

Study shows the five types of wheat differ greatly in protein composition

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The various types of wheat show great differences in the composition of their proteins as shown in a study conducted by the Universities of Hohenheim and Mainz. Credit: University of Hohenheim / Dorothee Barsch

In a large-scale study, now published in *npj Science of Food* and

conducted by the University of Hohenheim in Stuttgart and the University Medical Center Mainz, researchers identified a total of 2,896 different proteins in 150 flour samples from the five types of wheat—einkorn, emmer, spelt, and durum and common wheat. In addition to the place of cultivation, the respective variety plays a major role. That information could be put to good use. Proteins, whose occurrence depends primarily on the variety, could be influenced by targeted breeding. This could lead to better baking quality, higher yields, and also improved tolerance.

Wheat is an important and usually healthy staple food for human and animal nutrition. Together with [dietary fiber](#), minerals, and vitamins, it provides about 20% of the daily required amount of [protein](#) when consumed with 100 to 150 g of [wheat flour](#). At the same time, the proteins in wheat flour are important for baking quality. That is why knowledge about the totality of all proteins formed in cereals, known as the proteome, is of great importance—both for selecting the right variety and for further targeted breeding research.

However, not all wheat is the same. Even though they are closely related botanically, the ingredients of bread or common wheat (*Triticum aestivum* ssp. *aestivum*) and [durum wheat](#) (*Triticum turgidum* ssp. *durum*) differ, as do those of spelt (*Triticum aestivum* ssp. *spelta*), emmer (*Triticum turgidum* ssp. *dicoccum*), and einkorn (*Triticum monococcum* ssp. *monococcum*). So far, however, there has been little meaningful data that could allow for a direct comparison.

Milestone for future protein research

Against this background, researchers from the Universities of Hohenheim and Mainz analyzed all proteins contained in whole grain flour from these five different types of wheat. They examined ten varieties of each species. In order to also capture the influence of

environmental factors, these were each grown at three different locations.

In total, the researchers were able to identify 2,896 different proteins in the 150 flour samples—over 2,500 in each species. In the process, about half of all proteins differed among the individual species. "To our knowledge, this is one of the most comprehensive proteomic studies in cereals to date. It sets a milestone for much more targeted protein research in wheat in the future," said Prof. Dr. Friedrich Longin of the State Plant Breeding Institute at the University of Hohenheim.

Protein composition depends on location and variety

For their analyses, the researchers matched the proteins or subsections of them found with different databases whenever possible. However, a large part of them had not been studied in detail yet. "Many of the known proteins play a role in [product quality](#), such as in the formation of cereal starch or in stress regulation of plants, but also in allergic reactions in humans," Prof. Dr. Longin stated.

It is true that an appreciable proportion of proteins is formed as a result of environmental influences. But many proteins occur more in certain varieties. In einkorn, for example, the researchers identified a total of 2,540 proteins, 1,940 of which were formed in at least one cultivar at all three locations. "Since [genetic factors](#) are primarily responsible for this, we have a good starting point for selecting and breeding better wheat varieties," said Longin. To this end, the researchers compiled lists of those proteins that could be influenced by variety selection.

Significantly fewer allergenic proteins in einkorn

"Up to 10% of people who eat products made with wheat flour complain

of discomfort afterwards. The proteins found in wheat cause them to develop what is known as non-celiac wheat sensitivity (NCWS), which has not yet been well-defined. Another result is [celiac disease](#)—an inflammatory disease of the small intestine caused by gluten proteins in wheat, and some people develop a classic (immediate type) wheat allergy. In addition, there is also a much more frequent wheat allergy of the delayed type, especially in patients diagnosed with irritable bowel syndrome," stated Prof. Dr. Detlef Schuppan from the University Medical Center of the Johannes Gutenberg University Mainz.

The wheat species studied differ significantly in the amount of their potentially allergenic proteins. Common wheat and spelt have about the same total allergen frequency. In comparison, these are reduced by about two times in durum wheat and emmer and by 5.4 times in einkorn. The researchers do not yet have an explanation for this phenomenon.

In particular, the amount of ATIs (alpha-amylase/trypsin inhibitors) differs significantly. "They are suspected of being responsible for inflammatory reactions," said Prof. Dr. Stefan Tenzer from the Institute of Immunology at the University Medical Center Mainz. "Compared to the other wheat species, einkorn has a significantly lower amount of ATIs."

Clinical studies urgently needed

However, the researchers point out that they estimated the allergenic potential solely by cross-referencing with databases that list possible allergenic proteins. Targeted studies would have to show whether these results are also clinically relevant. "In light of our results, a clinical trial with einkorn compared to modern wheat would be particularly interesting," said Prof. Dr. Schuppan. The comprehensive mapping of these proteins can help design representative test diets, for example.

"To find products that are better tolerated, especially for people with wheat-related diseases, we also need to investigate what influence different processes in flour and bread production, such as a long sourdough fermentation, have on allergens," stated Prof. Dr. Longin.

Outlook: Einkorn as a sustainable crop for marginal lands

In addition to the lower amount of potential allergens, einkorn contains more protein and significantly higher amounts of secondary plant compounds, vitamins, and minerals compared to common wheat. Einkorn is also interesting from an agricultural point of view. "It has almost complete resistance to fungi. Moreover, it can be sown either before or after winter, which is not the case with other cereals," Prof. Dr. Longin said.

However, einkorn yields are much lower than common wheat under good soil conditions. "However, in marginal lands, such as sandy soils, [higher elevations](#) in mountainous regions, or where the use of nitrogen fertilizer is not possible, good results are obtained with einkorn, while the productivity of common [wheat](#) decreases," stated Prof. Dr. Longin, describing a possible field of application.

More information: Muhammad Afzal et al, Reference proteomes of five wheat species as starting point for future design of cultivars with lower allergenic potential, *npj Science of Food* (2023). [DOI: 10.1038/s41538-023-00188-0](https://doi.org/10.1038/s41538-023-00188-0)

Provided by University of Hohenheim

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