Bread of the future - Hohenheim researchers search for sustainable ways of production

Which cereal varieties defy climate change? How can new technologies help determine flour quality? And can old baked goods be recycled in the sense of the bioeconomy? To answer these and other questions about the bread of the future, the University of Hohenheim in Germany is conducting various research projects.

In Hohenheim, different departments are discussing which cereal varieties are still robust enough for tomorrow's supply under the changing environmental and cultivation conditions. (Photo: © Mareike Bähnisch)

Carbon dioxide levels of the year 2050 in the simulation

The bakery industry needs high-performance cereals with a sufficient protein content. This is the only way to ensure that bread dough is loose and pliable - and easy to work with. A project at the University of Hohenheim has shown how important these criteria are for the future of the industry. Among other things, the scientists grew wheat in climate chambers that simulate temperatures and carbon dioxide levels in 2050.

In principle, carbon dioxide has a beneficial effect on the growth of plants, as the greenhouse gas acts like a fertilizer. However, this is at the expense of quality: The model plants had a significantly lower protein content. The content of nutrients such as calcium, iron, magnesium and zinc also decreased. As did the concentrations of amino acids by up to eleven percent.

Robust wheat targeted

In Hohenheim, researchers from various disciplines are discussing which cereal varieties are still robust enough for tomorrow's supply under the changing environmental and cultivation conditions. In addition to criteria such as yield, disease resistance, dough and baking properties, the study analyses which varieties offer the best profile for human nutrition. Around 300 different wheat varieties are being cultivated and examined in four to eight different growing regions as part of the Betterwheat project in cooperation with the University Medical Centre in Mainz and the breeding companies DSV, Limagrain, KWS and WvB.

The key issue: All the criteria mentioned are subject to considerable fluctuations depending on environmental influences and choice of variety. But only those characteristics that are mainly influenced by the variety and less by the environment can be successfully influenced in the value chain. "We're doing pioneering work here that is highly relevant for domestic breeding and the development of new wheat products," explains project leader apl. Prof. Friedrich Longin from the State Seed Cultivation Institute at the University of Hohenheim. To do this, he and his team combine modern methods of genomics, proteomics, spectrometry and climate data.

Can digitalisation help?

The breeding of new cereal varieties is traditionally a slow business that takes years. Digitalisation promises help: "We are working on using DNA databases and biostatistical methods to optimise the search for the most promising 'parents' for a hybrid – and therefore to speed up the breeding process considerably," says Prof. Karl Schmid, head of the Department of Crop Biodiversity and Breeding Informatics. An important goal of breeding research is to stop the depletion of the gene pool. For only a broad genetic basis will make it possible to produce rapidly adaptable cereal varieties in the future that can cope with more extreme weather conditions and droughts, for example, and therefore ensure food for future generations.

Better baking properties through less fertilisation

The Hohenheim experts are also examining the criteria used to measure the quality of grain. Until now, it was above all a high protein content that was considered decisive. In addition to breeding appropriate high-performance varieties, this is achieved primarily through fertilisation. The rule of thumb is: The more nitrogen in the field, the more protein in the wheat. However, this can lead to serious environmental problems, such as contamination of the groundwater near the surface. Moreover, the world's phosphorus reserves are coming to an end - and are highly unevenly distributed globally. Politicians reacted in 2020 with a new fertiliser ordinance that poses major challenges for farmers. "Therefore, we want to get to the bottom of the relationship between protein content and baking quality," explains Prof. Christian Zörb from the Department of Plant Product Quality.

Initial results show that it is not so much the total amount of protein that is decisive, but above all the composition and quality of the proteins. "We estimate that more precise knowledge about which varieties and how much fertilisation actually produce the desired characteristics can help to save up to a quarter of nitrogen fertilisation in wheat cultivation worldwide," says Prof. Zörb.

Computer models are to optimise processes

If the quality of grain is to be determined in more detail in the future, not only in research but also in the milling and grain industry, new technologies are needed that are practicable and cost-effective. The Department of Process Analytics and Grain Science is therefore working on establishing a spectroscopy method: In addition to the concentrations of protein and starch, the aim is in particular to predict the baking properties, which up to now can only be determined with certainty by means of elaborate experiments.

In order to compensate for natural fluctuations in protein content and to improve the kneadability of low-gluten or gluten-free flour, further innovative strategies are also required. One possibility could be to treat the flour with cold plasma or ozone. "The cold plasma as well as the ozone cause a strengthening of the protein network in the flour through oxidation, which makes the dough elastic and viscous. The treatment is residue-free - only the oxidised molecules remain in the dough. Flour treatment agents, which otherwise take over the oxidation, are therefore no longer necessary," explains Prof. Bernd Hitzmann from the Department of Process Analytics and Grain Science. The expert takes a comprehensive look at all the important processes that take place in a bakery. Computer models are to help optimise processes in such a way that energy consumption and carbon dioxide emissions are minimised and as little food waste as possible is produced.

"We want to improve the utilisation of the machines, for example, by identifying individual steps that lead to delays in operation. At the same time, a forecasting tool will help to better estimate the required quantities. Algorithms calculate the potential demand for certain products based on weather data, typical holiday periods and old sales data, for example," reports Hitzmann.

Old baked goods: Raw material for plastics of the future?

As long as waste cannot be completely avoided in bakeries, the question of how to recycle it as sustainably as possible remains: Old baked goods could be an interesting starting material in the future to produce the platform chemical HFM and organic charcoal in biorefineries. HFM serves as the starting point for the bioplastic polyethylene furanoate (PEF). As a petroleum-free alternative to PET, PEF can be used for the production of bottles or synthetic fibres such as nylon.

"At the Biorefinery Technology Centre at the University of Hohenheim, we are currently researching how the technical process can be optimised to make it economically viable. Then these products also have a chance of quickly pushing fossil products out of the market and making a contribution to climate and environmental protection," reports Markus Götz, PhD student and research assistant at the Department of Conversion Technologies of Renewable Resources. The nutrient-rich solution, which is produced as a residue in the biorefinery, is in turn to be processed by a biogas plant and returned to the field. The organic charcoal can also be spread again as a fertiliser and soil additive. Spoiled old baked goods help to grow grain for new baked goods - for the researchers, a cycle in the sense of the bioeconomy.

Additional information and contact

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