NEW TECHNOLOGY PREVENTS TOXINS FROM REACHING PLANT SEEDS

The results we achieve by conducting research into universal biological processes often prove directly beneficial to society, the environment or human health.

BARBARA HALKIER
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Photo: leodikan/123RF

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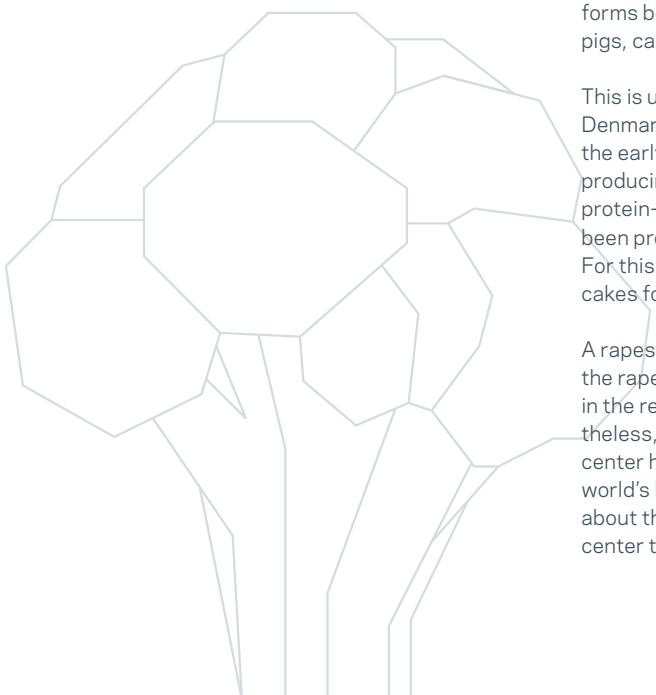
Curiosity-driven research has led to a discovery with vast practical applications. This discovery has struck a chord with many, catching the attention of not just researchers but also of companies with commercial interests.

"We never dared hope that it would come to this. This breakthrough is of a magnitude that will open unseen opportunities in plant breeding," explains Professor Barbara Halkier, who heads the Center for Dynamic Molecular Interactions (DynaMo) at the University of Copenhagen.

The research finding about which Halkier is so elated came after a long and arduous quest to understand some fundamental processes in plants. Curiosity was the engine driving this research, as well as a desire to gain new knowledge about biological processes at the molecular level. This quest culminated, however, in results that hold vast commercial potential and can also benefit the environment and human health.



From model plant to universal principles

A good model system is required to identify fundamental biological processes. The DynaMo center uses Arabidopsis (thale cress). This plant is ideal because its genome is rather small and its life cycle is just eight weeks. Not only researchers at DynaMo but also system biologists worldwide use Arabidopsis as a model plant, meaning that a wealth of biomolecular research tools, mutant collections and databases have been developed specifically for this plant. However, Halkier and her group are the first to have succeeded in producing a plant with seeds without glucosinolates, the defense compounds the plant produces to defend it against insects and microorganisms.

This discovery has numerous practical applications and has therefore struck a chord with many people, catching the attention not only of research communities but of farmers and companies with commercial interests. The reason behind this interest is that the discovery has created the basis for developing a technology that allows unwanted toxins to be removed from edible plant parts.

Commercial possibilities and good news for the agricultural sector

Arabidopsis is a weed and not used as feed for domestic animals or humans. However, Arabidopsis is closely related to the oilseed rape, which also produces glucosinolates for defense. Unfortunately, the kind of glucosinolates found in rape is toxic to life forms besides insects and fungi. Many large animals, including pigs, can tolerate rape only in small amounts.

This is unfortunate because rape is a very common crop in Denmark, where it colors the landscape bright yellow during the early summer. In fact, rape is the third most common oil-producing crop in the world. Farmers are well aware that the protein-rich rape cakes that are left after the rapeseed oil has been pressed can be used for pig feed only to a limited extent. For this reason, Denmark imports massive amounts of soya cakes for its pigs.

A rapeseed plant without glucosinolate in its seeds (and thus in the rape cake), but that retains its natural defense compounds in the rest of the plant is almost too good to be true. Nevertheless, this is exactly what the new discovery of the DynaMo center has made possible. Bayer Crop Science, one of the world's lead plant biotechnology companies, has no doubts about the potential and has formed a collaboration with the center to transfer its new scientific advances to rape.

As a result, this research finding comes with an unexpected bonus for both farmers and the environment.

Cancer-preventive cabbage

Not only does the research at DynaMo have the potential to make life easier for pigs and farmers, it also contributes with research that may have an immediate impact on human health. Halkier explains:

"The results we achieve by conducting research into universal biological processes often prove directly beneficial to society, the environment or human health."

Take, for instance, the well-known cabbage broccoli. One of the glucosinolates produced in large volumes by broccoli is glucoraphanin, a substance believed to have a cancer-preventive effect. Halkier's group has succeeded in mapping all the steps required for broccoli to produce glucoraphanin.

The center's knowledge about glucoraphanin has led to cooperation with the British Institute of Food Research with the aim to document that glucoraphanin is indeedt, the substance giving the cancer-preventive effect.

"Simultaneously, we are focusing on finding a way to produce the substance for use in dietary supplements and drugs," says Halkier. "The collaboration builds a bridge between frontier research and innovation, offering fertile ground for growth in the food and drug industries."

Pest control without pesticides

Glucosinolates are highly efficient defense compounds but are available only in plants from the Brassicaceae family such as Arabidopsis, rape, cabbage and a wide array of other utility plants. After having identified the genes that lead to the production of glucosinolates in Arabidopsis, researchers have succeeded in transferring them to tobacco plants. This feat has paved the way for a Danish-South American cooperative effort to increase the resistance of the potato plant to disease.

"We have chosen to test the strategy in tobacco, which like the potato belongs to the nightshade family, because tobacco is easier and faster to work with," explains Halkier.

The tests were successful, and with partners at the International Potato Center in Peru, center researchers are working to introduce the genes into the potato plant. This project holds enormous potential because potato farmers worldwide will no longer have to use the vast amounts of pesticides used today. Pesticide consumption for potato farming is disproportionately high. In Denmark, potatoes are grown on 6% of the agricultural land, but as much as 25% of total pesticides are used on the potato fields. As a result, this research finding comes with an unexpected bonus for both farmers and the environment.

Photo: Susanne Østergård

FACTS:

Center for Dynamic Molecular Interactions (DynaMo)
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