35th VH Yeast Conference

Advances in Science & Industrial Production of Baker's Yeast

Berlin - May 06-07, 2024

"Yeast, sourdough, enzymes: baking with?"

in cooperation with

GEA engineering for a better world

LALLEMAND BAKING

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KAESER KOMPRESSOREN

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VH Berlin

Invitation

We kindly invite you to participate in our 35th VH Yeast Conference 2024, with focus on “Yeast, sourdough, enzymes: baking with ?”.

Recent baking shows present a revival of traditional bread recipes with sourdoughs and starters of all kind. Our lecturers will share the developments on new baked products, as well as insights in functionalities of the microbial biocenosis of Lactic Acid Bacteria and Yeasts with you.

The visit program will adress the use of all kind of baking agents at the organic bakery „Märkisch Landbrot“, as well as intelligent use of renewable energy at the „EUREF Campus“.

We look forward to a lively exchange and a great networking event!

M. Eng. Sc. Antoine Chagnon,	President of VH Berlin
Dr.-Ing. Michael Quantz,	General manager of VH Berlin

Conference day I, all times in CEST = UTC +2h

Monday, May 06, 2024

10:00 a.m. Conference opening and welcome

President Antoine Chagnon

Lallemand Inc. (CAN)

Markets

10:15 a.m. The future of bread lies in its past: Sourdough diversity

Stefan Cappelle / Alice Constantini

Puratos (BEL) / LabID (ITA)

Sourdough has been around for thousands of years, but its use got under pressure since the industrial revolution due to the convenience of commercial baker’s yeast, able to standardize the proofing time of the dough. However, sourdough has experienced a resurgence in popularity during recent decades. Its ancient tradition, unique aroma, flavors, textures, longer shelf life, and nutritional

benefits it provides to bread and leavened baked goods have fascinated many customers. Sourdough biodiversity refers to the microbial composition mainly of yeasts and lactic acid bacteria species, flanked by other subdominant species (e.g., acetic acid bacteria). The intricate interaction among microorganisms and their environment is the secret of bread uniqueness.

Back in 2009, Puratos, in cooperation with Professor M. Gobbetti took the initiative to study in depth the biodiversity of type 1 spontaneously fermented sourdoughs, starting with Italian sourdoughs collected from several regions. This study culminated in the foundation of the world's only Sourdough Library in Sankt-Vith in 2013. Nowadays, it counts more than 150 spontaneous sourdoughs from ca. 30 countries around the world. It provides a lot of insights on how the microbial biodiversity is influencing flavor, texture, and nutritional benefits, such as the digestibility of bread and potentially increasing the bioavailability of nutrients (e.g., minerals and free amino acids).

But obviously many more sourdoughs are being fed somewhere in a household or a bakery in the world and for those, 'The Quest for Sourdough' has been created. It is an open platform where people can describe their sourdough and the feeding process. But for most passionate home bakers and professional bakers, their sourdough microbiome is still a big mystery, they would be interested to unravel. In order to provide access to this microbial resource, a new start-up company, called LabID, has been created at the Free University of Bolzano under the scientific supervision of Professor Gobbetti and Professor Di Cagno. The Sourdough biodiversity will be evaluated as the key point in determining the metabolic performance of sourdough and allow better to drive process and enhance the overall quality of bread or other leavened baked goods.

Applied Research

11:00 a.m. Yeast bio diversity on sourdough

Luciana Jimenez

Lesaffre (FRA)

Sourdoughs are natural consortia of yeasts and bacteria that deliver taste and flavor as well as texture. In addition, the use of sourdough enhances the shelf life of final bread. Through yeasts and bacterial diversity analysis of more than 100 multiple artisanal maintained sourdoughs from China, we determined that sourdough microbial composition shows process dependency. We hypothesize that this dependency may be related to raw material, back slopping procedures and process conditions as temperature and time.

Community charts reflect microorganism composition in among 100 different sourdough samples. At the fungal species level, *Saccharomyces cerevisiae, Kazachstania humilis, Saccharomycopsis fibuligera* and *Wickerhamomyces anomalus* have a high abundance. Community charts for bacteria composition show that *Fructilactobacillus sanfranciscensis, Pediococcus pentosaceus, Weissella cibaria* and *Lactiplantibacillus plantarum* are the bacteria with a high relative abundance.

Next to the diversity analysis we isolated and characterize more than 200 strains belonging to those communities. Complex interactions between those microorganisms are key to produce specific sourdough's characteristics however today these are not well understood. We compared, in a simplified sourdough, a combination of *Saccharomyces cerevisiae/Fructilactobacillus sanfranciscensis* and *Kazachstania humilis/Fructilactobacillus sanfranciscensis*, showing that interactions between yeasts and bacteria deliver the key sourdough physicochemical characteristics.

Finally, the variation observed between several generic profiles also suggests that several different yeasts and bacteria consortia can deliver a pleasing steam bread. The question that remains is to what extent the microbial composition, influenced by the artisanal process of back slopping, is of influence on bread quality parameters. This is key to understand as we strive to deliver the benefits these yeasts and bacteria consortia-based breads to a larger audience through industrial sourdough manufacturing.

11:30 a.m. Coffee Break

Analytics/Quality

12:00 p.m. Composite flour: New approaches to reduce wheat dependence in flour applications

Lutz Popper

Stern Enzym (GER)

Composite flour (CF) has gained renewed importance due to the upheavals caused by the Covid pandemic and the war in Ukraine. Non-wheat flours, e.g., from corn or cassava, are a challenge particularly in bread applications, because they lack the gluten necessary for positive baking behavior.

However, today, the industry today has at its disposal a large toolbox, mainly of enzymes, to compensate the negative influence of CF. This presentation also reports on the potential of modern flour treatment in managing the performance losses. It will provide recent example on the use of flour and dough improvers in composite flour. Furthermore, it will show facts from amazing international projects to replace wheat in baking and other flour applications. Finally, it will contribute to recognition of the economic potential of using composite instead of pure wheat flour.

Analytics and Quality

12:30 p.m. Investigating the influence of aging on metabolome and gene expression in *Saccharomyces* yeast

Marco Eigenfeld & Kilian Lupp

Med Uni Graz (AUT)

Saccharomyces yeast, a key model in aging research, undergoes chronological and replicative aging processes that influence cellular repair and age-related diseases. Traditional cell separation methods were labor-intensive and invasive, affecting accuracy and scalability. The novel approach utilizes magnetic labeling of yeast cell bud scars for age-specific fractionation, combining magnetophoretic and inertial forces to separate cells by age, as indicated by bud scar numbers.

Metabolomic analyses reveal age-related metabolic shifts, including changes in amino acid levels and cofactor production. Gene expression studies underscore these metabolic changes, indicating alterations in genes related to metabolism and stress response. This platform offers a high-throughput, non-invasive method for yeast cell fractionation, with implications for the beverage and pharmaceutical industries, providing insights into cellular aging and potential for enhancing product quality and research in aging dynamics.

01:00 p.m. Conference Lunch Break

02:15 p.m. Autotoxin-mediated latecomer killing in yeast communities

Tetsuhiro S. Hatakeyama

University of Tokyo (JAP)

Cellular adaptation to stressful environments such as starvation is essential to the survival of microbial communities, but the uniform response of the cell community may lead to entire cell death or severe damage to their fitness. Here, we demonstrate an elaborate response of the yeast community against glucose depletion, in which the first adapted cells kill the latecomer cells. During glucose depletion, yeast cells release autotoxins, such as leucic acid and L-2keto-3methylvalerate, which can even kill the clonal cells of the ones producing them.

Although these autotoxins were likely to induce mass suicide, some cells differentiated to adapt to the autotoxins without genetic changes. If non-differentiated latecomers tried to invade the habitat, autotoxins damaged or killed the latecomers, but the differentiated cells could selectively survive. Phylogenetically distant fission and budding yeast shared this behavior using the same autotoxins, suggesting that latecomer killing may be the universal system of intercellular communication.

Since this latecomer killing works within and also between species, it may serve as an inhibitory mechanism for the growth of undesirable microbes in food products.

Industry View

02:45 p.m. Refurbish blowers to increase yeast fermenter capacities

Manuel Dias

Kaeser Kompressoren (GER)

03:15 p.m. Improvements on yeast RVF & packaging machinery

Martin Dannenberg

van Mourik Yeast&Packaging (NED)

03:30 p.m. Coffee Break

Visit & Convivial evening

04:15 p.m. Bus transfer

04:45 p.m. Visit: EUREF campus tour / bakery "Märkisch Landbrot"

07:00 p.m. Convivial evening at Hotel SANA Berlin

In addition to a dinner event we will enjoy many networking opportunities.

10:30 p.m. End of conference Day 1

Conference day II, all times in CEST = UTC +2h

Tuesday, May 07, 2024

Applied research

09:00 a.m. The science of sourdough: How microorganisms can help to improve bread quality

Susanne Miescher Schwenninger

ZHAW Wädenswihl (SUI)

Sourdough has long been recognized for its positive impact on bread quality. It contributes to desirable attributes such as flavor, texture, shelf life, and nutritional profile. In addition to sourdough, the baking industry commonly employs food additives, including emulsifiers, hydrocolloids, and preservatives.

However, there is a growing consumer demand for clean-label products. Consequently, the baking industry faces the challenge of reformulating products while maintaining quality. Natural substitutes are becoming increasingly prominent, and one promising path is the use of sourdough inoculated with functional lactic acid bacteria (LAB). These LAB exhibit various metabolic activities, including the production of exopolysaccharides (EPS), which contribute to improved texture. Additionally, they demonstrate antifungal properties, synthesize vitamins, and aid in FODMAPs degradation.

The ZHAW Zurich University of Applied Sciences has undertaken research projects exploring the potential of functional LAB in bakery applications. The heart of this research is a collection of over 14,000 microbial isolates sourced globally, with a significant proportion originating from plant fermentations. These isolates serve as a valuable resource for identifying strains with specific functionalities relevant to fermentation processes, particularly in the context of sourdough production. To achieve this, target-oriented high-throughput screening techniques are employed. The goal is to find optimal LAB strains that exhibit desired attributes, such as improved texture, extended shelf life, and enhanced nutritional profiles. These strains contribute to the development of multifunctional ingredients for the bakery.

Beside an overview on the potential of functional LAB in sourdough and further cereal fermentations, the presentation will showcase research project examples from ZHAW Zurich University of Applied Sciences and provide a glimpse into the future of sourdough and fermentates in bakery applications, highlighting their role in enhancing bread quality and meeting consumer preferences for natural, healthier products.

09:30 a.m. Strain dependent assessment of dough's polymer structure and functionality during the baking process

Thekla Alpers

Technical University Munich (GER)

Saccharomyces cerevisiae is a centuries old ingredient in bread making. During the consecutive steps of the breadmaking process, the mechanical stress exerted by S. cerevisiae induces structural changes in the wheat dough matrix on a molecular and microstructural length scale. Thereby, the effect of growing gas cells outweighs the effect of chemical stressors on the dough matrix‘ mechanical properties and structure, especially during short fermentation processes. Up to now, the potential effects of yeast metabolites on the functionality of the dough´s polymers during the baking process were widely unknown. Hence, to elucidate the impact of yeast metabolites on the solidification behavior of wheat dough, the following hypothesis was formulated: yeast-induced changes on the different length scales of wheat dough alter the flow and solidification behavior of the wheat dough matrix during baking. To access the potential changes in the wheat dough’s functionality, lubricated squeezing flow and small amplitude oscillatory rheometry were applied to yeasted, chemically leavened and non-yeasted dough at temperatures relevant for the baking process. Supporting structural characterization was performed at the respective temperatures. In this regard, the extent of starch gelatinization and protein polymerization were quantified using Differential Scanning Calorimetry and an extraction method.

During the baking process, CO_2 accounted for the major changes in the solidification process occurring during baking. When comparing non-leavened to yeasted wheat dough, the extent of protein polymerization was limited and the starch gelatinization was initiated earlier in yeasted dough. These effects can be explained by the impact of yeast on the dough’s microstructure. During fermentation, the protein microstructure transforms from a dense, highly branched network to a partially degraded structure. Thus, the polymerization reaction of proximate proteins is limited and the starch accessibility is enhanced for hydration. One of the most important gluten functionalities, the strain hardening potential, was not observed to be impeded by the reduced molecular and microstructural connectivity. Contrarily, the self-enforcing nature of yeasted wheat dough led to an increased strain hardening index in presence of yeast metabolites, leading to a prematurely limitation of further oven rise in yeasted dough during baking. Thus, this work contributed to elucidating the effect of yeast metabolites on the functionality of wheat dough polymers during the baking process.

Applied research

10:00 a.m. Leveraging the potential of *Saccharomyces cerevisiae* for polyphosphate production

Makarius Baier

RWTH Aachen University (GER)

The world's growing population requires an adequate supply of phosphate to meet its agricultural needs, making the development of a circular phosphate economy crucial. One value-added product of this phosphate-economy is polyphosphate, which is currently produced from rock-derived phosphoric acid. The baker's yeast Saccharomyces cerevisiae is able to accumulate phosphate from low concentrated solutions as polyphosphate in its vacuole and with phosphate starvation followed by phosphate feeding, this polyphosphate storage can make up to 28% of the cell dry weight.

This project aims to exploit the potential of *S. cerevisiae* as a renewable source of polyphosphate. Utilizing a pipeline based on markerless engineering by CRISPR/Cas9 to modify the phosphate metabolism, multiple strains were constructed, some of them showing enhanced accumulation and cultivation properties. Coupled with high throughput screening of the VH Berlin strain collection of diverse industrial yeast strains and the EUROSCARF deletion collection, this will enable the creation of an optimized production host.

Concurrently, optimization of cultivation conditions addresses challenges encountered during upscaling from the original protocol, providing additional process insights and reducing overall costs.

In summary, this project holds promise for both industry and academia by delivering a biologically synthesized polyphosphate and polyphosphate rich yeast extract. Moreover, it contributes to advancing scientific comprehension of phosphate metabolism and polyphosphate synthesis.

10:30 a.m. Coffee Break

Production

10:45 a.m. GEA Westfalia Separator - 120 years of yeast separation / new aspects

Burkhard Schiemann & Dominik Krienke

GEA Westfalia Separators (GER)

GEA Westfalia Separator, founded in 1893, looks back on more than 130 years of history in centrifugation business. During the first years, the new established company, which firmed under the name “Ramesohl & Schmidt”, was driven by agriculture. The farmers needed to separate the fresh milk by the use of hand driven centrifuges into cream and skimmed milk. From the cream, butter was produced. In these early years, the founders quickly were known to build well machined and robust centrifuges, which were sold already at this time under the brand name “Westfalia”.

Nothing relates closer to butter than bread. In the early 20 century, industrialization in the bakery industry increased the demand on baker’s yeast. 1904 Ramesohl & Schmidt decided to enter the yeast business and developed their first yeast centrifuge. Only one year later, in 1905, 20 units of this first-generation centrifuge were sold, installed and commissioned in a press yeast factory in Teplice (Czech Republic). Since then, the company remained a close partner to the yeast industry, continuously improving both, machine and process technology.

When sliding bearings were replaced by ball bearings in 1921, the capacity of the machines increased rapidly. The first centripetal pump machine enabled the clarified liquid to be discharged under pressure. In 1983, GEA built the largest yeast separator in the world with a capacity of up to 260 m3 / h yeast wort.

Until today, GEA Westfalia Separator stands for bringing new ideas into the yeast industry, which simplifies installation and operation, reduces water and energy consumption and improves the product quality of yeast. Whereas in the past yeast was mainly produced for bakeries, breweries, wineries and extract producers, we see today a wide range of new yeast products for the food, new-food and non-food industry. Either the complete biomass is used or only certain extracellular or intracellular components.

Proteins, special alcohols, fatty acids, oils and sugar replacements are examples for such new creations. Proteins from yeast can be used for vegan food supplementing milk proteins. Special alcohols and fatty acids are used in cosmetic products to replace animal derived components. Oils can replace vegetable oils,

or in the non-food industry even biodiesel and kerosene. Low-calorie sweeteners or no-calorie sweeteners can replace sugars in special diet products.

The manufacturing of those new products requires new processes in which the disc stack centrifuge still plays its important role. GEA Westfalia Separator supplies disc stack centrifuges especially adjusted to the new needs, which are essential for the final product quality.

E.g. pre-treated yeast strains can be shear sensitive. In such cases acceleration forces and shear forces inside the centrifuge needs to be reduced not to destroy the cells or create heavy emulsions. In case fatty acids or oils are produced from yeast, the valuable phase is often not the yeast biomass, but the continuous or centrate phase. To isolate the valuable light components, a so-called 3-phase separator is required.

Centrifuges normally used in the yeast industry are solid/liquid machines. Here, a liquid/liquid or even liquid/liquid/solid machine is needed. Centrifuges, which are gas-tight and capable of steam-sterilizable are applied when low contamination values are requested.

In this presentation we will not only look back at the highlights of 120 years of yeast separation, we will also and especially look ahead into a new world of opportunities and chances opening up to yeast and what that means for the centrifugal separation part.

Applied research

11:15 a.m. Project scope "YeastControl" – smarter fermentation control by machine learning based process modelling

Florian Dymek & Jonathan Sturm & Erik Pollmann

Westfälische Hochschule (GER) / BlueSens (GER) / VH Berlin (GER)

The standard baker's yeast production is using a fed-batch process with the molasses feed being tightly controlled in order to avoid the "Crab tree" effect: When the sugar concentration in the medium becomes too high (>0.1%), the baker's yeast metabolism switches and produces large amounts of ethanol with only 15-20% of the biomass obtained without the Crabtree effect.

Most processes use an established "feed curve" which has been created for the process. As online sugar concentration measurement is not available, current process controls measure the ethanol concentration in the fermenter in order to determine if an over-feeding has happened already and thus the molasses feed should be reduced. Usually this is achieved by using a PID controller, but in large fermenter volumes response times of >20 minutes are often found and thus make an exact control difficult, therefore leading to the need of adjustments, often by a human supervisor. Variations in media composition and qualities (molasses) and differences between strains pose additional challenges.

In order to provide an alternative control system, the consortium of BlueSens gas sensor GmbH, Westfälische Hochschule Recklinghausen and VH Berlin aims to develop a new control system which will improve the feed-control, based on off-gas analysis and currently available process data. This model determines the current state of the fermenter and predicts the course of fermentation, allowing for an adjusted molasses feed control.

The company BlueSens gas sensor GmbH will provide their process gas sensors, their gas sensor expertise and develop an industrial "process control box" which can be integrated into any process control system. The control system will integrate soft sensors based on process models by all three partners.

The Westfälische Hochschule Recklinghausen will be developing the machine learning model which the control will be based on, allowing a predictive rather than a reactive process control.

VH Berlin is going to provide the baker's yeast expertise for what a "good process" is supposed to be, the data and variations from raw materials as well as fermentation data from the past as well as during during the project. The fermentation data will also be used to create a "process digital twin", which determines the current state of the fermentation and characterizes potential impact on the baker's yeast quality.

The project application is currently in the review phase by the AIF (German Federation of Industrial Research).

Production

11:45 a.m. From data spaces in Gaia-X to Industry 4.0: Enhancing efficiency through Human-Centered Digitalization - Illustrated with practical examples

Tim Kaluza

Fraunhofer Institute for Process Engineering and Packaging IVV (GER)

This presentation examines the integration of Gaia-X data spaces and digitalization aspects of Industry 4.0, highlighting the impact of human-centered digitalization across various sectors.

We provide concise examples that include: enhancing chocolate production through machine learning and computer vision, optimizing maintenance by predicting fouling in heat exchangers, and streamlining knowledge transfer in the bakery industry. Each case succinctly demonstrates how digital innovation, supported by human insight, can improve efficiency, or facilitate knowledge sharing.

12:15 p.m. Feedback & Farewell

Vice President Thomas Lotz

Lesaffre Germany (GER)

12:45 p.m. Conference Lunch

02:00 p.m. End of conference