Cerealier

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A magazine from
Lantmännen
Research Foundation

RESEARCH
The link between diet and mental health

NEW REPORT
Food trends in uncertain times

RECIPE
Brain food for the summer

THEME

BRAIN HEALTH

Sometimes the road to better mental health leads through the stomach

Helena Fredriksson
Health for body and mind

The link between diet and wellbeing features regularly in Cerealier and, in terms of our physical wellbeing, research has come a long way. In this Brain Health issue, we dive into mental health, where food and other lifestyle factors play an important role. We have interviewed researchers who are experts in this area and can say that although research on the influence of diet is only just getting started, a connection between the gut and the brain has been established. A varied diet with plenty of fibre from cereals appears to have a positive effect on our mental wellbeing.

ON PAGE 23, you can read about our foundation's research into baking, where the aim is to improve baking with traditional ingredients such as wheat and oats – but also with novel ingredients, like pea shells. Using legumes in new ways feels absolutely right, as new dietary guidelines state that we should eat legumes every day. You can also read about two research initiatives at the Swedish University of Agricultural Sciences that are making innovative use of Nordic ingredients. Tempeh based on faba beans and oats is being developed in a project inspired by Indonesian cuisine, while the second project focuses on how legumes taste in end products such as bread.

"Using legumes in new ways feels absolutely right ..."

Rounding off, we offer a summer recipe that is good for both body and soul, with colourful veggies – lovely with salmon and preferably with a fibre-rich crispbread.

Happy reading!

Helena Fredriksson
Lantmännen Research Foundation

PHOTO: GOLDEN RETRIEVER

Brain health

The gut and brain work together to influence our wellbeing. ***Pages 7–13***

Cerealier

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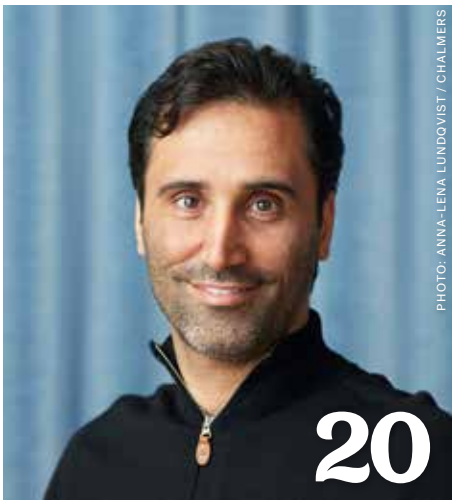

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PHOTO: ISTOCK

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LANTMÄNNEN
RESEARCH FOUNDATION

Sustainable dietary transitions in the Arctic

Climate change's impact on the Arctic is having consequences for the region's food production. In a new project, Armando Perez-Cueto, professor of food, nutrition and meal science at Umeå University, will explore sustainable dietary transitions in the northern parts of Sweden and Finland.

The research project is part of The Arctic Six, a consortium of the Nordic region's northernmost universities. It will investigate how to address the issues of food security, public health and environmental sustainability in the Arctic. ●

Read more: https://www.umu.se/en/feature/exploring-the-future-of-food-and-nutrition-in-the-arctic/

10 years

Climate & Nature, Lantmännen's programme for future agriculture is celebrating its first decade! ●

Belgium to host a conference on oats

The third global conference on oats, the Food Oats Conference, will be held on 12–14 October in the Belgian city of Leuven.

The programme includes the entire value chain, from cultivation and processing to oat products and their health effects. ●

Read more: www.foodoatsconference2025.com/

ILLUSTRATION: LENE DUE JENSEN

Survey shows more people eating wholegrains

The Bread Institute has presented the results of its annual survey, which measures bread consumption in Sweden.

According to the survey, the negativity about carbohydrates that existed a few years ago has faded. Most people eat bread at breakfast and, for many, it is an entire meal. Interest in wholegrains has increased markedly, especially among young people.

A majority are aware that wholegrains offer good protection against cardiovascular diseases and type 2 diabetes. More than 1,000 people aged between 18 and 80 responded to the survey. ●

Read more (in Swedish): www.brodinstitutet.se/brodtermometern/

Podcast on legumes as future food

The latest podcast episode of "Feeding your mind" from SLU Future Food is dedicated to legumes. It discusses how legumes such as peas and faba beans could be used in innovative foods.

Trials are already underway to develop better and higher-yielding varieties. In the future, domestic faba beans could replace imported soya. Guests on the programme include Åsa Grimberg, researcher in plant breeding at SLU, the Swedish University of Agricultural Sciences – read more about her on page 14. ●

Listen (in Swedish): https://soundcloud.com/slu-future-food/

PHOTO: JOHAN GUNSÉUS

↑ New solutions are needed to achieve a sustainable food system, says Anna-Karin Karlsson, RISE.

Protein-rich crops and better preparedness are strong trends in the food system

RISE, Research Institutes of Sweden, has presented its trend report for 2025, describing what awaits the food system in the short and long term. The idea is that the report can be used as a basis for future research initiatives. It paints a dark picture of the times we live in, marked by numerous crises due to a heating climate and political uncertainty. New solutions are needed to create a sustainable food system.

The first report was published at the end of 2023 and, according to Anna-Karin Karlsson, head of marketing in RISE's Department of Agriculture and Food, all the trends it presented have continued.

"Examples include an interest in health, hybrid products, biodiversity and soil health, as well as the rising costs across the food industry. Food preparedness is also something that is very much in focus," she says.

MORE DOMESTIC CULTIVATION and food production are necessary for increased sustainability in all areas of the food system. Karlsson highlights peas and faba beans as the protein crops that will increase the most, not least thanks to Lantmännen's investments in pea protein in Lidköping, where a new factory is being built.

"Also, Swedish-grown chickpeas could soon be competing with imported ones," she predicts. "But there needs to be more varieties adapted to a northern climate. The soya bean, for example, has a long growing season and needs a lot of sun, as well as a couple of hours of darkness every night. Swedish summers make it difficult for soya beans to develop and mature."

THE DEVELOPMENT OF plant-based analogues for meat, milk and cheese remains relevant, but their taste, texture and nutritional value must be improved before sales can increase, RISE predicts. Only then can the production of ready meals using analogues and hybrids begin in earnest.

"Plant-based ingredients will also be used in more forms, as nutritious snacks and as spreadable foods," concludes Karlsson.

Ingar Nilsson

Read more (in Swedish): https://www.ri.se/sv/om-rise/nyheter-och-press/trendspaningar/framtidens-matsystem-2025

Upcoming thesis on plant-based foods

Jaqueline Auer will defend her thesis at the Swedish University of Agricultural Sciences on 23 September. Cerealier 4/2024 presented part of her research when we featured PAN Sweden, the research centre she is affiliated with.

Her research includes investigating the structure of different plant-based ingredients and products and their mineral content, such as iron and zinc, as well as the way mineral availability can be improved through processes such as fermentation. ●

From porridge championship to documentary

The World Porridge Making Championship, which we wrote about in Cerealier 1/2025, has now been immortalised on film. In the documentary, *The Golden Spurtle*, Australian filmmaker Constantine Costi records life in the small Scottish village of Carrbridge as it prepares for the competition.

Every October, participants from around the globe come to make porridge and compete for the coveted trophy. The film's world premiere was in March at the Copenhagen International Documentary Festival. ●

PHOTO: ISTOCK

New dietary advice focuses on vegetables and wholegrains

Sweden's National Food Agency has presented its new dietary guidelines for adults. They are based on scientific consensus about what is healthy for humans, the climate and the environment.

The agency highlights the importance of eating at least 500 g of fruit and vegetables a day, preferably more. In addition, it recommends eating peas, beans and lentils every day and choosing more wholegrains, at least 90 g per day.

FISH IS RECOMMENDED two to three times a week, and smaller quantities of red meat, up to 350 g per week. Fermented milk or yogurt, rapeseed oil and other keyhole-labelled fats are recommended, as are unsalted nuts. However, soft drinks, sweets and snacks should be avoided. ●

Read more (in Swedish): www.livsmedelsverket.se/om-oss/publikationer/artiklar/2025/l-2025-nr-04-livsmedelsverkets-generella-kostrad-for-den-vuxna-befolkningen

Faba bean genetics investigated in new thesis

Hannah Ohm, PhD student at the Swedish University of Agricultural Sciences, has cultivated and studied 220 varieties of faba beans over two growing seasons. They showed great variation in flowering time, height, yield and seed composition. The cultivation characteristics of the different varieties were determined by analysing their genetics. The knowledge of faba bean genetics that the thesis presents will be useful when breeding this protein-rich bean. ●

Thesis: Hannah Ohm: *Genetic insights into seed development, fl wering and diversity in faba bean: pre-breeding for sustainable agriculture.* SLU. 2025

ILLUSTRATION: ELLEN RÉMY

THEME

BRAIN HEALTH

Increasing numbers of researchers are realising that the interaction between the brain and the gut can affect our mental health, and that what we eat influences our psychological status. The Swedish Brain Foundation recommends a balanced diet, rich in fruits, vegetables, oily fish and legumes. However, more components are necessary for good brain health, such as physical activity, good sleep and social interaction. A combination of these with a diet that benefits our gut flora can have a positive impact, which is the focus of the research presented in this issue.

Photo **Golden Retriever**

Suzanne Dickson, brain researcher at the University of Gothenburg, is interested in how the gut communicates with the brain. The brain influences what we eat and how much, and also sends information to the gut about the food being digested. Text **Ingar Nilsson**

Communication pathways between gut and brain

Suzanne Dickson is a neurobiologist and professor of neuroendocrinology at the University of Gothenburg. She is also president of the European Brain Council, an umbrella organisation for all types of activities that are interested in the brain and brain research. Her research has long focused on obesity, so she knows a great deal about which hormones send signals to the brain when we feel hungry or satiated, as well as the link between obesity and the risk of depression.

"There are many communication pathways between the gut and the brain," Dickson says. "These include hormones. There are cells in the gut that can detect the food's nutrients and respond by releasing hormones."

ANOTHER COMMUNICATION pathway is from the gut to the brain through the vagus nerve. A lot of information is sent to the brain via this route, as the stomach and intestines fill and empty.

"Our gut's flora, its microbiota, is a third information channel. We don't yet know exactly how our gut bacteria communicate with the brain. Individuals have different microbiota, even twins who are genetically the same. There is a growing body of evidence that the microbiota's composition affects our metabolism, body weight and brain function," she says.

DICKSON STATES THAT a diverse microbiota is beneficial. Its composition is influenced by various factors, including what we eat and the proportion of fibre and fermented foods in our diet. As a neurobiologist, Dickson knows that our lifestyle and diet can help protect the neurons in the brain and contribute to good health. She mentions the GLP1 analogues in the new anti-obesity drugs, of which Ozempic is one example – these also appear to protect the neurons of patients with Parkinson's disease.

PHOTO: JOHAN WINGBORG

"...people with depression who switch to a Mediterranean diet feel slightly better."

Suzanne Dickson Neurobiologist, Professor of Neuroendocrinology, University of Gothenburg

THE ROLE OF DIET in mental health is receiving increasing attention in psychiatric research. Dickson mentions an Australian professor of nutritional psychiatry, Felice Jacka, who founded the country's Food & Mood Centre at Deakin University and who has conducted several studies on the relationship between diet and mental health.

Her research results have shown that people with depression who switch to a Mediterranean diet feel slightly better. The study also showed that the diet was as effective as medicine.

"However, until we understand the mechanisms, we have to guess how it works," Dickson concludes. ●

Read more: Dickson et al. "Intranasal Delivery of a Ghrelin Mimetic Engages the Brain Ghrelin Signaling System in Mice". *Endocrinology.* 2025.
Read more:
https://foodandmoodcentre.com.au/

PHOTO: ISTOCK

We know that the brain can control the gut and that stress is one factor that inhibits digestion. Julia Rode's research shows that the reverse also applies – what we eat can affect how we think, feel and perform. Text **Ebba Arnborg** Illustration **Lene Due Jensen**

What we eat affects our brain

A growing body of research suggests that the gut flora, the microbiota, can affect the brain via something called the gut-brain axis.

"There is a two-way communication system between the gut and the brain. What we eat can affect how we feel mentally," says Julia Rode.

She is an associate senior lecturer at Örebro University's School of Medical Sciences and has long studied the connection between the gut and the brain. She has used double-randomised studies, with a placebo control group, self-assessments and brain imaging (fMRI) to investigate how taking probiotics, which are beneficial bacteria, affects brain function.

IN ONE STUDY, a group of healthy adults were given a probiotic supplement for four weeks. Their brain activity was measured while they performed emotional tasks with negative visual impressions before and after the four-week study period. After probiotic supplementation, the results showed changed activity in areas linked to emotions and cognition, and that probiotics could mitigate the brain's stress response. The field of cognition includes brain functions such as thinking, attention, memory, learning, consciousness, language and decision-making.

"We have seen that probiotics can improve cognitive function and how you feel mentally. Our studies have shown that even young and healthy people who did not feel depressed experienced improved wellbeing after a few weeks of probiotic treatment," she says.

One theory is that inflammation levels in the body, including the brain, are affected. Another is that the gut flora can metabolise food components and produce substances that can act locally in the gut or are transported to the brain via the blood. In one study, Rode demonstrated that oxidative stress, which forms free radicals, has a negative impact on tryptophan uptake across the blood-brain barrier. Tryptophan is an amino acid that the body uses to make serotonin, a neurotransmitter that may govern mood. The study also showed that the butyric acid in the gut, which is formed when dietary fibre is metabolised in the colon, could compensate for this, which suggests that butyric acid may have a protective role for mental ill-health.

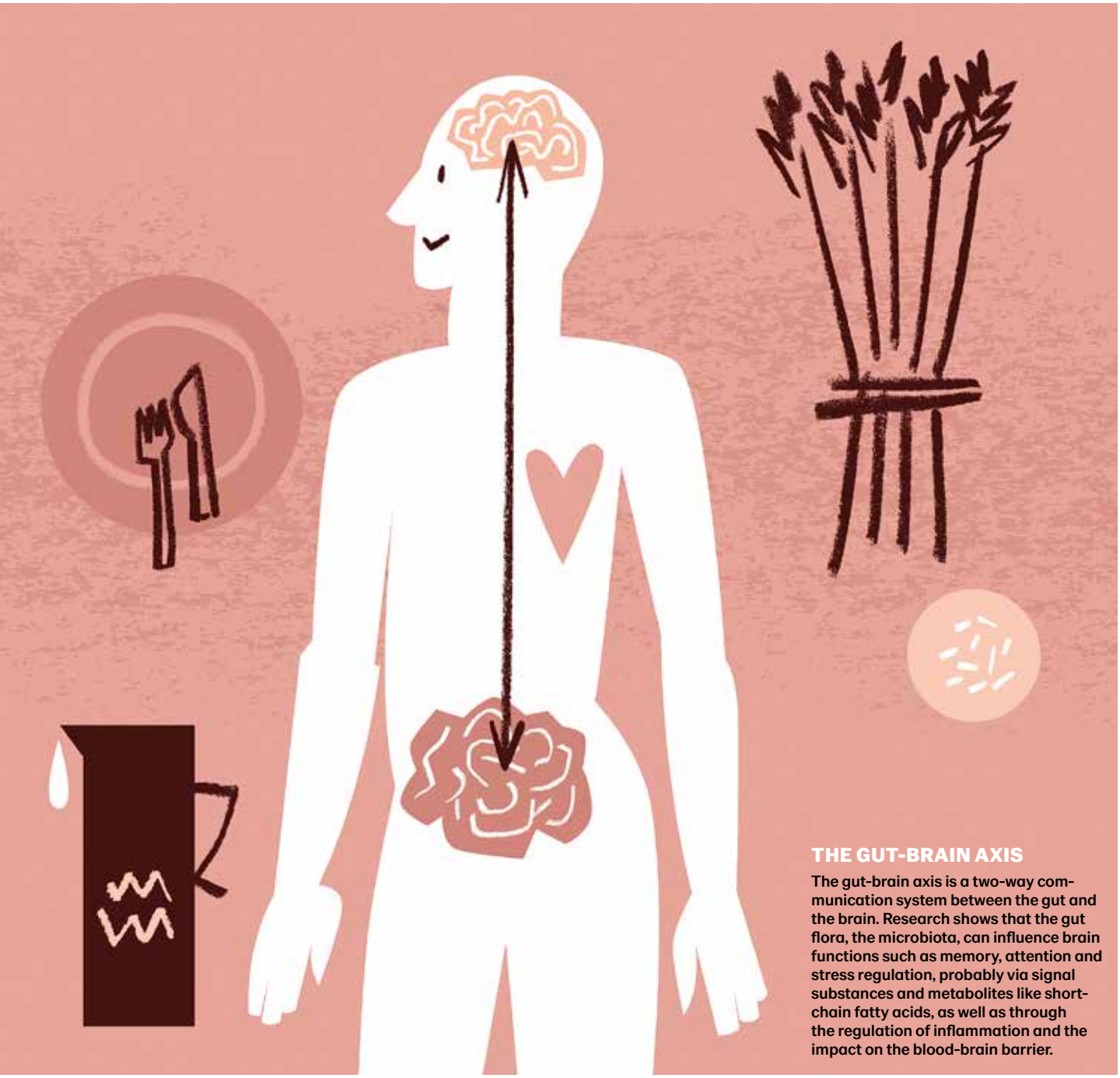
THESE RESULTS PROVIDE the basis of a new model in which researchers expose skin cells to gut and faecal samples to better understand how the gut flora affects the brain.

"Skin cells are the closest we can come to brain cells," explains Rode. "Researchers can use the model to investigate what is needed to start beneficial chain reactions and counteract oxidative stress. For example, we know that many IBS patients have lower levels of serotonin. One hypothesis is that these patients could change their diet to help the body absorb more tryptophan, which would then increase the production of neurotransmitters such as serotonin."

Probiotics are only one part of the story.

"We have seen that probiotics can improve cognitive function..."

Julia Rode



THE GUT-BRAIN AXIS

The gut-brain axis is a two-way communication system between the gut and the brain. Research shows that the gut flora, the microbiota, can influence brain functions such as memory, attention and stress regulation, probably via signal substances and metabolites like short-chain fatty acids, as well as through the regulation of inflammation and the impact on the blood-brain barrier.

Cereals and legumes may also affect gut health and thus also brain health, she continues. Fibre and, to some extent, proteins provide fuel for the microbiota, with butyric acid being formed when they are converted in the gut. They also contain vitamins that are important for brain and nerve function.

"The gut microbiota may benefit. I also believe that cereals and legumes affect the gut-brain axis, although this is unresearched," says Rode.

She is also working on finding biomarkers that can help diagnose or predict how patients with mental illness respond to treatment. She believes that we will be able to give more individualised dietary advice – also for mental health – in the future.

"We can already adapt our diet to physical needs, but we are not yet there when it comes to brain health. I believe it will happen," she says. ●

PHOTO: ÖREBRO UNIVERSITET

↑ **Julia Rode is an associate senior lecturer at the School of Medical Sciences, Örebro University.**

Read more: Rode et al. "Fecal samples and rectal swabs adequately refl ct the human colonic luminal microbiota". *Gut Microbes.* 2024.

↖ Professor Veronica Witte's research has shown that diet, social interaction and exercise all impact wellbeing.

Changes in gut flora may influence our dietary choices

Professor Veronica Witte, from the Max Planck Institute for Human Cognitive and Brain Sciences, has studied food's impact on health for more than 15 years. In one of her latest projects, Witte's research group in Leipzig investigated how a change in overweight patients' gut microbiota can alter their eating behaviour and how they choose the foods they want to eat.

Text **Ingar Nilsson**

When Witte started her doctorate in 2009, research on the gut-brain axis was just beginning.

"We knew that a certain diet could control blood sugar levels and protect against cardiovascular disease, but we didn't have evidence of how it was linked to brain function," she says.

At the time, her research focused on memory and the impact of eating behaviours. Memory tests were conducted on healthy older people, which showed that those who reduced their calorie intake performed best.

WITTE IS A STRONG advocate for research that examines the influence of diet and, indirectly, the gut flora on the brain, as well as other factors that may affect our wellbeing. In one intervention study of a group of people with incipient memory loss, she examined what happened when both their diet and their physical and social activities changed.

"We had two participants groups who all received the same diet. One group also did aerobics while the other group walked together. Several people in the first group dropped out after a while, but everyone in the walking group continued because they had such a good time together. This makes it difficult to decide what is more important for wellbeing: diet, exercise or social interaction," Witte says.

IN HER LATEST research study, she examined a group of 59 overweight adults who were given a fibre-rich diet. Participants were given a daily dose of 30 grams of inulin, a prebiotic dietary fibre that is extracted from chicory root, for 14 days.

"Inulin is a soluble fibre that the microbiota ferments, creating short-chain fatty acids that can stimulate the vagus nerve in the gut. In turn, this excites areas of the brain via the brain-gut connection. Short-chain fatty acids can also reach the brain via the bloodstream and activate receptors in the hypothalamus, which controls our eating behaviour and reward system," she says.

"... diet and gut flora are just one aspect of our mental health. We must also examine a person's living environment and other social factors to get the full picture."

Veronica Witte Professor, Max Planck Institute

On four occasions during the study, participants were asked to choose between meals and then eat the one they preferred while their brain activity was recorded via MRI. Researchers could see a difference between their choices while they were taking prebiotics and what they chose subsequently, when they were taking a placebo with the same calorie content. By measuring changes in gut flora, they could see that signals from the brain's reward system were weaker when participants were given prebiotics. This means it should be possible to steer food choices towards healthier options.

"We'll follow up this study with a six-month intervention to check our findings," Witte says. "The problem for those of us who do this type of research is the limited funding, which also limits the number of participants in the studies."

She also feels that research into overweight and obesity has decreased since the introduction of weight loss drugs, such as Ozempic.

WITTE IS NOW leading a group of research students in three projects: eating patterns in young adults, social interaction and mental health, and diet and ageing.

"However, diet and gut flora are just one aspect of our mental health. We must also examine a person's living environment and other social factors to get the full picture," Witte concludes.. ●

Read more: Witte et al. "Prebiotic diet changes neural correlates of food decision-making in overweight adults: a randomised controlled within-subject cross-over trial". *BMJ Journals.* 2023.

PHOTO: ANTJE GILDEMEISTER

Wanted:

MILD-TASTING PEAS AND FABA BEANS

Protein-rich legumes could be an important element in the food of the future. Research is underway to discover how pea and faba bean flours affect the flavour, aroma and texture of bread. Text **Ylva Carlsson**

Only half the food bought in Swedish shops is produced domestically. Various measures are needed to increase the country's self-sufficiency; one is replacing imported soya with legumes grown in Swedish fields.

Faba beans and peas are two legumes whose seeds have a high level of protein. They are already cultivated in Sweden, but on only about 2% of arable land, and are mostly used for animal feed.

"Peas and faba beans have the potential to be grown and used in food production to a far greater extent than today," says Åsa Grimberg, researcher at the Department of Plant Breeding at the Swedish University of Agricultural Sciences (SLU).

SHE HAS A LONG-STANDING interest in faba beans, and her research includes the development of genetic markers for various traits in this crop.

"We have characterised 220 different varieties of faba bean in field trials and linked these results to DNA analysis. This allows us to identify genetic markers for different traits that can be used for plant breeding."

This work is being conducted within SLU Grogrund with partners that include Lantmännen. A breeding programme has started to develop new varieties of peas and faba beans that can be grown in much of Sweden. Some of the most interesting varieties of faba bean are also part of a Formas project that aims to identify appetising products made from peas and beans. This project is coordinated by Gun Hagström at SLU Food Lab.

"Peas and faba beans have the potential to be grown and used in food production to a far greater extent than today."

Åsa Grimberg Researcher, Department of Plant Breeding, SLU

FABA BEANS' TASTE is usually described as nutty, but slightly bitter. They are increasingly being used as an ingredient in products such as veggie mince and burgers.

"We need to find beans and peas that have a mild, neutral taste, because we know that these are the types of flavours that most people prefer," says Grimberg.

She and her colleagues have studied how the seed quality of different pea and faba bean varieties affects tortilla bread's flavour, aroma and texture. During baking, some of the wheat flour was replaced by flour from faba beans and peas. The bread samples were then evaluated by a trained panel.

"Our aim is to link the peas' and beans' seed quality to a specific flavour to help us decide which traits to focus on during plant breeding."

The next step will be to take these results to a food producer, who can do baking tests on a larger scale.

"One important agronomic advantage of growing legumes is that they absorb nitrogen from the air, so they do not require nitrogen fertilisers," says Grimberg. ●

THE PROJECT

"Tasty pea and bean food products: An integrated approach of plant breeding, raw material processing and food product development" is funded by Formas and runs until 31 December 2025. The participants are SLU, Lund University, Linnaeus University, RISE, Ipsos and Kalmar Ölands Trädgårdsprodukter.

The project is based on diversity panels for peas and faba beans that were characterised by SLU Grogrund.

↑ The seed quality of faba beans and peas can affect the taste, aroma and texture of the finished product.

↓ 220 faba bean varieties have been characterised and their DNA analysed to identify different traits.

↓↓ Researchers have baked tortilla bread using pea and faba bean flours.

↓ Åsa Grimberg, researcher in plant breeding at SLU.

PHOTO: PRIVATE

PHOTO: ÅSA GRIMBERG

PHOTO: ÅSA GRIMBERG

Innovation platform makes the right choice easy

Unhealthy eating habits are one of the biggest risk factors for disease and premature death. The PUSH platform aims to shift responsibility for choosing the right diet away from the individual by creating a system that makes it easy to choose healthy and sustainable food.

Text **Ebba Arnborg**
Illustration **Lene Due Jensen**

By 2035, the food system will promote a healthy life for everyone. This is the goal of the PUSH transformation platform, which is currently funded by Vinnova under its "A new recipe for the food system" initiative. Work is led by Livsmedelsakademin in collaboration with Chalmers University of Technology, Frisk Mat and the Swedish Association of Registered Dietitians.

"It is an issue of democracy. Everyone should be able to live a healthy life based on what they eat. Our starting point is the Nordic Nutrition Recommendations, where wholegrains and legumes are important components that we need to both eat and produce more of. I believe they are the key to the future," says Amanda Allvin, project leader for PUSH.

PUSH HAS INVESTIGATED what underlies our current food choices. These come partly from our attraction to food environments that offer unhealthy choices in an inviting way, and are partly due to taste, habits, economics and a lack of knowledge and time.

"All of these factors can be turned around, so there is also a great deal of potential. We need the innovation, development and tools to change norms and preferences," says Allvin.

THIS FUTURE FOOD SYSTEM requires new products and concepts, and better distribution methods, business models and communication channels, among other things. It could mean significant benefits for individuals and society, as a drop in diet-related lifestyle diseases may lead to reduced societal costs and less sick leave.

"One of our action areas concerns economic drivers – developing healthier solutions must be profitable. At the societal level, there is great potential for economic benefit that could be translated into incentives and policy instruments," she says.

PUSH'S MISSION IS to inspire more people to contribute to this vision. The platform brings together a portfolio of projects and actions, and gathers stakeholders in learning labs and workshops where they can exchange experiences and find new ideas and opportunities for cooperation. Its report was released recently and highlights current engagement in the food system.

"We wanted to showcase the efforts already being made. No one can do everything, but everyone can do something. Major food companies, small, innovative and agile companies, public bodies, civil society, academia and research – when we meet outside our usual bubbles, that's when magic can really happen," concludes Allvin. ●

PHOTO: KAVSAR KURASH

"Everyone should be able to live a healthy life based on what they eat."

Amanda Allvin
Project Leader, PUSH

Read more (in Swedish):
www.pushfood.se/The PUSH report

RECIPE

A treat for the brain

This creamy salad features tender vegetables in a mustard dressing. A perfect side dish for oily fish and great food for the brain. Serve with really crunchy crispbread.

Recipe **Swedish Heart Lung Foundation www.hjart-lungfonden.se/halsa/recept/ (link in Swedish)**

A salad with brainy ingredients

Serves 4
Preparation time: 45 min

400 g new potatoes
2 carrots, peeled and cut into sticks
1 bunch green asparagus (250 g)
½ bunch radishes, thinly sliced (use a mandoline)
2 Chioggia beetroots, peeled and thinly sliced
1 pinch salt
1 pinch freshly ground black pepper

Mustard dressing
100 ml natural low-fat yogurt
1 tsp French mustard
1 garlic clove, peeled and grated
Grated zest of ½ lemon
Freshly ground black pepper

INSTRUCTIONS:

1. Boil the potatoes.
2. Let the potatoes cool slightly, then cut into pieces.
3. Simmer the carrots in lightly salted water for 2–3 minutes.
4. Break off the bottom part of the asparagus. Parboil the top of the asparagus in lightly salted water for 3–4 minutes. Rinse in ice-cold water and cut into pieces.
5. Combine everything in a large bowl, along with the dressing.
6. Serve in the bowl or on plates.

PHOTO: ULRIKA EKBLOM

Solja Pietiäinen, formerly a doctoral student at the Swedish University of Agricultural Sciences (SLU) and Lantmännen, has created fluffy white bread with a high-fibre content. Text **Ylva Carlsson**

More nutritious white bread with a high-fibre ingredient

Do you start your day with soft white bread? You're not alone – 70% of Swedes eat too little dietary fibre. Changing our eating habits is difficult, despite supermarket shelves that offer many wholegrain products.

However, white bread can be made healthier, as shown in a thesis by Solja Pietiäinen at SLU. Her research focused on wheat bran, which is a side stream from the production of wheat flour and is mainly used in animal feed. Wheat bran contains lots of dietary fibre, bioactive components and vitamins.

"Changing the structure of the fibre in wheat bran means we can bake white bread with a good texture and high volume," says Pietiäinen.

THIS OUTCOME WAS a pleasant surprise. When the new fibre ingredient was added to the dough, both texture and volume improved so much that the result is comparable to white bread without added fibre.

"This proves that it is possible to create white bread with a high fibre content. I hope and believe that many people will like this bread, because it is like the bread that they are already used to."

Pietiäinen now works as a project manager at Lantmännen, focusing on side streams, dietary fibre and wholegrains. The aim of her work is to use research to continue promoting issues that relate to sustainability.

IN ADDITION TO the health benefits, she also wants to highlight the importance of utilising wheat bran to make grain management more resource efficient.

"Globally, 150 million tons of wheat bran are produced every year and not used for food. We need to increase the value of this side stream, which would benefit everyone, from growers to consumers."

When will bread and other products with your fibre ingredient be available in stores?

"Within a few years. We now know this works in a lab, so the next step is to create the right conditions for scaling up production," says Pietiäinen. ●

Solja Pietiäinen was a doctoral student at SLU and Lantmännen. The project was funded by the Swedish Foundation for Strategic Research (SSF), Lantmännen and Lantmännen Research Foundation.

PHOTO: GÖRAN EKEBERG

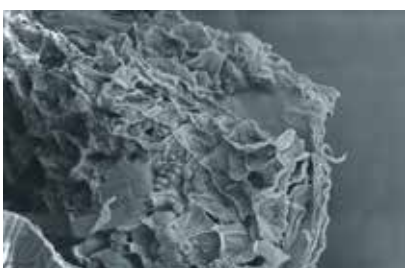


FOTO: SOLJA PIETIÄINEN

↑ **Wheat bran at 400x magnification.**

← **In her research, Solja Pietiäinen has used the wheat bran side stream to increase the fibre content of white bread.**

THESIS

Solja Pietiäinen
Modification of wheat bran arabinoxylan extracts for functional properties in breadmaking
SLU (2024).

https://publications.slu.se/?file=publ%2Fshow&id=132426&lang=en

New collaboration for high-fibre dairy analogues

Chalmers University of Technology, together with Lantmännen and Arla Foods, has started a research collaboration that aims to deal with some of the major challenges facing the food industry. They will build knowledge and expertise in the field of food biotechnology, promoting the future production of food that is both healthy and environmentally sustainable.

Text **Ingar Nilsson**

The initiative is being led by Mehdi Abdollahi, associate professor of food science at Chalmers University of Technology, while the two industrial partners are involved in designing the projects.

OVER FOUR YEARS, Abdollahi, a doctoral student and two postdoctoral researchers will develop fermentation processes for new dairy analogues. The project will also have access to the unit's other expertise in areas such as fermentation, food technology and nutrition.

"We want to develop biotechnology's potential for creating new foods. Initially, the focus will be on dairy analogues and, by utilising dietary fibre and antioxidants, on exploring how they can be improved. We will also design fermentation techniques to regulate taste and nutritional value," says Abdollahi.

Existing fermentation processes for traditional dairy products do not work for new dairy analogues and hybrid products. Instead, the project will attempt to link traditional techniques, such as fermentation using yeast or lactic acid bacteria, to potential biotechnological solutions.

"Hybrid products and food biotechnology comprise a rapidly growing area of research, and we are trying to build a bridge between the two. One problem we face is that there is an endless number of ways that plant-based resources can be combined with dairy products. We will simply have to work step by step and choose the combinations we believe in," says Abdollahi.

IT IS IMPORTANT that the dairy analogues taste good, retain their traditional character and have a pleasant mouthfeel, he points out. Additionally, the products should have a high nutritional value.

"The most important element of these four years is building knowledge and expertise, so when the project ends, we can hand over a good package of practical and theoretical knowledge. This will help build capacity in this area in the food industry," Abdollahi concludes. ●

PHOTO: ANNA-LENA LUNDQVIST / CHALMERS

"We want to develop biotechnology's potential for creating new foods."

Mehdi Abdollahi Associate Professor of Food Science, Chalmers University of Technology

Read more: https://www.chalmers.se/en/current/news/life-biotechnology-for-sustainable-food-production-of-the-future-1/

PHOTO: ISTOCK

The key to tasty tempeh

New plant-based foods often have unusual and challenging tastes and textures. The aim of Alejandra Castaneda's doctoral project at the Swedish University of Agricultural Sciences is therefore to create a tasty alternative to meat – tempeh made from Nordic ingredients. At the halfway point, she is well on her way to achieving this.

Text **Ingar Nilsson**

Tempeh, a fermented product that is an essential part of Indonesian cuisine, is traditionally made from soya beans.

"Soya beans do not grow in the Nordic climate and importing soya has a negative environmental impact," says Castaneda.

Instead, she has chosen to create a new recipe for tempeh using ingredients such as faba beans and wholegrain oats. In addition, she has made changes to the traditional production process.

"To give tempeh a good taste and texture, the soya beans are soaked and then fermented. I used the traditional method with faba beans and oats, but also had a soaking stage that included the lactic acid bacterium, *Lactobacillus plantarum.*"

The different mixtures were then boiled and, once they had cooled, she added the *Rhizopus microsporus* fungus to start the fermentation process. Six different varieties of tempeh were produced, with varying processes and amounts of wholegrain oats, from 100% faba beans up to 15% oats.

This Nordic tempeh was then sent to Finland, where it was cooked. Eight volunteers from the Food Sciences Unit at the University of Turku discussed and characterised the different tempeh products' taste and texture. After this, a group of 107 randomly selected participants rated the products.

THE CHEMICAL COMPOSITION of every sample was measured, because substances such as aldehydes, esters and acids can affect taste and texture.

"Some can give fruity flavour notes while others give almond or roasted, nutty flavour notes," says Castaneda.

The samples were given points. The one that received the most had been soaked with lactic acid bacteria and had the highest oat content.

"That sample had a higher level of umami, as well as more nutty, buttery and sour notes than the others," she says. "It also had the lowest level of bitter flavours and had an appealing texture. Using *Lactobacillus plantarum* during soaking is thus a powerful tool for enhancing the taste experience." ●

PHOTO: GALIA ZAMARATSKAIA

"Some can give fruity flavour notes while others give almond or roasted, nutty flavour notes."

Alejandra Castaneda
Doctoral student, SLU

FACTS

Alejandra Castaneda's research is part of the "HealthFerm" EU project and the strategic research area "Trees and Crops for the Future (TC4F)" at SLU.

Her thesis aims to investigate the health effects of fermented legumes and cereals.

PHOTO: ALEJANDRA CASTANEDA

↓ A new tempeh has been created using faba beans and wholegrain oats.

Read more: Castaneda et al. "Optimizing Soaking and Boiling Time in the Development of Tempeh-like Products from Faba Bean (*Vicia faba* L.)". *Fermentation*. 2024.

PHOTO: ADOBE STOCK

↑ Researchers will investigate how flour components affect bread quality.

Research that focuses on baking

Bread is a staple food in many parts of the world. The latest bread survey from Sweden's Bread Institute showed that more than half of Swedes eat bread every day, and also that bread consumption has changed. With changing habits, better knowledge is needed to bake the perfect bread. This is always a topical research area at Lantmännen Research Foundation.

Text **Annelie Moldin, Lantmännen R&D**

Flour has components such as protein, starch and fibre, all of which affect its baking properties. Other important factors are the type of grain that is used, variety, growing conditions, drying and milling.

MOST OF THE PROTEIN in wheat is gluten proteins, which form a network when the dough is kneaded and help the bread rise during fermentation. The composition and amount of gluten proteins and other components in the flour affect bread quality.

IN A FOUNDATION-FUNDED project at RISE, Research Institutes of Sweden, researchers will investigate how components in flour contribute to the properties of the finished bread so that baking can be directed towards the desired quality. Different flours are tested and evaluated by first separating them into starch, protein and fibre, and then creating a flour with a specific composition.

Sifted wheat flour, which does not contain the outer bran, is the flour most used in baking. When it is sifted, wheat bran is produced as a side stream. In her thesis, Solja Pietiäinen studied the potential for baking with fibre from wheat bran – read more in the interview on page 18. Extracting functional ingredients from side streams is a growing area of research. One example of this is a recently started research project at RISE, which evaluates extruded pea shells as a functional ingredient in baking.

OATS ARE ANOTHER interesting cereal for baking, the only one of Sweden's four cereals that is naturally gluten-free. This lack of gluten makes oat bread more compact. Oats also contain more fat than other cereals, so they are heat-treated to prevent them from going rancid. This heat treatment has been shown to affect baking properties, but it is not known how. The effect of heat treatment and oat flour's particle size will be studied in a new project at Norway's Nofima research institute.

These are a few examples of projects focusing on bread that are funded by the foundation. Previous projects have included baking with rye and sourdough, and, not least, wholegrains, in the search for the perfect bread. ●

FOTO: HANS JONSSON / LANTMÄNNEN

↑ Peas, here the Ingrid variety, are increasingly used as a foodstuff due to their high protein content.

Recently completed projects

Tastier pea protein

Globally, after soya protein, pea protein is the most used plant-based protein ingredient in food. Researchers at Chalmers University of Technology have investigated how to improve the taste of a pea protein ingredient. The results show that proper handling of peas after harvesting and adding antioxidants during the production process lead to a better taste profile. ●

Forage in pig feed?

Forage is the dominant crop in Sweden. Research at RISE has evaluated whether feed protein can be produced by growing a filamentous fungus on juice extracted from forage. The conclusion was that, in the given conditions, the juice's low sugar content makes it an unsuitable substrate for the fungus, so this is not a viable route for creating feed protein. ●

Reduced ergot

Ergot is a plant disease that attacks some grass species. Of the Swedish cereals, it particularly affects rye. The disease is caused by a fungus that produces toxic substances. Researchers at SLU have studied whether problems with ergot can be reduced. The results indicate that grass weeds may contribute to an increased risk and that, in most cases, cleansing infested grain volumes reduces the risk. ●

About the research foundation

Lantmännen Research Foundation supports research in the entire chain, from field to fork. It grants SEK 25 million to research annually, focusing on three areas:

• Agriculture and machinery
• Bioenergy and green materials
• Food and health

The goals of this research funding include increased agricultural production with minimised environmental impact, and establishing how agriculture can contribute to the development of a biobased society. In the area of food, we want to increase knowledge of grains and legumes as a natural element of healthy and sustainable future food.

The foundation has an open call for proposals every year. Applications are assessed on their newsworthiness, scientific quality and business potential. ●

See: *www.lantmannen.com/researchfoundation*

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