components we could carry out the various process steps for the complete use of rapeseed in a technical plant, along with how the entire system would need to be designed," explains Dr. Robert Hartmann, group manager of Biomass Fractionation at Fraunhofer CBP.

The EthaNa process works with de-hulled rapeseed in order to reduce the proportion of bitter substances and other substances that are unnecessary or even harmful to people and animals, while also reducing fiber. After intensive development, the project team were able to successfully create a de-hulling system that can de-hull up to 100 kg of rapeseed per hour in continuous operation. The hulls of the seeds are first split open and then separated from the heavier kernel in an air stream created by a fluidized bed system. The hull fraction is an additional product that can, for instance, be used to manufacture biobased insulating materials, as demonstrated by Fraunhofer CBP researchers in a project funded by the State of Saxony-Anhalt.

The low fiber content means conventional mechanical pressing for producing oil from de-hulled rape kernels is not an option. Instead, the EthaNa process uses ethanol, an alcohol, which was proven to be optimal in the researchers' studies. In a process referred to as displacement extraction, small droplets of the rapeseed oil from the ground kernel are emulsified in the ethanol phase at mild 70°C. Another advantage of the technology is that secondary plant substances from the rape kernel, like sinapinic acid, tocopherols and polyphenols, are soluble in ethanol. If these can be selectively extracted, the bioactive contents can be used for cosmetic or pharmaceutical purposes, for instance.

High-grade, pre-raffinate-quality oil

To release the oil from the rape kernels, the de-hulled kernels are first mixed with ethanol and ground before separation. "We treat the conditioned biomasses in either a modified screw press or a decanter, to separate the ethanol-oil fraction, the liquid phase, from the protein-rich solid fraction," explains Dr. Fabian Steffler, who led the project at Fraunhofer CBP. Finally, the emulsified oil is separated from the ethanol using a decanting tank.

"Our investigations demonstrated that the oil obtained in the EthaNa® pilot plant is almost entirely free from free fatty acids and phosphatides," says Steffler. The advantage for oil mills is obvious. "The oil no longer requires intensive purification, as the ethanol extraction brings it to pre-raffinate or semi-raffinate quality. This means it

can be integrated directly into existing production lines and further processed," the researcher continues.

Protein-rich rapeseed concentrate for food and animal feed

The remaining, largely de-oiled, solid material contains proteins in concentrated form. "To further de-oil the rapeseed concentrate, various extraction steps are used, which can be combined with each other in various ways," explains Steffler. The concentrate is dried in a tube bundle dryer, recovering the ethanol.

The protein-rich rapeseed concentrate obtained in this way is a significantly higher-grade product than the rapeseed meal from industrial oil mills. "Our rapeseed concentrate is free from hulls and secondary plant substances and therefore contains only extremely small amounts of unwanted tannins and bitter substances," Steffler is pleased to announce. The high protein content, currently 42–43 percent, is similar to the cold-pressed, partially de-hulled rapeseed cakes of decentralized oil mills.

Another considerable advantage is the mild processing conditions of the EthaNa process, which leave the structure of the proteins unchanged, meaning they have continuing economic use and value. "The proteins are easily soluble in water. This means we can extract them and use them as alternative plant-protein sources for the food industry, for instance, in meat-replacement products," says Hartmann. Further research work, for example on how the rapeseed proteins can be obtained to manufacture food, has already begun as part of a new EU project.

The rapeseed concentrate is also considered a high-grade livestock feed. Rapeseed meal from conventional oil mills is already used as feed for pigs, poultry and cattle. But for young poultry or pregnant animals the high levels of glucosinolates in the meal, which come from the rapeseed hulls, are undesirable. In order to ensure the required amount of protein is provided, feed mixes are currently supplemented with up to 30 percent soybean extraction meal – imported from overseas. Rapeseed concentrate is also very well suited to ruminants, because of its low fiber content, which is even below that of soybean meal.

New business lines for oil mills

"The rapeseed concentrate, which is rich in high-grade proteins, will open up new sources of income for oil mills," Hartmann is convinced. The EthaNa® pilot plant at Fraunhofer CBP is now available for test runs with the rapeseed from industrial oil mills, to provide product samples on a larger scale. New systems can also be integrated into the existing infrastructure at oil mills as alternative processing lines. This is where the company B+B Engineering – the firm that also planned the pilot plant at Fraunhofer CBP – comes in.

At the same time, the researchers at Fraunhofer CBP are also improving the operation of the pilot system to ensure the process is robust and stable with improved economy and energy efficiency. "We have identified potential ways of optimizing the oil yield," Steffler clarifies. "In addition, we also want to expand the plant to include a countercurrent process for ethanol extraction, so that we can re-circulate the ethanol we used for oil extraction," the expert says. He and his team also intend to increase the protein content of the rapeseed concentrate to almost 50 percent.

Hartmann is sure the procedure has yet more potential. "We're already in discussions about researching the processing of other seeds in the EthaNa® plant, like sunflower or beech nuts, or even coffee grounds and hemp seeds."

The rapeseed concentrate obtained from the EthaNa® pilot plant contains over 40 percent high-quality proteins. (© Fraunhofer CBP) |

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In the de-hulling plant, up to 100 kilograms of rapeseed per hour can be de-hulled in continuous operation. (© Fraunhofer CBP) |

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