The study of the microbiome enables new strategies for healthy and climate-resilient crops

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A study led by TU Graz is providing evidence for the co-evolution of plants and microorganisms. Credit: Lunghammer, TU Graz

Agriculture is facing enormous challenges worldwide due to global

changes caused by human activities. Drought, severe weather events, record temperatures and emerging pathogens threaten the world's food supply. For this reason we need to make our crops more robust without further polluting the environment. Microbiome research and management offer great potential to achieve these goals. A new study by an international research group led by Graz University of Technology (TU Graz), published in the scientific journal *New Phytologist*, opens up new perspectives here.

The importance of the microbiome for living organisms

Microbiome research is only a few decades old, but it has already produced some groundbreaking findings. One is that humans, animals and plants have very specifically adapted microbiomes that have taken over essential functions. Both organism and microbiome have evolved in co-evolution, i.e. in mutual influence. This was confirmed by the present study. Today, we consider all organisms to be "holobionts"—jointly functioning units with numerous specialized microorganisms. The latter are always numerically superior; humans, for example, have ten times more microorganisms than their own cells. The microbiome is thus classified as an important target for new health therapies and prophylaxis. This is equally true for cultivated plants, but the potential here has so far been little known or exploited.

Confirmation of the coevolution theory

The interdisciplinary group of researchers compared the microbiome of modern domesticated apple crops—i.e. specifically bred and cultivated varieties—with the microbiome of their wild ancestors as well as with the microbiome of closely related species. With the help of molecular analyses and bioinformatic methods, the group was able to determine for

the first time that the microbiome is inherited to the same extent as the genes. Apples that are genetically similar thus also harbor a similar microbiome. And surprisingly, our modern apple varieties still contain some of the microbiome of their wild ancestors.

The study shows that the microbiome is also "bred" and has greatly changed over time. Until now, this has happened unintentionally and many microorganisms have been lost in the process. These lost microorganisms could now help us to make our crops fit for climate change again. This is because the focus of breeding now is no longer on the size and sweetness of the apples, but on their resilience and health. The research group is convinced that the microbiome of the wild ancestors originating from the inner-Asian Tien Shan mountain range contains valuable microorganisms for this purpose.

Useful research results for agriculture

For the first author in the study, Ahmed Abdelfattah from the Institute of Environmental Biotechnology, "the results clarify a long scientific debate and lay the groundwork for new ecological strategies in plant breeding."

It would be conceivable, for example, to change the plant microbiome through the targeted introduction of microorganisms in order to increase the resistance of the plants. This is what the Institute of Environmental Biotechnology at TU Graz specializes in, and Marie Curie Fellow Ahmed Abdelfattah specifically chose it as a research location due to its expertise in the field of microbiome biotechnology. "My apple microbiome journey started during my visit, as Ph.D. student, to Dr. Michael Wisniewski's lab in 2015", Abdelfattah says. Wisniewski, the last author of the article and on whose the research the original experiment was designed, is a professor at Virginia Tech with a long-established scientific contribution to fruit research.

In Graz again, the vision of Institute head Gabriele Berg and her team is to use this new knowledge for plant health as well as for that of humans and our planet. The apple is thus only a symbol, as it has been many times in human history.

More information: Ahmed Abdelfattah et al, Evidence for host–microbiome co-evolution in apple, *New Phytologist* (2021). DOI: 10.1111/nph.17820

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