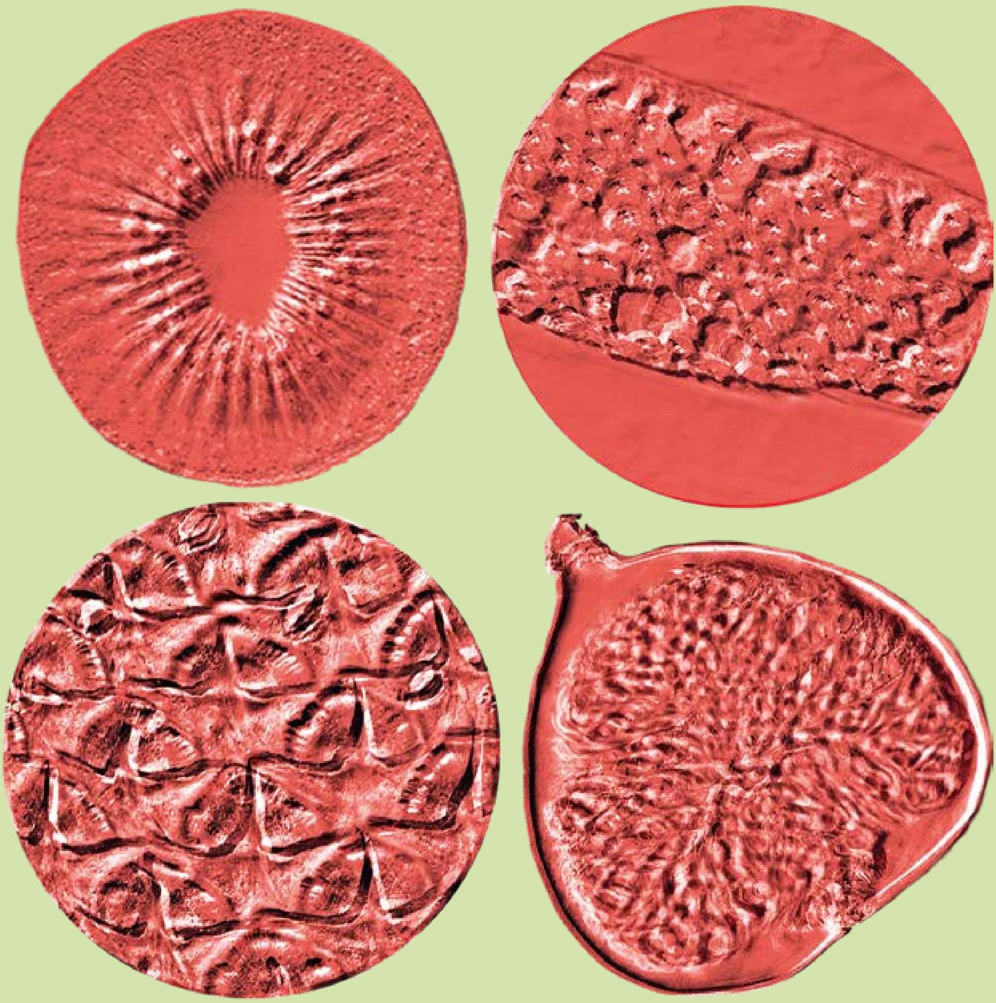
Enzymes
Cool Facts



by Lutz Popper

Preface

Dear employees,

Enzymes are an important ingredient of success of the Stern-Wywiol Gruppe. As biocatalysts, these active proteins cause, accelerate and control reactions in the organism and in many areas of everyday life. They are a wonder of nature, all-purpose tools without which life on earth would not be possible. Dr. Lutz Popper, enzyme fan and scientific director at the Stern-Wywiol Gruppe, vividly and grippingly describes the versatility of enzymes through 72 stories about their silent yet decisive action in ordinary circumstances as well as in curious or even futuristic situations. He succeeds in showing the potential of enzymes in a very interesting way, even if only a fraction of their possibilities can be mentioned.

Enzymes played an important role in the development of the company, and today they are a significant cornerstone of our promise “We future food!”. We understand Enzymes as tools to “sharpen” many of our products and businesses. The motto of “sharpening with enzymes” as well as the love and enthusiasm for enzymes we owe to our “enzyme eminence” Dr. Helmut Uhlig, to whom we dedicate this book posthumously.

Let yourself be inspired!

Matthias Moser

Dear readers,

The theme and subject of this book are the descriptions of selected enzymes. The author reports on what knowledge has been gained about their efficacy in general and also on what he himself has gained through research. Some are groundbreaking findings from the past; others are insights from the present. Research results are listed and highlighted that show how important and significant enzymes are for all of us.

It also deals with solutions directed toward the future, thus providing an insight into the fact that not everything has been researched about the effectiveness of enzymes and their use for the benefit of humans and animals. Even application possibilities against cancer (see Episode 62) could be possible.

The writing style is popular-scientific and makes it easy for the reader to more readily grasp the chemical or biological processes. In places, this leads to a critical discussion of current consumer comments (e.g., restructured meat as a consistent way to fully utilize slaughtered animals). What is particularly noteworthy are the curiosity-inducing title headings, which animate the (certainly sometimes baffled) reader to enter the episodes. They are well resolved argumentatively in the articles that follow.

While a basic knowledge of chemical and biological processes can’t add to the enjoyment of this book, such knowledge can be enhanced by a keen interest in these exciting biocatalysts. A worthwhile book that takes up the cudgels for enzymes!

I enjoyed working on the book very much.

Marianne Rathmann,
Editor of the German edition

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Production AlsterWerk MedienService, Hamburg
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Publisher
Robert Wenzel
An der Alster 81, 20099 Hamburg
www.robert-wenzel.de

Printer
AlsterWerk MedienService GmbH
www.alsterwerk.com

1. edition 2022

ISBN 978-3-9820751-8-1

72 enzyme episodes

Basics

Origins

Applications

Health

Exciting

Future

Wing chairs

Did you know that enzymes are like fireside chairs?
Oops? Well, this is a metaphor, of course. Enzymes are composed of long chains of amino acids folded in a particular manner. The folding creates three-dimensional structures, for instance, dimples, tunnels, valleys, etc.

The actual place of the catalytic action is pretty small. It is the enzyme's so-called active site, characterized by distinct amino acids acting like the armrests of a comfortable armchair. The substrate molecule, for instance, the chain of a starch molecule (e.g., amylose), binds to this active site, because it fits into the specific structure of the enzyme, just as we fit into the chair, but a deer or elephant does not. And then it relaxes — virtually, because the binding forces between the components of the molecule (in amylose, it is glucose) are lowered due to the interaction with the enzyme. Now the substrate falls apart thanks to the permanent shaking of all small particles (called Brownian motion; nice animation on https://en.wikipedia.org/wiki/Brownian_motion).

I am glad that we humans are not small particles.

Enzymes are like fireside chairs

Has a lot:
Soft Red Winter

Has less:
Hard Red Winter

Has nothing:
Durum

Puroindolines – friends or foes of enzymes?

The wheat puroindolines (PINs) are non-gluten proteins with an accessible lipid binding site. They are unique among the plant proteins because of their high tryptophan (an amino acid) content, which gives them hydrophobic properties.

The occurrence of puroindolines PinA and PinB, collectively also referred to as friabilin, on water-washed starch granules distinguishes hard from soft wheats because they are found at lower levels in hard wheats than in soft wheats and are entirely absent from durum.

Puroindolines are surface-active proteins that absorb spontaneously at air-water interfaces and form very stable foams. The stability of PIN foams is about ten times higher than the stability of foams from egg white protein.

A variety of positive effects on food processing properties have been attributed to PINs:

- improved hydration of flour, thence better dough development;
- stabilization of gas cells in doughs;
- improved dough rheology;
- finer texture;
- sometimes larger baked volume, especially with weaker flours;
- greater fermentation tolerance of pre-doughs and doughs;
- better freeze-thaw stability of doughs;
- better structure, also minimized cracking;
- better foam stability of beers;
- higher starch yield (e.g., with rice starch).

Many of these functions can also be performed by enzymes. Could PINs, therefore, replace enzymes? So far, however, they are not available in large quantities because they are not manufactured by fermentation like enzymes.

Or are they more likely to cooperate with each other? Adsorption of puroindolines at water-lipid interfaces has been shown to activate enzymes, especially lipases and lipoxygenases, resulting in improved dough and baked goods properties. The improved swelling of starch granules may also improve accessibility by amylase.

At present, we must assume that puroindolines and enzymes are companions rather than competitors, but further research is needed.

Even your shoes need enzymes

… unless you're just wearing sneakers.

However, if your shoes contain some leather, several enzymes were involved in their creation.

The production of leather involves several steps starting with the raw skin typically being dried and preserved, e.g., by salt. This step is called curing.

This is followed by soaking, during which the hides or skins are rehydrated and washed to remove dirt. Surfactants and enzymes improve this step.

The subsequent dehairing or dewooling was traditionally carried out under extremely alkaline conditions. The introduction of enzymes (proteases, keratinases) and processing at moderate alkaline pH have improved the quality of the leather while significantly reducing water contamination and energy consumption (due to lower processing temperatures).

The subsequent bating (or softening) step, a prerequisite for a supple leather, was particularly unappetizing because it required the use of animal manure (with digestive enzymes). Today, industrially produced enzymes are used instead, especially proteases.

The last step is the tanning (dyeing) of the raw leather. No enzymes are needed, unless plant dyes extracted with the help of enzymes are used.

No leather without enzymes!

Dangerous enzymes?

Of course, there are also enzymes that are dangerous for humans among the estimated 25,000 enzyme specificities. Hardly anyone knows that the toxin from the food spoilage pathogen *Clostridium botulinum*, which causes many hundreds of people worldwide to fall ill every year and some even die, is a protease. It is similar to the toxin from *Clostridium tetani*, also a protease, which is responsible for often fatal cases of tetanus infections.

The botulinum toxin paralyses the respiratory muscles and can lead to death. The effect, however, is completely reversible if detected and treated in time.

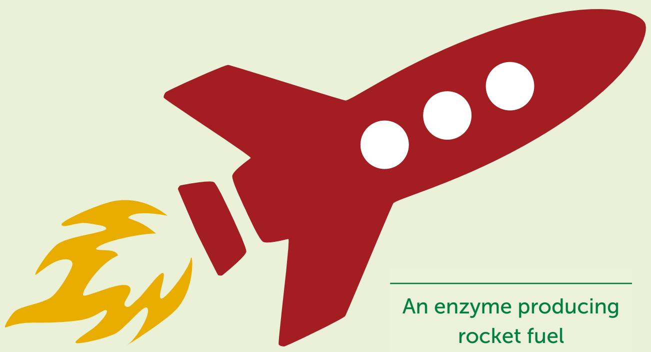
Nevertheless, far more people benefit from the "dangerous" enzyme than suffer its damage. An important application of the botulinum toxin in medicine is alleviation of suffering through muscle relaxation in convulsive diseases and, in cosmetics, the reduction of wrinkles through the relaxation of small muscles under the skin.

A popular question for students of food technology is whether it is still possible to eat a canned food contaminated with *Clostridium botulinum*. The correct answer is, "Yes, if you heat it sufficiently long." The bacterium itself is heat-stable and can, therefore, withstand inadequate heat treatment. The actual toxin, on the other hand, is, like almost all enzymes: heat sensitive.

Are there dangerous enzymes?

Future

Enzymes give rise to hope



An enzyme producing rocket fuel

To the moon with enzymes

Hydrazine is the strongest reductant on earth (hence, a perfect partner in oxidizing reactions that yield oxygen). Some bacteria living without oxygen called “annamox” (anaerobic ammonium-oxidizing) use this substance in their metabolism. It is produced by the enzyme *hydrazine synthase*. In spite of its high capacity to store hydrogen as potential alternative fuel for vehicles, hydrazine is used only for space missions or military purposes because it is highly toxic.

Microorganisms handle the toxic hydrazine by another enzyme, *hydrazine dehydrogenase*, that converts the toxic molecule into nitrogen and hydrogen.