



What makes Tucson so

HOT?



**The 72nd Annual Meeting of the
American Society of Brewing Chemists**

ASBC



2009

Annual Meeting

June 6-10

Tucson, Arizona

June 6–10, 2009

**Hilton Tucson
El Conquistador**

Tucson, Arizona

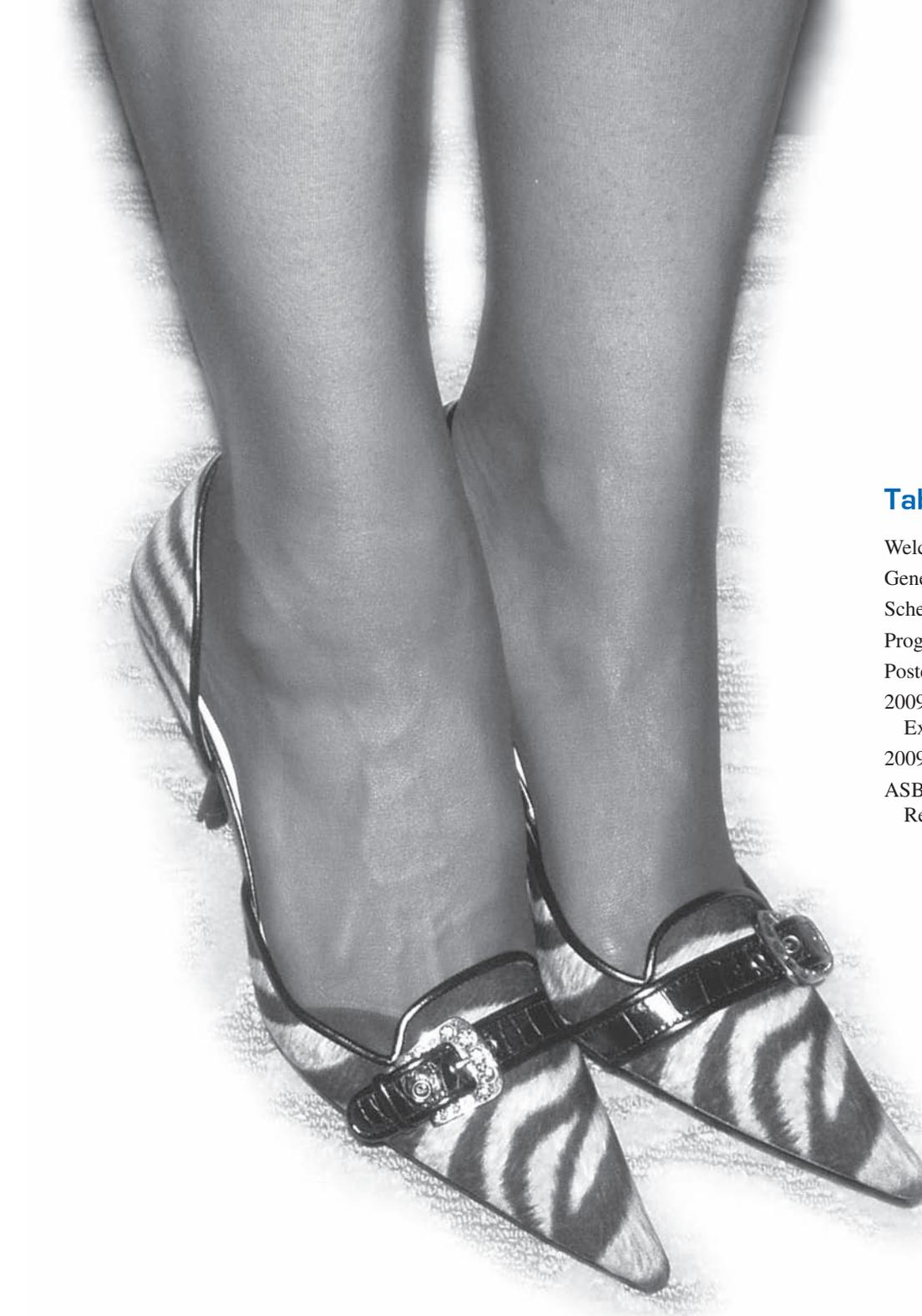


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Photos courtesy Metropolitan Tucson Convention & Visitors Bureau. Downtown Tucson by Steve Renzi; Mission San Xavier del Bac Arch by Rick Machle; Springtime in the Catalinas by Gill Kenny.

The Hottest Brewing Meeting of 2009

What makes Tucson so HOT?! You do! So, thank you for joining us for the 72nd Annual Meeting of the American Society of Brewing Chemists.

The past year has been a challenging one for most of us. It's probably fair to say that we've all have been touched, either directly or indirectly, by changes in the brewing industry and by uncertainty in the global economy. So, it seems very special to be able to come together to learn and discuss relevant and timely topics surrounding our favorite beverage, beer!

The ASBC Program Committee has always delivered an interesting and valuable program to its members, but challenges in the brewing industry and the economy have provided further impetus to "brew up" more value than ever before. With this in mind, we've made some changes to the program format that we hope you'll find enhance the ASBC meeting experience. This is a jam-packed program that includes two pre-annual meeting short courses, six workshops, seven technical sessions, poster and exhibit sessions, presenters representing 12 countries, a new format for the popular Emerging Issues forum, and the introduction of two Pearls of Wisdom sessions, where controversial topics and points-of-view will be debated in a point/counterpoint-style forum.

The ASBC Annual Meeting continues to be a terrific venue to meet up with old friends and colleagues and develop new relationships that can last a career and a lifetime. I think this year's program offers great opportunities to interact with your brewing buddies and learn about and discuss hot brewing topics in new and fun ways!

On behalf of the Program Committee, I welcome you to the ASBC Annual Meeting at the Hilton Tucson El Conquistador and to our brewing community. I hope you take full advantage of the many opportunities to expand your brewing science knowledge, share your expertise, and gain new insights into the fascinating world of brewing. I personally welcome your feedback on the new program format—just look for the woman with the pointy tiger shoes!

Cindy-Lou Dull
Program Committee Chair



General Meeting Information

Registration Desk

Registration will be located at the Satellite Desk near the Turquoise Ballroom Foyer.

Saturday, June 6	3:30 – 6:30 p.m.
Sunday, June 7	8:00 a.m. – 5:00 p.m.
Monday, June 8	7:30 a.m. – 3:00 p.m.
Tuesday, June 9	7:30 a.m. – 3:00 p.m.
Wednesday, June 10	7:30 a.m. – 12:00 p.m.

Exhibits

Turquoise Ballroom

Exhibit Set Up

Saturday, June 6	3:30 – 5:30 p.m.
Sunday, June 7	9:00 a.m. – 1:00 p.m.

Exhibits Open

Sunday, June 7	3:30 – 5:30 p.m.
Monday, June 8	10:00 a.m. – 12:00 p.m.
Tuesday, June 9	11:30 a.m. – 1:30 p.m.

Exhibit Take Down

Tuesday, June 9	1:30 – 4:00 p.m.
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Posters

Turquoise Ballroom

Poster Set Up

Saturday, June 6	3:30 – 5:30 p.m.
Sunday, June 7	9:00 a.m. – 1:00 p.m.

Posters Open

Sunday, June 7	3:30 – 5:30 p.m. (Poster Authors Present 4:30 – 5:30 p.m.)
Monday, June 8	10:00 a.m. – 12:00 p.m. (Authors Present: Even Numbers 10:00 – 10:30 a.m.; Odd Numbers 11:30 a.m. – 12:00 p.m.)
Tuesday, June 9	11:30 a.m. – 1:30 p.m. (Authors Present: Odd Numbers 11:30 a.m. – 12:00 p.m.; Even Numbers 1:00 – 1:30 p.m.)

Poster Take Down

Tuesday, June 9	1:30 – 2:30 p.m.
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Technical Subcommittee Meetings

Attend any of the 11 ASBC Technical Subcommittee meetings during the ASBC Annual Meeting. Each meeting is specific to a Technical Subcommittee run from 2008 to 2009 and will provide an overview of the results and recommendations. The meetings are open to all meeting attendees, and your feedback and participation in these meetings are essential to ensuring the quality of the methods being tested. In addition, there will be meetings for a number of standing subcommittees, including Methods of Analysis Reviews, Craft Brewers, and the New and Alternate Subcommittees, where you will have the opportunity to make recommendations for future technical subcommittees.

ASBC Foundation Silent Auction

Help students pay for their meeting registration by bidding on items at the ASBC Silent Auction. The silent auction will take place in the Turquoise Ballroom Foyer by the registration desk during the following hours.

Sunday, June 7	8:00 a.m. – 5:00 p.m.
Monday, June 8	7:30 a.m. – 3:00 p.m.
Tuesday, June 9	7:30 a.m. – 1:15 p.m.

2009 Proceedings CD

Take home the research and presentations from the ASBC Annual Meeting! Every meeting attendee will receive an ASBC 2009 Proceedings CD. This will be a resource for you for years to come!

Guests

Guest registration includes breakfast from 9:00 to 10:30 a.m. Sunday in the Canyon Suite III room and access to guest hospitality. Guests wishing to attend any of the receptions or the Recognition Lunch must purchase tickets.

Guest Hospitality

Canyon Suite III

Sunday, June 7	1:00 – 6:00 p.m.
Monday, June 8	10:00 a.m. – 5:00 p.m.
Tuesday, June 9	10:00 a.m. – 5:30 p.m.

Meeting Attire

Business casual dress is encouraged for all meeting events.

Photo Release

ASBC staff will take photos throughout the meeting for use in promotional materials after the meeting has concluded. By virtue of your attendance, you agree to ASBC's use of your likeness in said promotional materials.

Emergency Procedures

The Hilton Tucson El Conquistador is fully prepared to handle different types of situations to assist guests. Following is information on its emergency procedures:

The hotel internal emergency number is 1911. The hotel has an emergency response team 24 hours a day. In the event of an emergency, calling the emergency number 1911 will initiate the appropriate response. Paramedics, fire department, and the police department are located approximately 10-15 minutes from the hotel. The Security Department, as well as a small number of other employees, is trained in CPR and first aid. Emergency evacuation routes and procedures are located on the inside of all guest room doors.

Nearest hospital and emergency room:

Northwest Medical Center
1551 E. Tangerine Road
Oro Valley, AZ 85755
+1.520.901.3500

Approximately 5 miles from the hotel.

Schedule at a Glance

Saturday, June 6	Sunday, June 7	Monday, June 8	Tuesday, June 9	Wednesday, June 10
<p>Board of Directors Meeting and Lunch 8:00 a.m. – 5:00 p.m.</p> <p>Short Course: Water Quality 1:00 – 5:00 p.m.</p> <p>Short Course: Introduction to Distilled Spirits 1:00 – 5:00 p.m.</p> <p>Registration 3:30 – 6:30 p.m.</p> <p>Hospitality 4:00 – 11:00 p.m.</p>	<p>Speaker Orientation and Breakfast: All Oral and Poster Presenters 7:00 – 8:00 a.m.</p> <p>Program Committee Meeting and Breakfast 8:00 – 9:00 a.m.</p> <p>Registration 8:00 a.m. – 5:00 p.m.</p> <p>General Session and Opening Keynote Using Systems Science to Make Strategic Decisions for a Sustainable Future 9:15 – 10:45 a.m.</p> <p>Break 10:45 – 11:00 a.m.</p> <p>New Products and Services Session 11:00 a.m. – 12:00 p.m.</p> <p>Technical Subcommittee Meetings 11:00 a.m. – 12:00 p.m.</p> <p>Workshop: TTB Topics of Interest to Brewers 1:00 – 3:00 p.m.</p> <p>Technical Session I – Hops/Barley/Malt 1:00 – 3:55 p.m.</p> <p>Exhibits, Posters, and Hospitality 3:30 – 5:30 p.m. <i>(Poster Authors Present 4:30 – 5:30 p.m.)</i></p> <p>Pearls of Wisdom: First Strand 5:45 – 6:30 p.m.</p> <p>Meeting Orientation 6:30 – 7:00 p.m.</p> <p>Welcome Reception 7:00 – 9:30 p.m.</p> <p>Hospitality 9:00 – 11:00 p.m.</p>	<p>Registration 7:30 a.m. – 3:00 p.m.</p> <p>Silent Auction Open 7:30 a.m. – 3:00 p.m.</p> <p>Technical Session II – Fermentation 8:00 – 9:20 a.m.</p> <p>Award of Distinction Lecture: Graham Stewart. High gravity brewing and distilling— Past experiences and future prospects. 9:20 – 10:00 a.m.</p> <p>Exhibits and Hospitality 10:00 a.m. – 12:00 p.m.</p> <p>Poster Session 10:00 a.m. – 12:00 p.m. <i>(Authors Present: Even Numbers 10:00 – 10:30 a.m.; Odd Numbers 11:30 a.m. – 12:00 p.m.)</i></p> <p>Technical Subcommittee Meetings 10:30 – 11:30 a.m.</p> <p>ISIHAS Hop Subcommittee Meeting 10:30 – 11:30 a.m.</p> <p>Recognition Lunch 12:15 – 1:45 p.m.</p> <p>Technical Session III – Microbiology 2:00 – 3:20 p.m.</p> <p>Workshop: Cachaça – The Next Big Deal? 2:00 – 4:00 p.m.</p> <p>Break 3:20 – 3:35 p.m.</p> <p>Emerging Issues Forum 3:40 – 5:00 p.m.</p> <p>Hospitality 4:30 – 11:00 p.m.</p> <p>Evening Open – Free Time</p>	<p>Silent Auction Open 7:30 a.m. – 1:15 p.m.</p> <p>Registration 7:30 a.m. – 3:00 p.m.</p> <p>Technical Session IV – Analytical 8:00 – 10:30 a.m.</p> <p>Workshop: Beer Judging 10:30 a.m. – 12:00 p.m.</p> <p>Exhibits and Hospitality 11:30 a.m. – 1:30 p.m. <i>(11:30 a.m. – 1:00 p.m. Lunch Available in Exhibit Hall)</i></p> <p>Poster Session 11:30 a.m. – 1:30 p.m. <i>(Authors Present: Odd Numbers 11:30 a.m. – 12:00 p.m.; Even Numbers 1:00 – 1:30 p.m.)</i></p> <p>Technical Subcommittee Meetings 11:30 a.m. – 12:30 p.m.</p> <p>Technical Session V – Yeast 1:30 – 2:50 p.m.</p> <p>Break 2:50 – 3:10 p.m.</p> <p>Technical Session VI – Packaging 3:15 – 4:35 p.m.</p> <p>Local Section Officers Meeting 4:30 – 5:30 p.m.</p> <p>Hospitality 4:30 – 11:00 p.m.</p> <p>Pearls of Wisdom: Second Strand 4:45 – 5:30 p.m.</p> <p>Evening Open – Free Time</p>	<p>Registration 7:30 a.m. – 12:00 p.m.</p> <p>Technical Session VII – Flavor Compounds, Flavor Stability 8:00 – 10:25 a.m.</p> <p>Technical Subcommittee Meeting – New and Alternate Methods of Analysis 10:30 – 11:30 a.m.</p> <p>Workshop: Critical Role of Quality in a WCM Packaging Environment 10:30 a.m. – 12:00 p.m.</p> <p>Program Committee Meeting and Lunch 11:30 a.m. – 1:15 p.m.</p> <p>Publications Committee Meeting and Lunch 11:30 a.m. – 1:15 p.m.</p> <p>Technical Committee and Subcommittee Chairs Meeting and Lunch 11:30 a.m. – 1:15 p.m.</p> <p>Workshop: Sensory Shelf-life Testing 1:30 – 3:30 p.m.</p> <p>Workshop: Climate Changes and Impact on Raw Materials 1:30 – 3:30 p.m.</p> <p>Break 3:30 – 3:45 p.m.</p> <p>Closing Session 3:45 – 4:30 p.m.</p> <p>Closing Reception 7:00 – 10:00 p.m.</p> <p>Hospitality 9:00 – 11:00 p.m.</p>

Program

Friday, June 5

8:00 a.m. – 5:00 p.m.	Technical Committee Meeting and Lunch	Boardroom
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Saturday, June 6

8:00 a.m. – 5:00 p.m.	Board of Directors Meeting and Lunch	Boardroom
1:00 – 5:00 p.m.	Short Course: Water Quality*	Canyon Suite I
1:00 – 5:00 p.m.	Short Course: Introduction to Distilled Spirits*	Canyon Suite II
3:30 – 5:30 p.m.	Exhibit/Poster Set Up	Turquoise Ballroom
3:30 – 6:30 p.m.	Registration	Satellite Desk
4:00 – 11:00 p.m.	Hospitality	Sundance

*Additional registration required.

Saturday Highlights

Water Quality

Rick Brundage, Nalco Chemical Co., Moon Township, PA
Charles Eckermann, MillerCoors, Milwaukee, WI
James Mellem, Sierra Nevada Brewing Co., Chico, CA
Dan Quintanar, City of Tucson Water Department – Tucson
Water, Tucson, AZ

A panel of experts from the fields of brewing and water technology will present current information related to water quality and treatment and optimization of water needs related to beer styles and brewery demands. Topics include source water quality, analytic measures, and sanitization of water for various brewing applications. Discussions of trials related to brewing water change and case studies from each expert will lead to roundtable discussions involving all attendees. *Additional registration is required.*

Introduction to Distilled Spirits

Steven Wright, Spiritech Solutions, Ontario, Canada

Discover the world of distilled spirits. This course will cover a range of topics including a global view of spirits business and technical talks on the methods used in the production of leading spirits brands. From bourbon to rum, you will learn about methods used in the fermentation, distillation, and maturation of some of the top spirits styles. *Additional registration is required.*

Sunday, June 7

7:00 – 8:00 a.m.	Speaker Orientation and Breakfast: All Oral and Poster Presenters	White Dove
8:00 – 9:00 a.m.	Program Committee Meeting and Breakfast	Boardroom
8:00 a.m. – 5:00 p.m.	Registration	Satellite Desk
8:00 a.m. – 5:00 p.m.	Silent Auction Open	Turquoise Ballroom Foyer
9:00 a.m. – 1:00 p.m.	Exhibit/Poster Set Up	Turquoise Ballroom
9:15 – 10:45 a.m.	General Session and Opening Keynote Using Systems Science to Make Strategic Decisions for a Sustainable Future <i>George Basile, Arizona State University Decision Theater, Tempe, AZ</i> <i>Tim Lant, Arizona State University Decision Theater, Tempe, AZ</i>	Presidio I, II
10:45 – 11:00 a.m.	Break	
11:00 a.m. – 12:00 p.m.	New Products and Services Session	Presidio I, II
11:00 a.m. – 12:00 p.m.	Technical Subcommittee Meetings • Craft Brewers • Soluble Starch • Wort and Beer Fermentable Total Carbohydrates by HPLC	Canyon Suite II Joshua Tree Canyon Suite I
1:00 – 3:00 p.m.	Workshop: TTB Topics of Interest to Brewers	Canyon Suite II
1:00 – 3:55 p.m.	Technical Session I – Hops/Barley/Malt <i>Moderator: Bob Foster, MillerCoors, Golden, CO</i> 1:05 p.m. O-1. S. Heisel. The U.S. barley research infrastructure. 1:30 p.m. O-2. N. Kageyama. Degradation of astringent substances in malt for control of beer aftertaste.	Presidio I, II

- 1:55 p.m. O-3. M. Voetz. Malt-derived gushing and mycotoxin formation—Causes, correlations and reliable risk assessment.
- 2:20 p.m. Break
- 2:40 p.m. O-4. P. Hughes. The impact of hop aromas on perceived beer bitterness and astringency.
- 3:05 p.m. O-5. C. Schoenberger. Influence of filtration and stabilization on beer quality parameters and utilization rate of hop downstream products.
- 3:30 p.m. O-6. E. Evans. Investigation of premature yeast flocculation (PYF) using TRFLP and clone libraries to develop a practical and reliable screening solution for PYF malt.

3:30 – 5:30 p.m.

Exhibits, Posters, and Hospitality

(Poster Authors Present 4:30 – 5:30 p.m.)

5:45 – 6:30 p.m.

Pearls of Wisdom: First Strand

6:30 – 7:00 p.m.

Meeting Orientation

7:00 – 9:30 p.m.

Welcome Reception

9:00 – 11:00 p.m.

Hospitality

Turquoise Ballroom

Presido I, II

Canyon Suite III

Poolside Courtyard

Sundance

Sunday Highlights

Opening Keynote: Using Systems Science to Make Strategic Decisions for a Sustainable Future

George Basile, Arizona State University Decision Theater, Tempe, AZ

Tim Lant, Arizona State University Decision Theater, Tempe, AZ

Moderator: Fred Strachan, Sierra Nevada Brewing Co., Chico, CA

When it comes to “sustainability,” businesses face both a growing set of global challenges and an emerging suite of potential opportunities. It can be both daunting and confusing. Tim Lant and George Basile will discuss sustainability from a strategic perspective, touching on a variety of topics such as water, energy, and exploring how our short-term decisions can be informed by large-scale issues of global sustainability.

George Basile and Tim Lant, along with their teams at Decision Theater and the Global Institute of Sustainability, explore how to make the best decisions for a sustainable future. They work with diverse decision makers from business to science to policy, and their team addresses issues from water planning and climate change to pandemic flu and preparedness. The Decision Theater is a research center and decision laboratory that is part of the Global Institute of Sustainability at Arizona State University. It combines collaborative decision making with cross-systems analysis and a unique visualization facility. The Decision Theater works as the interface between research and application, exploring how to most effectively use systems science to make strategic decisions for a sustainable future.

New Products and Services Session

Moderator: Scott Heisel, American Malting Barley Association, Milwaukee, WI

Learn about the newest products and services on the market. Each supplier will have the floor for only a few minutes. This is your opportunity to hear from a lot of suppliers in a short amount of time!

Workshop: TTB Topics of Interest to Brewers

John Masschelin, U.S. Treasury Tax and Trade Bureau, Walnut Creek, CA

Charles Tull, U.S. Treasury Tax and Trade Bureau, Walnut Creek, CA

Moderator: Fred Strachan, Sierra Nevada Brewing Co., Chico, CA

Join members of the U.S. Treasury Tax and Trade Bureau as they discuss several items pertinent to the brewing industry. This workshop will be a comprehensive overview of the bureau’s structure and procedures as well as a discussion regarding the details of the projects and science conducted in the compliance lab. Other areas to be covered are future labeling initiatives, including serving facts, flavored malt beverages, and food allergens associated with the production of alcoholic beverages.

Pearls of Wisdom: First Strand

DMS Formation...The Debate Continues

Position Statement: Critical process control points for finished beer DMS fall entirely within brewhouse operations and malt material specifications—yeast as a CCP (critical control point) is irrelevant.

Greg Casey, MillerCoors, Littleton, CO

Graham Stewart, GGStewart Associates, Caerphilly, United Kingdom

Moderator: John Engel, MillerCoors, Milwaukee, WI

Experience a point/counterpoint style debate at the Pearls of Wisdom, where controversial topics, outrageous points-of-view, and audience participation are guaranteed! Presenters open the session with opposing perspectives and supporting evidence. Then the floor is open for all to participate!

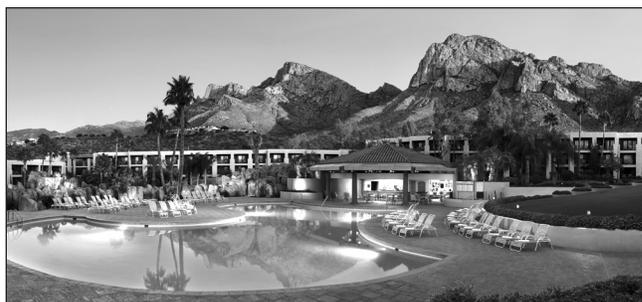
Meeting Orientation

Grab a bottle of beer, meet other attendees, and learn what you can do at the ASBC Annual Meeting. Rub elbows with and have your questions answered by the past presidents of ASBC.

Sunday Highlights continued

Welcome Reception

Meet poolside and kick off the meeting with friends and colleagues, hors d'oeuvres, and, of course, cold beer. And, if that's not enough, come and enjoy authentic mariachi music from Los Chanquitos Feos De Tucson.



Courtesy of the Hilton Tucson El Conquistador Golf & Tennis Resort.

Monday, June 8

7:30 a.m. – 3:00 p.m.	Registration	Satellite Desk
7:30 a.m. – 3:00 p.m.	Silent Auction Open	Turquoise Ballroom Foyer
8:00 – 9:20 a.m.	Technical Session II – Fermentation <i>Moderators: Greg Casey, MillerCoors, Littleton, CO Fred Strachan, Sierra Nevada Brewing Co., Chico, CA</i>	Presidio I, II
8:05 a.m.	O-7. S. Kreis. The influence of the amino acid profile of barley worts on fermentation performance and beer quality.	
8:30 a.m.	O-8. T. Arai. Analysis of the flavor compounds by brewing yeasts in insufficient nutrition.	
8:55 a.m.	O-9. J. Layfield. Characterization of hybrid strains of <i>Saccharomyces pastorianus</i> as related to desiccation tolerance and fermentation performance.	
9:20 – 10:00 a.m.	Award of Distinction Lecture: Graham Stewart. High gravity brewing and distilling—Past experiences and future prospects (O-10). <i>Moderators: Greg Casey, MillerCoors, Littleton, CO Fred Strachan, Sierra Nevada Brewing Co., Chico, CA</i>	Presidio I, II
10:00 a.m. – 12:00 p.m.	Exhibits and Hospitality	Turquoise Ballroom
10:00 a.m. – 12:00 p.m.	Poster Session <i>(Authors Present: Even Numbers 10:00 – 10:30 a.m.; Odd Numbers 11:30 a.m. – 12:00 p.m.)</i>	Turquoise Ballroom
10:30 – 11:30 a.m.	Technical Subcommittee Meetings • HLP Media • Malt MOA Review • Sensory Analysis and Sensory MOA Update • Sulfur Dioxide in Beer by Flow Injection Analysis	Joshua II Canyon Suite I Canyon Suite II
10:30 – 11:30 a.m.	ISIHAS Hop Subcommittee Meeting	Joshua I Boardroom
12:15 – 1:45 p.m.	Recognition Lunch	Presidio IV
2:00 – 3:20 p.m.	Technical Session III – Microbiology <i>Moderator: Chris Powell, Lallemand, Montreal, Canada</i>	Presidio I, II
2:05 p.m.	O-11. G. Zhou. 10-HDA could be used in draft keg conditioned wheat beer as an ideal antimicrobial agent.	
2:30 p.m.	O-12. V. Pittet. Detection of beer-spoiling gram-negative <i>Firmicutes</i> using real-time PCR.	
2:55 p.m.	O-13. K. Siebert. The problem of microorganism identification.	
2:00 – 4:00 p.m.	Workshop: Cachaça – The Next Big Deal?*	Canyon Suite I
3:20 – 3:35 p.m.	Break	
3:40 – 5:00 p.m.	Emerging Issues Forum	Presidio I, II
4:30 – 11:00 p.m.	Hospitality	Sundance
Evening Open – Free Time		

Monday Highlights

Workshop: Cachaça – The Next Big Deal?

Steven Wright, Spiritech Solutions, Ontario, Canada

Moderator: Kelly Tretter, New Belgium Brewing Co., Fort Collins, CO

As the world's third largest category of spirits, even bigger in volume than whisky (all whiskies), how come we don't know more about cachaça? In this workshop you will learn about the variety of methods used in producing this traditional Brazilian beverage and will be able to taste how different crafting methods create such unique and distinctive flavor differences. In Cachaça – The Next Big Deal? you can form your own opinion. *Additional registration is required.*

Recognition Lunch

You will not want to miss this event! Experience a menu specially created for ASBC. The chef's theme is "The Science and Art of Beer & Food Pairings." The unique combinations will engage your pallet and provide you with a better understanding of the nuances of pairing food and beer.

Emerging Issues Forum—New Format for 2009!

Roger Lawrence, McCormick & Co. Inc., Sparks, MD

Jerry Mullins, Cargill, Wayzata, MN

Paul Pettinger, New Belgium Brewing Co., Fort Collins, CO

Robert Taylor, MillerCoors, Milwaukee, WI

Moderator: Rebecca Newman, Boston Beer Co., Boston, MA

Emerging issues are ever-changing, and we are taking this opportunity to provide a workshop on agents of change. Building on the work started by Tony Cutaia in past years, this workshop will provide insight into current challenges. As we all move toward global lean or best-of-class manufacturing, what do these concepts mean to quality, sanitation, residuals, and ingredient supply chain? Are we keeping up with the developments in government, food safety, academia, and industry? As experts in lean manufacturing, sanitation, supply chain and residuals, the panel members, along with the moderator, will offer presentations and discussions that are salient to the moment and demands for the future.

Tuesday, June 9

7:30 a.m. – 1:15 p.m.	Silent Auction Open	Turquoise Ballroom Foyer
7:30 a.m. – 3:00 p.m.	Registration	Satellite Desk
8:00 – 10:30 a.m.	Technical Session IV – Analytical	Presidio I, II
	<i>Moderator: David Maradyn, InBev NV/SA, Leuven, Belgium</i>	
	8:05 a.m. O-14. K. Siebert. Elements of analytical measurement.	
	8:30 a.m. O-15. G. Spedding. Analysis of protein and total usable nitrogen in beer using a microwell ninhydrin assay.	
	8:55 a.m. O-16. R. Folz. Development and validation of a foam measurement device.	
	9:20 a.m. Break	
	9:40 a.m. O-17. J. Chang. Rapid mycotoxins analysis by high resolution LC/MS.	
	10:05 a.m. O-18. M. Lewis. Non-targeted small molecule profiling of beer by ultra-high pressure liquid chromatography-mass spectrometry.	
10:30 a.m. – 12:00 p.m.	Workshop: Beer Judging*	Coronado Ballroom
11:30 a.m. – 1:30 p.m.	Exhibits and Hospitality	Turquoise Ballroom
	<i>(11:30 a.m. – 1:00 p.m. Lunch Available in Exhibit Hall)</i>	
11:30 a.m. – 1:30 p.m.	Poster Session	Turquoise Ballroom
	<i>(Authors Present: Odd Numbers 11:30 a.m. – 12:00 p.m.; Even Numbers 1:00 – 1:30 p.m.)</i>	
11:30 a.m. – 12:30 p.m.	Technical Subcommittee Meetings	
	• Accurate IBU Measurement of Dry Hopped Beer	Canyon Suite I
	• ATP Bioluminescence	Canyon Suite II
	• Solid-Phase Microextraction-Gas Chromatography/Mass Selective Detection Fingerprint of Beer Volatiles and Semivolatiles	Agave II, III
1:30 – 2:30 p.m.	Poster Take Down	Turquoise Ballroom
1:30 – 2:50 p.m.	Technical Session V – Yeast	Presidio I, II
	<i>Moderator: Sylvie van Zandycke, Lallemand Inc., Lawrenceville, NJ</i>	
	1:35 p.m. O-19. G. Zhou. Enhancing the concentration of 4-vinylguaiacol in top-fermented beers—A review.	
	2:00 p.m. O-20. M. Krahl. Excretion of bioactive compounds from yeast induced through maltreatment in the brewing process.	

* Additional registration required.

	2:25 p.m.	O-21. M. Muro. Identification of yeast strains by PAGE method using mismatch-specific endonuclease.	
1:30 – 4:00 p.m.		Exhibit Take Down	Turquoise Ballroom
2:50 – 3:10 p.m.		Break	
3:15 – 4:35 p.m.		Technical Session VI – Packaging	Presidio I, II
		<i>Moderator: Fred Strachan, Sierra Nevada Brewing Co., Chico, CA</i>	
	3:20 p.m.	O-22. F. Verkoelen. A novel method for measuring total package oxygen.	
	3:45 p.m.	O-23. R. Pahl. The influence of chemical disinfectants for cold aseptic filling on oxygen permeation of PET bottles.	
	4:10 p.m.	O-24. M. Tata. A novel dissolved carbon dioxide analyzer.	
4:30 – 5:30 p.m.		Local Section Officers Meeting	Sundance
4:30 – 11:00 p.m.		Hospitality	Sundance
4:45 – 5:30 p.m.		Pearls of Wisdom: Second Strand	Presidio I, II
Evening Open – Free Time			

Tuesday Highlights

Workshop: Beer Judging

Scott Bruslind, Analysis Laboratory, Lebanon, OR

Ted Hausotter, Beer Judging Certification Program

Mountain/Northwest, Baker City, OR

Neva Parker, White Labs, Inc., San Diego, CA

Moderator: Aaron Porter, Sierra Nevada Brewing Co.,

Chico, CA

This workshop will provide information about the Beer Judging Certification Program (BJCP) and define the BJCP certification process, including judge training and testing. The fundamental concept of beer styles will be explained, with emphasis on how styles are defined, modified, and benchmarked. During the workshop, participants will use the BJCP score sheet to conduct an evaluation of a beer and have the opportunity to ask questions about beer judging and beer competitions in a fun and interactive setting. *This workshop is free but requires advance registration.*

Pearls of Wisdom: Second Strand

Don't Love Your Head – The Brewing of Optimal Beer Foam

Position Statement: Current knowledge of foam physics and beer component attributes needs further refinement. However, the greater challenge is “dialing in” realistic foam attributes to specific beer styles while operating in a global environment with numerous variables in ingredient availability, brewery design, distribution networks, and consumer expectations.

Evan Evans, University of Tasmania, Tasmania, Australia

Lance Lusk, MillerCoors, Milwaukee, WI

Moderator: John Engel, MillerCoors, Milwaukee, WI

Experience a point/counterpoint style debate at the Pearls of Wisdom, where controversial topics, outrageous points-of-view, and audience participation are guaranteed! Presenters open the session with opposing perspectives and supporting evidence. Then the floor is open for all to participate!

Wednesday, June 10

7:30 a.m. – 12:00 p.m.		Registration	Satellite Desk
8:00 – 10:25 a.m.		Technical Session VII – Flavor Compounds, Flavor Stability	Presidio I, II
		<i>Moderator: Suzanne Thompson, MillerCoors, Milwaukee, WI</i>	
	8:05 a.m.	O-25. U. Kattein. The influence of the wort boiling system on the concentrations of miscellaneous flavor components from malt and hops in wort and beer.	
	8:30 a.m.	O-26. L. Garbe. Isomeric 4,5-epoxy-2E-decenals in beer: Novel (off) flavor and highly reactive compounds—Formation pathways and accurate determination.	
	8:55 a.m.	O-27. M. Kobayashi. Mechanism of 3-methyl-2-butene-1-thiol production during fermentation.	
	9:20 a.m.	Break	
	9:35 a.m.	O-28. R. Mattos. A quantitative study on the influence of transport and storage variables on the flavor stability of Pilsen beer.	
	10:00 a.m.	O-29. M. Krahl. Novel malt-based beverages.	

10:30 – 11:30 a.m.	Technical Subcommittee Meeting – New and Alternate Methods of Analysis	Canyon Suite I
10:30 a.m. – 12:00 p.m.	Workshop: Critical Role of Quality in a WCM Packaging Environment	Joshua Tree
11:30 a.m. – 1:15 p.m.	Program Committee Meeting and Lunch	Boardroom
11:30 a.m. – 1:15 p.m.	Publications Committee Meeting and Lunch	Agave II, III
11:30 a.m. – 1:15 p.m.	Technical Committee and Subcommittee Chairs Meeting and Lunch	White Dove
1:30 – 3:30 p.m.	Workshop: Sensory Shelf-life Testing	Joshua Tree
1:30 – 3:30 p.m.	Workshop: Climate Changes and Impact on Raw Materials	Canyon Suite I
3:30 – 3:45 p.m.	Break	
3:45 – 4:30 p.m.	Closing Session	Presidio I, II
7:00 – 10:00 p.m.	Closing Reception	Last Territory
9:00 – 11:00 p.m.	Hospitality	Sundance

Wednesday Highlights



Workshop: Critical Role of Quality in a WCM Packaging Environment

Jay Chung, MillerCoors, Irwindale, CA
 Doug Endicott, Temple Inland Corp., Indianapolis, IN
 Michelle Johnson, MillerCoors, Irwindale, CA
 Robert Maruyama, MillerCoors, Golden, CO
 Becky Minske, Owens Illinois, Perrysburg, OH
 Moderators: Kathy Kinton, MillerCoors, Shenandoah, VA
 Robert Maruyama, MillerCoors, Golden, CO

Incoming packaging material quality is vital to a brewery's performance. The success of the brewery is dependant on the success of its suppliers, so they should be considered an extension of the brewery's family. This can be achieved through building a strong partnership and implementing a Supplier Continuous Improvement Toolbox that engages a supplier in the brewery's methodology for continuous improvement and develops their skills in problem solving. The toolbox provides proven techniques to systematically solve problems, eliminate variation, and reduce defects at the supplier's location. In turn, these improvements can help reduce brewery cost, increase performance, and eliminate waste. These efforts will also better equip suppliers to partner with brewery teams to drive results on the packaging floor. This workshop will discuss the advantages of incorporating the toolbox into your existing supplier quality management program.

Workshop: Sensory Shelf-life Testing

Teri Horner, MillerCoors, Golden, CO
 Rebecca Newman, Boston Beer Co., Boston, MA
 Dana Sedin, MillerCoors, Golden, CO
 Suzanne Thompson, MillerCoors, Milwaukee, WI
 Moderator: Kendra Bowen, Anheuser-Busch InBev, St. Louis, MO

As part of this workshop, brewers will be asked to gauge beer shelf life. Different beer styles respond differently to forced age testing and flavor change. Understanding methods for evaluating flavor change, instruments to gauge change, and proper analysis is challenging. By including various beer styles, one can gain an understanding of the challenges encountered in detecting change, thus our workshop on Sensory Shelf-life Testing. This presentation will provide the perspectives of both large and craft brewers. We have assembled a panel of sensory and brewing scientists that will provide information and discussion related to sensory methodology, instruments, analyses, the beer flavor wheel, and flavors associated with age and oxidation. There will be tasting; therefore, *preregistration is required.*

Workshop: Climate Changes and Impact on Raw Materials

Tom Blake, Montana State University, Bozeman, MT
 Scott Garden, John I Haas, Yakima, WA
 Mary-Jane Maurice, Malteurop North America, Inc., Milwaukee, WI
 Moderator: Evan Evans, University of Tasmania, Tasmania, Australia

In an ever-changing world of brewing materials, beers, and package presentations, the impact of climate change is critical to our business. This interactive session will cover some of the current climate issues that are impacting the brewing and allied industries and what possible actions can be taken by brewers to assist the industry in alleviating the public's concerns that transcend the entire supply chain. This workshop will provide practical instruction and discussion on a subject that is top-of-mind for brewers around the world.

Poster Presentations

Moderator: Kelly Tretter, New Belgium Brewing Co.,
Fort Collins, CO



- P-30. M. DiPietro. A comparison of the antioxidant potential of beer and wine polyphenols.
- P-31. G. Derdelinckx. Beer maturation in presence of cherries (*Prunus cerasus*).
- P-32. Withdrawn
- P-33. R. Foster. Cardiolipin influence in lager beer dimethyl sulphide levels: A possible role involving mitochondria?
- P-34. H. Mukumoto. Control of 3-methyl-2-butene-1-thiol production during fermentation.
- P-35. S. Pei. Detection of aflatoxin B1 in barley, corn, and rice by ELISA using heavy chain IgG2b isotype monoclonal antibody.
- P-36. Y. Li. Determination of lipoxygenase in barley and malt: A novel high-throughput screening method.
- P-37. S. Fernandez. Evaluation of three different yeast propagation methods and their effects on fermentation performance.
- P-38. H. Yamagishi. Gene-expression analysis of brewing yeast during high-gravity brewing.
- P-39. U. Usansa. Improvement of nitrogenous content in wort produced from rice malt.
- P-40. M. Bossert. Issues regarding residual iso- α -acids in reduced hop products and the formation of detectable 3-methyl-2-butene-1-thiol.
- P-41. A. Daar. Practical application of ESR/EPR for process improvement in a brewery.
- P-42. D. Zhang. Preparation of cross-linked carboxymethyl modified corn starch and adsorption of heavy metal ions in brewery wastewater.
- P-43. D. Langrell. The impact of turbidity on wort color measurement.
- P-44. M. Libardoni. Wine flavor analysis by comprehensive two-dimensional gas chromatography with time-of-flight mass spectrometry (GC \times GC-TOFMS).
- P-45. P. Ferstl. The influence of fluid mechanical process design during mashing on attenuation degree.
- P-46. C. Henson. A comparison of barley malt amylolytic enzyme thermostabilities as indicators of malt sugar concentrations.
- P-47. A. MacLeod. A laboratory fermentation method that can determine the influence of micro-nutrient levels on wort fermentability.

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BENEOPalatinit

2740 Rte. 10 W., Ste. 205, Morris Plains, NJ 07950; Telephone: +1.973.539.6644, Fax: +1.973.539.7295, Website: www.beneo-palatinit.com. BENEOPalatinit exhibits the new functional carbohydrate PALATINOSE™ for use in beer and beer specialties. Unable to be metabolized by typical microbial beer contaminants, PALATINOSE™ was researched to prolong freshness and flavor stability of beer and beer-mix products and to improve the palate-fullness, as well as other sensorial qualities, of beer containing low or no alcohol.

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Steinfurth, Inc.*

305 Etowah Trace, Ste. 102, Fayetteville, GA 30214; Telephone: +1.678.674.1096, Fax: +1.678.674.1097, Website: www.steinfurth.com. Steinfurth, specialist for high efficiency quality control instruments, will be presenting its automatic foam stability tester and the SF-PastControl system

(pasteurization logger). The just released Steinfurth Automatic Multiple Sampler AS380C is rounding out the family of instruments for high efficiency workflow management in the area of QC. It can be connected with any kind of flow through instruments (e.g., CO₂ tester, O₂ analyzer, etc.). Steinfurth's range of products for the beverage industry includes CO₂ measuring systems; devices for calibrating pressure and temperature; a torque tester; a logger for pressure, temperature, and pasteurization; packaging testing devices, measuring for foam stability and turbidity in beer; laboratory carbonization systems; and sampling devices.

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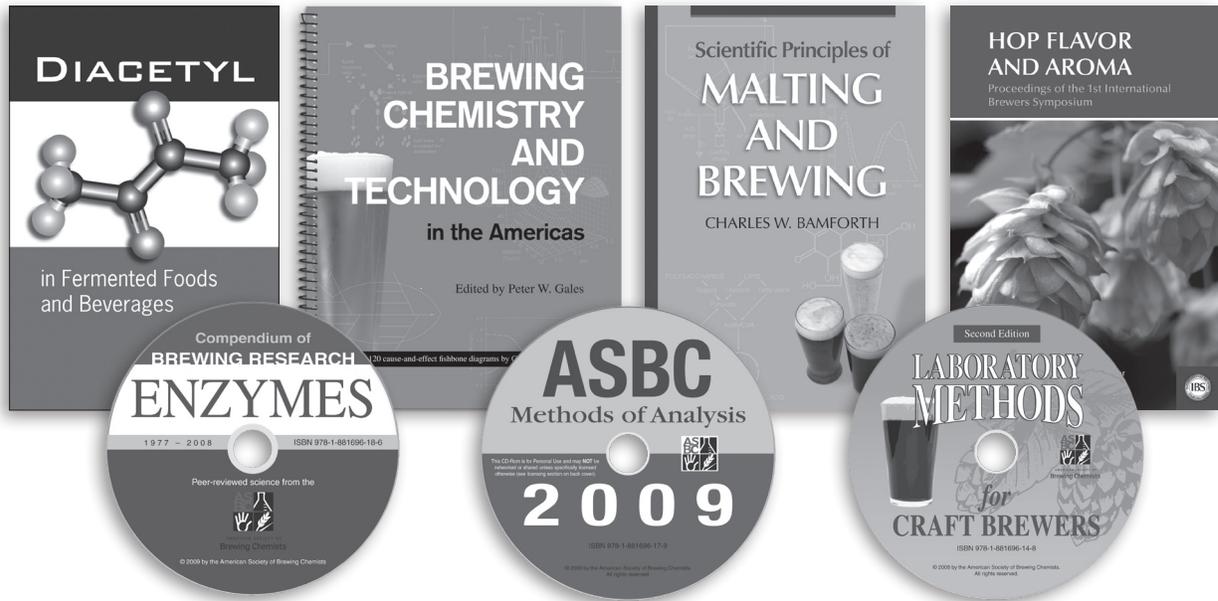
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AMERICAN SOCIETY OF
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2009 Annual Meeting Abstracts

O-1

The U.S. barley research infrastructure

SCOTT E. HEISEL (1), Michael P. Davis (1)

(1) American Malting Barley Association Inc., Milwaukee, WI

A viable and productive national barley research infrastructure is essential in helping ensure an adequate supply of malting barley for the U.S. malting and brewing industry. Barley research has taken on added importance with the recent decline in barley acreage to historic lows. In the United States, there are malting barley breeding programs at five state universities, one USDA facility, and two private-sector companies. Supporting research is also conducted by these and other entities at other locations. To address the malting barley supply situation, primary research goals include increased yield, development of winter barley varieties, resistance to abiotic stress (drought, heat, cold), pest resistance (disease, insects), and improved quality. Applied research is now combined with state-of-the-art molecular biology and genomic research. The American Malting Barley Association (AMBA) and the AMBA-led National Barley Improvement Committee (NBIC) work to enhance the national barley research infrastructure to the benefit of all U.S. malting barley research programs. AMBA provides direct funding to applied malting barley breeding and support programs, and the NBIC works to maintain and enhance federal funding. Key federally funded programs that have been brought about by this effort include the US Barley Genome Project, Barley Coordinated Agricultural Project (CAP), Barley for Rural Development, and the US Wheat & Barley Scab Initiative. This presentation will review and highlight the applied and basic malting barley research that comprises the U.S. barley research infrastructure and the interaction among federal, state, and private research programs.

Scott Heisel received B.S. degrees in biochemistry and in agronomy from the University of Wisconsin – Madison in 1982. In 1986 he received his M.S. degree in agronomy. Scott worked for several years at the USDA/ARS Barley and Malt Laboratory and has published several papers on characterizing various enzymes of germinated barley and the use of biochemical techniques to identify barley varieties. He joined the American Malting Barley Association, Inc. (AMBA), Milwaukee, WI, in April 1987 and currently is the vice president and technical director. Scott is an active member of the American Society of Brewing Chemists, serving on boards and committees. He also is a member of the National Barley Improvement Committee, which helps ensure adequate funding for federal research programs.

O-2

Degradation of astringent substances in malt for control of beer aftertaste

NORIHICO KAGEYAMA (1), Kaneo Oka (1), Akira Isoe (1)

(1) Suntory Limited, Osaka, Japan

We have already reported that the malt acrospire contains ingredients that could aggravate the aftertaste of beer. By NMR

and mass spectral analysis, the chemical structures of those components were determined to be derivatives of hordatine. We have also demonstrated that the removal of acrospire from malt by the malt fractionation technique was a good way to improve beer quality by reducing astringent substances in beer. In this presentation, we discuss another way to control astringent substances in malt and beer, not by means of physical removal but by means of chemical degradation. First, the purified astringent substance was treated with hydrochloric acid in methanol at 100°C, which is a popular condition in chemical approaches, and several typical intermediates of hydrolysis were observed. This result suggested that the astringent substances in malt could be degraded by hydrolysis. As this measure of malt treatment with hydrochloric acid would not be suitable for the practical malt production and brewing process, other degradation measures were evaluated and the treatment of malt with sub-critical H₂O, which was our original malt processing, was found to be an effective way to hydrolyze and thermally decompose the astringent substances in malt without any chemical agents. Malt was treated with sub-critical H₂O, and the content of residual astringent substances in the malt was determined. Their content in the sub-critical H₂O-treated malt was decreased compared with that in the original malt. The content of astringent substances in malt could be reduced to about 20% during treatment. A brewing trial in pilot scale was carried out by using the malt treated with sub-critical H₂O. It was shown that the test beer had better aftertaste compared with the control beer by sensory analysis. The treatment of malt with sub-critical H₂O could be a useful tool to control beer quality.

Norihiko Kageyama received his M.S. degree in chemistry from Osaka University in 1998. He joined the Institute for Fundamental Research, Suntory Ltd. in 1998 as a chemist researching natural products. Prior to developing brewing technologies in the Beer Development Department, he worked in the Process Development Department and developed material processing technologies, mainly based on sub-critical fluid technology, for development of new food and beer products. He was also actively involved with studies on identification of malt astringent substances and development of malt fractionation technology. He was a winner of the JB Award, for his excellent article published in the Journal of Biochemistry, by the Japanese Biochemical Society in 2000. He received the SCEJ Technology Award from the Society of Chemical Engineers, Japan, for his contribution on the development of sub-critical fluid technology in 2005.

O-3

Malt-derived gushing and mycotoxin formation—Causes, correlations, and reliable risk assessment

MICHAEL VOETZ (1), Frank Rath (1)

(1) VLB Berlin, Germany

Numerous malts produced from European barley harvested in 2007 and 2008 are characterized by an exceptional high gushing potential. Within the last 18 months we examined hundreds of malt samples, not only for their gushing risk but

also for the mycotoxins deoxynivalenol (DON), zearalenone (ZEA), and T2/HT2 toxin. Compared to the years before, in particular, the barley and malt samples of the 2007 harvest also showed a clear increase in DON contents. The share of negative samples declined from 80% to only one-third, while the number of samples found with 50–250 ppb DON increased. Despite a DON content that increased altogether, barley and malt samples with critical values of DON constituted an absolute exception. In contrast to the DON analyses, the examinations carried out for ZEA and T2/HT2 did not reveal any significant changes compared to the years before. Using a quantitative real-time PCR approach, it could be shown that the fungal load of gushing-positive malt samples was much higher with respect to different *Fusarium* species. Based on a representative spot test including more than 300 malt samples we could not identify any correlation between DON content and the gushing risk determined by the Modified Carlsberg Test (MCT). The evaluation of the gushing risk of malts by means of the MCT takes several days and requires special laboratory equipment. Thus, barley or malt batches are mostly restricted to the counting of “relevant red grains” when they are accepted in breweries. The evaluation of this method showed that the share of red grains in a malt sample in fact makes it possible to make an inference about the gushing risk. Unfortunately, the reverse is not possible: the absence of red grains in a sample does not provide any safety with regard to the avoidance of gushing risks. The MCT based on mineral water has proven the only useful tool for routine gushing risk assessment. However, the insufficient inter-laboratory reproducibility of this test frequently led to intensive discussions. To solve this problem, an inter-laboratory test with different experimental malts was carried out in close cooperation with interested brewers and maltsters. The evaluation results from the participating laboratories were partly very different from each other. As a reason for that problem it could be found out that although exactly following the MEBAK protocol (I) the sample preparation, (II) the water mix used, and (III) the way and intensity of shaking during the incubation were not identical in the different laboratories. A modified analytical procedure was developed in order to harmonize the test conditions and the equipment used.

Michael Voetz, born in 1964, is head of the Biological Laboratory at VLB Berlin. He earned a Ph.D. degree in plant molecular biology from the University of Cologne/Max-Planck-Institute for Breeding Research in 1995. From 1995 to 2000, he was a scientific collaborator in the Research Department of the Weissheimer Malzfabrik in Andernach, working in the field of barley biotechnology. From 2000 to 2007, he was head of the biotechnology/PCR laboratory at the Research Institute for Raw-Materials within VLB in Berlin.

O-4

The impact of hop aromas on perceived beer bitterness and astringency

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Historically it has proved difficult to relate sensory and analytical measures of beer bitterness. This is despite the fact that, for most beer styles, it is well-known that the major

contributors to bitterness are the iso- α -acids, which themselves are amenable to HPLC analysis. In other areas of food science, it is recognized that there can be a synergy between distinct flavors that occur together, for instance because they are derived from the same raw material (e.g., the sweetness of specific flavors of some fruits). Applying the same argument, we speculated that the perception of bitterness might be due to an interaction between hoppy aroma and hop bitterness. To test this, we took two commercial lager beers (12 mg/L and 25 mg/L; North American and Continental styles, respectively) and added “low,” “medium,” and “high” levels of each of Pure Hop Aromas (Botanix, UK). These products are highly refined mixtures of hop-derived aroma compounds typically used downstream to modify the hoppy character of final beer. Full sensory flavor profile analysis of the 18 samples (2 beers \times 3 products \times 3 doses) showed that bitterness increased as the dose of any of the hop aromas increased. Analysis of the beers after dosing confirmed that there was no impact on the analytical levels of the iso- α -acids. Furthermore, we observed that, while bitterness increased with hop aroma dosing, astringency was increasingly suppressed. There was no observable change in the sensory responses of ostensibly unrelated flavor terms (e.g., estery, sulfury). Based on these results, we contend that there is a synergy between bitterness and hoppy aroma. The impact on astringency is less clear. One possibility is that changing the levels of hoppy aroma in either of these quite different beers affects the astringency/bitter balance, perhaps pointing to a bitterness quality index, although this needs to be more fully explored. Furthermore, while the product range was limited, the two beers tested were quite distinct and suggests that the observed effects may be generalized, at least across the lager beer product segment. The implication of these observations is that to more reliably determine sensory bitterness analytically measures of hoppy aroma and, perhaps, astringency are required. In a broader context, there may be scope for identifying other flavor synergies to better enable flavor prediction from analytics.

Paul Hughes trained as a chemist before joining BRI in 1990. Here he worked on a range of projects and, latterly, managed various technical functions. In 1999 he joined Heineken Technical Services as principal scientist responsible for a range of quality- and safety/integrity-related activities. In 2005, Paul joined Heriot-Watt University as professor of brewing and became director of the International Centre for Brewing and Distilling in 2006. Currently Paul is also director of research for the School of Life Sciences at Heriot-Watt. Paul holds B.S., Ph.D., and MBA degrees. He also holds an IBD Diploma of Brewing. He has been awarded the IBD Cambridge Prize and the ASBC Eric Kneen Memorial Award. Paul is also a liveryman of the Worshipful Company of Brewers and a Freeman of the City of London. He currently chairs the EBC's Modelling in Brewing Subgroup. He has a range of research interests, including hops, sensory and flavor science, novel measurement and detection systems, computational chemistry, and innovation management. He has published over 40 papers, patents, and book chapters across brewing-related areas and is coauthor, with Denise Baxter, of Beer: Quality, Safety and Nutritional Aspects.

O-5

Influence of filtration and stabilization on beer quality parameters and utilization rate of hop downstream products

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Hop downstream products as tetra- and iso- α -acids are used to adjust bitterness and foam properties in beers. Normally these products are added during filtration. Not only do certain product properties, such as pH value and hydrophobic character, influence their solubility, the utilization rates also influences filtration and stabilization. Filtration and stabilization are crucial parts of the beer process, as quality parameters such as clarity, flavor, and flavor stability are directly influenced in the filter cellar. Utilization rates of downstream products added during filtration are said to be within 60–90%. However, it is not clearly understood what kind of physical reactions take place that influence utilization rate and also influence the physical and sensory properties of the beers. In this project, different filtration and stabilization combinations and their effect on tetrahydro-iso- α -acids and iso- α -acid utilization were investigated. DE filtration is the state-of-the-art filtration technology for beer, with thousands of filter lines in operation globally. The new filter aid Crosspure is a synthetic polymer for filtration and stabilization in one step/one filter. Just like PVPP, Crosspure can be regenerated in a combined regeneration and filtration system with dosing vessel, filter unit, and CIP system. Numerous different filtration and stabilization combinations consisting of diatomic earth, silica gel, single use PVPP, and Crosspure (compound of polystyrene and PVPP) were used to investigate the utilization of tetrahydro-iso- α -acids and iso- α -acids. These findings will show the influence of stabilization and filtration on beer quality parameters and, furthermore, help the industry optimize the use of hop downstream products.

Christina Schoenberger studied brewing and beverage technology at the Technical University of Munich-Weihenstephan, Germany (1995–1999), graduating as an engineer in 1999. She worked as a brewing intern in 2000 in Kyoto and Tokyo, Japan, at the Suntory Brewing Company. From 2000 until September 2003, Christina pursued doctoral thesis work at the chair for Brewing Technology I (Professor Back) in Weihenstephan on “Sensory and Analytical Characterisation of Non-volatile Taste Compounds in Bottom Fermented Beers.” After working for the German Brewers Association for one year as a consultant for technical and governmental issues, she joined the Barth Haas Group in 2005 as manager of technical services. Within this role, she is also responsible for the guidance of research projects and authors hop-related professional articles.

O-6

Investigation of premature yeast flocculation (PYF) using TRFLP and clone libraries to develop a practical and reliable screening solution for PYF malt

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(1) University of Tasmania, Hobart, Australia; (2) Joe Maltings Pty. Ltd., Adelaide, Australia; (3) Dalhousie University, Halifax, NS, Canada

Premature yeast flocculation (PYF) is an intermittent brewing fermentation problem that results in incomplete wort fermentation and is a significant problem for some breweries. When PYF occurs, it can cause significant losses in out-of-specification beer (incompletely fermented beer) to the brewer. The occurrence of PYF appears to be related to certain malt batches; however, detection of these problem batches by way of a fermentation test is problematic and time-consuming. Previous investigations have been directed at identifying the causal wort PYF-active components of PYF. These approaches have not been particularly successful over the past 40+ years. Consequently we have approached the problem from a different perspective. That was to use molecular fingerprinting of malt microbes as a step to identify the microbial taxa that cause PYF by comparing PYF +ve/–ve malts using terminal restriction fragment length polymorphism (TRFLP). TRFLP is a rapid, sensitive, sequence-based technique for microbial diversity assessment based on the conserved small subunit rRNA genes, allowing comparison of the composition of microbial populations. We have made a significant breakthrough with the TRFLP approach and concept. Very striking differences in the microbial DNA fingerprint patterns, particularly for the fungal PCR primers, between PYF +ve/–ve malts are obvious by using the TRFLP technique. Various microbial taxa, particularly some fungal members, are strongly associated with the PYF +ve malt determinations made with conventional fermentation tests. We are currently screening further confirmed PYF +ve/–ve batches of malt to validate our discovery.

Evan Evans graduated with a B.Agr.Sc. (Honors) degree in 1986, followed by a Ph.D. degree in 1990, both at the University of Melbourne. In 1992, he joined the University of Adelaide, where he developed his interest in malting barley and brewing. In 2002 Evan relocated to the University of Tasmania, where his brewing research interests continue to be in improving malt quality to improve beer quality and the efficiency of the brewing process. Evan is currently serving on the IBD Awards Committee and is a member of the editorial board for the ASBC Journal. In 2005, Evan was made a Fellow of the Institute of Brewing and Distilling.

O-7

The influence of the amino acid profile of barley worts on fermentation performance and beer quality

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Flavor stability and sensory analysis of beer, but mainly the yeast fermentation performance, is influenced by amino acids. The amount of amino acids of all malt wort is determined mainly by the malting procedure and adjustments at lower mashing temperatures. A tool to influence the amino acid composition is not established. As unmalted barley is used worldwide as brewing raw material, the aim of this paper was to show which amino acid contribution the barley can add to the wort profile. In a system of barley and exogenous enzymes,

one can imagine that not only the amount, but the composition as well can be influenced by the choice of specific enzymes and, therefore, provides a tool to design a favorable amino acid composition. All standard analysis has been executed according to the *Analytica EBC*. The amino acid profile was measured by HPLC (*Dionex Gemini*). Lab fermentations have been executed at Novozymes A/S Bagsvaerd, pilot trials at Lehrstuhl für Technologie der Brauerei I in Weihenstephan, Germany, and at the pilot plant of Ziemann in Ludwigsburg, Germany. With a new developed enzyme system, it was possible to process 100% barley and investigate the contribution of barley to the amino acid profile of the wort, as well as the influence on fermentation performance and the flavor stability of the final beers. The results show that wort derived from 100% barley combined with exogenous enzymes has a lower amount of amino acids but also a different amino acid profile. By applying the right exogenous proteases, the amount can be enhanced to 80% of all malt wort. According to the absorption ranking from Jones, the barley wort profile has 30% more amino acids in groups 1 and 2 but only a small content of prolin. It was shown that for the same fermentation performance a lower amount of amino acids were necessary, and it was found that the amount of residual amino acids can be reduced within barley wort fermentation significantly, which should lead to a better flavor stability. The development of different amino acids (e.g., prolin and leucin) over the whole production process has been investigated and compared with the measurement of wort aroma components and beer aging components. Pilot trials in 60-L scale (Weihenstephan), as well as in 10-hL scale (Ziemann) have been executed. The results will show the influence of the different amino acid profiles on fermentation performance, as well as on the sensory analysis and flavor stability of the final beer.

Stefan Kreis studied brewing and beverage technology at the *Technischen Universität München-Weihenstephan, Germany (1991–1997)*. He graduated as an engineer in 1997. From 1997 until 2002 he completed his doctoral thesis at the *Institute for Brewing Technology I in Weihenstephan on the filterability of wort and beer*. From 2000 until 2002 he worked as a scientific employee and assistant at the malt laboratory at the *Institute for Brewing Technology I*. From 2002 until 2007 he was an assistant professor and head of the malt laboratory. His main research interests have been cereals and malting technology and beer filtration. He also worked as a consultant for malteries and breweries. Since May 2007 he has worked as a science manager for *Novozymes A/S in the Department for Brewing and Alcoholic Beverages in Copenhagen, Denmark*. He has presented several papers at *EBC Congresses and World Brewing Congresses*.

O-8

Analysis of flavor compounds by brewing yeasts in insufficient nutrition

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In Japan, the consumption of *happoshu* and the so-called “third category beer” is increasing. Because these new Japanese beer-flavor beverages are brewed with less or no malt compared to

regular beer, insufficient nutrition (free nitrogen amino acids, minerals, vitamins, etc.) leads to changes in yeast metabolism, and thus, off-flavors tend to increase. Among the off-flavors, sulfur-containing compounds, such as hydrogen sulfide (H_2S), are of particular interest for many brewing scientists and brewers, because they have an unpleasant flavor and very low threshold. We have extensively studied the metabolism of H_2S in yeast, and at World Brewing Congress 2008 in Honolulu, HI, we reported that the pH value of secondary fermentation influences the yeast H_2S production. Furthermore, we are interested in other off-flavors, which might be of importance in brewing new products with different raw materials. In order to deal with this issue, we investigated the changes in flavor compounds on various nutrient conditions at a laboratory scale and tried to predict risks in brewing new products. During the investigation, we found several off-flavors, which are different from sulfur-containing compounds. Gas chromatography analysis revealed that one of these flavors was indole. In brewing, indole has been recognized as an off-flavor, which is thought to be produced by some microorganisms contaminated during fermentation. However, in our experiments, indole was produced reproducibly. Therefore, we postulated that indole is synthesized by yeast and not a contaminant microorganism. In yeast metabolism, indole is synthesized from (3-indoxyl)-glycerol phosphate and subsequently metabolized into tryptophan by tryptophan synthase. The latter reaction is known to require pyridoxial-5'-phosphate (PLP) as a coenzyme. PLP is synthesized from vitamin B_6 ; however, in this experiment, vitamin B_6 content in wort was undetectable. We hypothesized that the lack of vitamin B_6 in wort would cause the deficiency of PLP, and as a result, indole accumulates in yeast due to the inhibition of tryptophan synthase reaction. To verify this hypothesis, we examined whether production of indole is repressed by adding vitamin B_6 to the wort. As expected, we found that vitamin B_6 had a significant effect in lowering the indole content of the product. This suggests that one possible reason for indole accumulation is the deficiency of vitamin B_6 in wort, and the vitamin B_6 content in wort might be significant in controlling off-flavor content in other types of product.

Takeshi Arai received a M.S. degree from the Department of Agricultural and Environmental Biology, Tokyo University. He found employment with Sapporo Breweries, Ltd. in April 2007 as a microbiologist in the Frontier Laboratories of Value Creation.

O-9

Characterization of hybrid strains of *Saccharomyces pastorianus* as related to desiccation tolerance and fermentation performance

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Dry yeast can be utilized in both ale and lager beer production to provide an inexpensive source of large amounts of viable cells for fermentation. This study examines the desiccation tolerance of different strains of *Saccharomyces pastorianus* and the subsequent fermentation performance in comparison to *S. cerevisiae*. The use of active dry brewer's yeast (ADY), *S. cerevisiae*, as a starter for the production of ales has been

gaining popularity within the brewing industry, spurring manufacturers to also produce active dry lager yeast (ADLY), *S. pastorianus*. The drying process is known to have a greater effect on the cell viability and physiology of ADLY than that of ADY, possibly due to the fastidious growth, low production temperature, and poor thermotolerance of *S. pastorianus*. This may result in lower cell viability and concentration of ADLY starter cultures, which could lead to stuck or slow fermentations. *S. pastorianus* is a hybrid organism resulting from a cross between *S. cerevisiae* and *S. bayanus*. It has been proposed that it can be categorized into two distinct groups: Group 1 (*S. pastorianus*–Saaz type) has lost a significant amount of the genomic content contained within *S. cerevisiae* and, therefore, is closer to *S. bayanus*, while Group 2 (*S. pastorianus*–Frohberg type) has retained almost all of the genomic content of *S. cerevisiae*. To investigate whether these groups differ in their tolerance to desiccation, both groups of *S. pastorianus* were spray-dried at 140°C and rehydrated in a phosphate buffer at 22°C for 30 min. The viability of the rehydrated cultures was determined using microscopic counting after methylene-blue staining and also with plating tests. The fermentation performance of the cultures was tested by inoculating equal counts of viable rehydrated cells into brewer's wort and monitoring changes in cell count and carbohydrate and alcohol concentration until completion. The findings suggest that the retention of the genetic content of *S. cerevisiae* provides *S. pastorianus*–Frohberg type with a higher desiccation tolerance, making it more suitable for drying applications than *S. pastorianus*–Saaz type. The utilization of the correct strain of ADLY could reduce the possibility of contamination, stuck fermentations, or an extended lag phase.

Johnathon Blake Layfield received a B.S. degree in food science-science concentration from North Carolina State University in Raleigh. He is currently pursuing a M.S. degree in food science-fermentation, with a minor in biotechnology, at N.C. State under John D. Sheppard and Trevor G. Phister. Johnathon is a member of both the Institute of Food Technologists (IFT) and the ASBC. He has served on both the Executive Board of the NCSU Food Science Club and as co-head of the Activities Committee.

O-10

High-gravity brewing and distilling—Past experiences and future prospects

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High-gravity brewing employs wort (15–20°P original gravity) at higher than normal concentration, and to obtain sales gravity, beer requires dilution with water (usually carbon filtered and de-oxygenated) at a later stage in processing. By this means, increased production demands can be met without significant expansion of brewing, fermenting, and storage facilities. Also, Scotch whisky production, particularly grain whisky, increasingly employs high-gravity techniques (18–21°P wort) during a continuous fermentation procedure. There are a number of advantages and disadvantages to both of these processes. The principal advantage is the more efficient use of existing plant facilities. Other advantages include reduced energy, labor, and cleaning costs, improved beer physical and flavor stability, and

greater product flexibility. There are a number of disadvantages, including decreased beer foam stability, a variety of stress effects on yeast, and problems with beer flavor matching compared to sales gravity brewed beers. Hydrodynamic stress effects on yeast, particularly when employing centrifugation at the end of fermentation to crop the yeast for re-cycling into a subsequent fermentation, are also a problem. Finally, difficulties encountered in both brewing and distilling include the inability of yeast to completely ferment the largest size wort sugar—maltotriose. This final problem will be discussed in detail.

Graham Stewart, emeritus professor of brewing and distilling at the International Centre for Brewing and Distilling (ICBD), Heriot-Watt University, Edinburgh, was its director for 12 years. He founded GGStewart Associates, providing services and advice to the beverage and industrial alcohol industries. He received B.S. degrees (Honors) in microbiology and biochemistry from the University of Wales at Cardiff and Ph.D. and D.S. degrees from Bath University. He lectured in biochemistry in the School of Pharmacy at Portsmouth College of Technology (now Portsmouth University) (1967–1969). He held a number of technical positions with Labatt's in Canada (1969–1994) and was director of brewing technical affairs for John Labatt Limited (1986–1994). He is a member of the ASBC, MBAA, and IBD; was the ASBC's international director from 2000 to 2002; and was presented with the ASBC Award of Distinction in 2008. He holds fellowships in the IBD, the Institute of Biology, and American Academy of Microbiology. He was the IBD president in 1999 and 2000 and received the IBD Horace Brown Award in 2008. He is a 1983 and 1998 recipient of the MBAA Presidential Award. He has co-authored and edited 6 books and published over 250 original papers, patents, and reviews.

O-11

10-HDA could be used in draft keg-conditioned wheat beer as an ideal antimicrobial agent

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10-Hydroxy-2-Decenoic Acid (10-HDA), an important unsaturated fatty acid, is only found in royal jelly in nature. The content of 10-HDA is 1.4–2.0% in royal jelly; also, around 50% of total fatty acids in royal jelly is 10-HDA. 10-HDA possesses several biological activities, including anticancer activity by inhibiting lymphoma, breast cancer, and other cancer cells, enhancing immune function. In the present study, we provide a method for extraction of 10-HDA from royal jelly. The antimicrobial effect of 10-HDA on several microorganisms found in beer was determined by drug sensitivity test and flow cytometry assay. The antimicrobial effect of 10-HDA on three strains of bacteria and two strains of yeasts was determined by flow cytometry and bacteriostatic circle experiments, and we also determined the minimum inhibitory concentration (MIC) of 10-HDA by a double-dilution method. Similar antibacterial effects were obtained while using the flow cytometry test or bacteriostatic circle method. Our results showed that 10-HDA could significantly inhibit the microorganisms commonly found in beer. In contrast, no inhibition effect was found while

treating yeast with 10-HDA. The antimicrobial effects of 10-HDA on different strains of bacteria and yeasts were as follows: *Escherichia coli* > *Bacillus subtilis* > *Staphylococcus aureus* > yeast. A novel approach for preparing draft keg-conditioned wheat beer was developed with wheat malts and barley malts. Top-fermenting yeasts (No. 303) were used for brewing the beer as primary fermentation in the main fermenter. Then the fermentable extract and bottom-fermenting yeasts (No. 308) were added in the beer for keg conditioning. Since living yeasts were included in the beer, the process of pasteurization could not be used. The beer prepared by the above technique is of top grade, with a lot of white and exquisite foam and a taste of wonderful freshness. However, it is difficult to maintain clean, sanitary conditions during brewing and kegging. In the present study, 10-HDA was added in the fermenting liquor while kegging. The results showed that the beer met all of the national hygiene standards based on the physicochemical property and microorganism index. Our study confirmed that 10-HDA increased the sanitary state of the keg beer and reduced the difficulty of producing top-grade beer. Therefore, 10-HDA could be developed as a novel antimicrobial agent for producing draft keg-conditioned wheat beer.

Guangtian Zhou is a professor in bioengineering and also a director of China-Germany Brewing Technical Service Center in the Shandong Institute of Light Industry. Guangtian received his B.S. degree in bioengineering from Shandong Institute of Light Industry in Jinan, China. He worked in the Jinan Beer Group from 1982 to 1987 as a brewer. From August 1987 until November 1988, he studied at Doemens Brewing Akademie in Munich, Germany, as a scholar. Next, he worked in the Jinan Beer Group as a chief engineer. Since 1994 he has been working in Shandong Institute of Light Industry as a professor. He is now the director of the China-Germany Brewing Technical Service Center. Guangtian is also an editor of China Brewing (a famous journal in China) and a council member of the Microorganism Association of Shandong, China.

O-12

Detection of beer-spoiling Gram-negative Firmicutes using real-time PCR

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The organisms that are most commonly problematic for brewers are classified within the Firmicutes phylum. They include Gram-positive facultative anaerobic bacteria (e.g., *Lactobacillus* and *Pediococcus* species) and Gram-negative anaerobic bacteria (e.g., *Pectinatus* and *Megasphaera* species). The broad range of bacteria that are able to spoil beer makes detection of beer-spoiling organisms a daunting task, requiring detection systems that can handle numerous genera and species. However, early detection of problematic organisms is extremely beneficial, allowing appropriate quality control measures to be implemented. An easy and quick detection method that can screen for beer-spoiling organisms, therefore, would be very useful in a brewery setting. Using multiple sequence alignments of 16S ribosomal RNA gene sequences, a unique region present only in Gram-negative Firmicutes was determined.

This region was then used to develop a probe for use in real-time PCR for rapid detection of Gram-negative Firmicutes. This probe works in combination with two other probes that have previously been published—one universal, detecting all eubacteria, and one specific for all Firmicutes. The combination of these probes, therefore, can be used to rapidly screen for contaminating bacteria to determine the general type of isolates that are present. Specifically, the results of one screening assay tell whether a bacterial contaminant is present and whether the contaminant is either a Gram-positive or a Gram-negative Firmicute, thus enabling a better prediction of the beer-spoilage capability of the organism(s) present. This method, therefore, will enable faster and easier detection of possible beer-spoiling organisms, thus providing better quality control of problematic contaminations in a brewery.

Vanessa Pittet received a B.S. (double honors) degree in microbiology and biochemistry from the University of Saskatchewan, SK, Canada, in 2008. She has been working in the area of brewing microbiology since 2007, with undergraduate summer research projects as well as with her fourth-year honors final research project. She is currently doing her post-graduate masters program under the supervision of Barry Ziola in the area of ethanol tolerance of lactic acid bacteria and brewing spoilage microbiology.

O-13

The problem of microorganism identification

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Microorganisms can be identified using data from one or more of a wide variety of techniques, including colony or cell morphology, biochemical tests, spectroscopic procedures, electrophoresis of macromolecules or their fragments, antibody recognition, and various nucleic acid analysis methods, among others. Whatever the source of the data, the problem is basically one of pattern recognition—finding a microorganism response pattern that matches the response of an unknown. Depending on needs, the degree of matching (known as the operational taxonomic unit) could be to the family, genus, species, or strain level. The traditional approach is the decision tree, in which a test is performed and the outcome determines the next test to apply; however, an incorrect test result is fatal with this sequential approach. Use of a matching coefficient enables tests to be carried out in parallel (and so more quickly), and a single incorrect result is less likely to produce a totally incorrect classification. Both preceding methods require binary scoring (positive or negative) for each test performed. Multivariate pattern recognition methods allow tests to be performed in parallel and can represent degrees of response (such as rapid or slow, strong, delayed, or weak, etc.). An example will be shown in which lactic acid bacteria growth on 49 sole carbon sources was examined with K-nearest neighbor analysis (KNN), K-means clustering (KMC), and fuzzy c-means clustering (FCM). KNN performed better with 5-point scaled than with binary data, indicating that intermediate values were helpful to the classification. KMC performed slightly better than KNN and was best with fuzzified data. The best overall results were obtained with FCM.

Karl Siebert received a Ph.D. degree in biochemistry from Penn State in 1970. He then joined the Stroh Brewery Company in Detroit, where he spent 18 years and held positions from research associate to director of research. In 1990, Karl joined Cornell University as professor of biochemistry in the Department of Food Science and Technology. He served five years as department chair and now has a predominantly research commitment. Karl is active as a consultant in beverage technology and chemometrics. He twice received MBAA Presidential Awards for papers he presented, and he and his colleague, Penny Lynn, received the ASBC Eric Kneen Memorial Award (for the best paper in the ASBC Journal in the previous year) three times. Karl was made an honorary professor of the Moscow (Russia) State Academy of Food Processing in 1996, and in 1999 he received the ASBC Award of Distinction. He is currently a member of the ASBC Journal Editorial Board and the ASBC Foundation Board. Karl's research interests involve foam and haze in beverages, the application of chemometric methods in food science, and assessment of microbiological risk.

O-14

Elements of analytical measurement

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Successful analytical methods employ a means of detection that is sufficiently sensitive to determine a substance of interest (the analyte) in relevant samples with reasonable precision and accuracy. An analyte must be adequately separated from interference prior to detection. The degree of separation required depends on the specificity of the detector and the nature of the sample (mainly the interference present). A completely specific detector needs no separation (e.g., the glass electrode is so specific for hydrogen ions that usually no separation is required before a pH measurement). Methods of low specificity for substances in a sample matrix (e.g., a flame ionization detector) require a high degree of separation (such as capillary gas chromatography) before detection. Methods that have moderate specificity typically require only a modest degree of separation (e.g., specific gravity measurements can determine alcohol and real extract in beer after distillation into two phases). Often specificity is obtained through a chemical reaction that produces an observable response to some analyte or group of analytes (typically compounds having a common functional group, such as amines, acids, or vicinal diketones). In some cases where multiple observations are made on a set of samples (e.g., absorbance at multiple wavelengths), a separation may be achieved mathematically rather than physically. This is useful either to determine a single analyte in a difficult matrix or to simultaneously measure multiple analytes (e.g., protein, moisture, and fat in barley by near infrared spectroscopy). Method error is largely a function of analyte concentration in a sample, because small proportional responses to compounds present in larger amounts become increasingly important as analyte concentration decreases.

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joined Cornell University as professor of biochemistry in the Department of Food Science and Technology. He served five years as department chair and now has a predominantly research commitment. Karl is active as a consultant in beverage technology and chemometrics. He twice received MBAA Presidential Awards for papers he presented, and he and his colleague, Penny Lynn, received the ASBC Eric Kneen Memorial Award (for the best paper in the ASBC Journal in the previous year) three times. Karl was made an honorary professor of the Moscow (Russia) State Academy of Food Processing in 1996, and in 1999 he received the ASBC Award of Distinction. He is currently a member of the ASBC Journal Editorial Board and the ASBC Foundation Board. Karl's research interests involve foam and haze in beverages, the application of chemometric methods in food science, and assessment of microbiological risk.

O-15

Analysis of protein and total usable nitrogen in beer using a microwell ninhydrin assay

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In this study we present a ninhydrin-based microwell assay that can be utilized in place of the traditional Kjeldahl method for the determination of the protein content of beer or wine. In addition, the assay is ideal for the determination of free amino acids in beer (FAN) used by brewers and yeast assimilable nitrogen (YAN) used by enologists. The assay only measures α -amino acids and ammonia, so other nitrogen sources are not detected, resulting in a 30% reduction in total protein of a variety of beers compared to the Kjeldahl method, which measures nitrogen from all sources. The results also showed that only 25% of the total "protein" in beer is actually derived from peptides larger than 3,500 kDa. Analysis of beer with the microwell assay for total usable nitrogen was compared to the standard FAN methods, and conditions were determined for maximum efficiency and precision. Superior results were obtained with low reaction volumes and a stable sodium acetate-buffered ninhydrin reagent at pH 5.5. As an alternative for use with cuvettes, a reduced-volume FAN assay using the same pH 5.5 sodium acetate-buffered ninhydrin reagent gave comparable results. The assay is economical, rapid, accurate, and applicable to large numbers of beer samples.

Gary Spedding received his Ph.D. degree from the University of Leicester, England, in 1984. Gary later entered the brewing industry via the Siebel Institute of Technology, as a chemist involved in beer analysis and development of new technologies. Following this, he joined Alltech, Inc. in 2000, with an appointment as analytical services manager. In 2002 Gary then left Alltech and formed Brewing and Distilling Analytical Services, LLC in Lexington, KY. The company provides for the chemical, physical, and sensory testing of alcoholic beverages.

O-16

Development and validation of a foam measurement device

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Foam is among the quality parameters of a beer that is recognized by every customer. Since 1913 a lot of studies have been published dealing with head retention and its evaluation. One of the problems is a reliable method of measurement for foam. Detecting the time of foam decay is the principle of any system. For a couple of years, environmental effects have been detected as a source of imprecision when comparing different laboratories: inaccurate sampling and differences in sample temperature, ambient temperature, atmospheric pressure, humidity, air breeze, and air pollution. The realization of these factors resulted in the development of a closed system. Furthermore, a precise sampling based on a constant beer volume, as well as a high level of automation, showed positive effects on the precision of the data. The latest stage of development is represented by the Steinfurth Foam Stability Tester, which is based on an apparatus introduced by Rasmussen in 1981. Results of several collaborative tests generated a new method that was accepted by DLG (Deutsche Landwirtschafts-Gesellschaft), annual beer contest, in March 2007, as well as by MEBAK (Mittleuropäische Brautechnische Analysenkommission) in April 2007.

Roland Folz was an apprentice brewer and maltster at the Beck's brewery in Bremen, Germany. After working another year for the Beck's brewery, he started his studies in Berlin and received his Diploma Engineer degree in brewing technology from the Technical University, Berlin. After graduation, he was head of the Technical Department/Production at the Preussen Pils brewery in Pritzwalk, Germany, for two years. In October 2006, he returned to VLB Berlin as a consultant for brewing technology and now works in the Engineering and Packaging Department as the specialist for the Filling Department and PET bottles. Since January 2009, he is head of the VLB Department of Brewing and Beverage Science & Application.

O-17

Rapid mycotoxins analysis by high-resolution LC/MS

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Mycotoxins are toxic secondary metabolites produced by certain species of microfungi that can infect and colonize various agricultural crops in the field and during storage. Environmental factors such as temperature and humidity influence the occurrence of these toxins on grains, nuts, and other commodities susceptible to mold infestation. In addition, any crop that is stored for more than a few days is a target for mold growth and mycotoxin formation. Most mycotoxins are relatively stable compounds that are not destroyed by food processing or cooking. Although the generating organisms might not survive processing, the toxin can still be present. Mycotoxins can cause disease and death in humans and other animals through the ingestion of contaminated food products. They can be teratogenic, mutagenic, or carcinogenic

in susceptible animal species. Most mycotoxins are toxic in very low concentrations and, therefore, require sensitive and reliable methods for their detection. A quick and simple high-resolution LC/MS method was developed for the determination of mycotoxins in various matrices. Using a simple sample preparation without an extensive clean-up step, it is possible to simultaneously measure the following 12 mycotoxins: nivalenol (NIV), deoxynivalenol (DON), aflatoxin G1, aflatoxin G2, aflatoxin B1, aflatoxin B2, fumonisin B1, fumonisin B2, diacetoxyscripenol (DAS), T2-toxine, ochratoxin A, and zearalenon (ZEN). It is also shown how thermo high-resolution LC/MS systems can help overcome matrix effects and lower isobaric chemical noise with unique features of high-resolution and heated-electrospray ion source (H-ESI).

James Chang received a Ph.D. degree in organic chemistry from the University of Maine in Orono, ME. He began employment with Thermo Scientific in December 2004 as a senior application chemist. His major responsibilities include development of a method in GC, GC/MS, GC/MS/MS, LC, and LC/MS/MS for environmental and food safety applications. Prior to employment with Thermo Scientific, he was the director of the Central Environmental Laboratory in Kuwait.

O-18

Non-targeted small-molecule profiling of beer by ultra-high pressure liquid chromatography–mass spectrometry

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Development of the liquid chromatography-mass spectrometry (LC-MS)-based metabolomics field has recently been accelerated by the emergence of high-resolution separation and mass detection technology. As a result, this science is becoming increasingly applicable in areas of research previously dominated by other analytical techniques. While GC-MS has a common and well-established place in the brewing chemist's laboratory, we propose the value in analysis of samples, from malt to finished beer, by ultra-high pressure LC-MS (UPLC-MS). Through non-targeted small molecule profiling studies and the use of multivariate statistical analysis, we have successfully revealed molecular components suggestive in differentiating same-brand-beers stored at refrigeration versus room temperature. In addition, we have begun exploring the beer metabolome in terms of brand identity and subjective malt quality. Compounds identified by this process can be efficiently screened by UPLC-MS in a high-throughput fashion requiring little to no sample processing. The unique combination of sensitivity, specificity, global scope, and preparation efficiency make analysis by UPLC-MS a novel tool by which the brewmaster can establish a more complete scientific basis for improving the choice of raw materials, brewing process, and product quality.

In 2004, Matthew Lewis received a B.S. degree in biochemistry from Colorado State University in Fort Collins, CO. A year later he obtained his M.S. degree in the same discipline. He then

served as an instructor within the Department of Biochemistry and Molecular Biology and shortly after transitioned to the Colorado State University core facility, with the task of developing the new university metabolomics program. Since 2006, he has been immersed in the small-molecule study of many subdisciplines within plant and agricultural biology, as well as human disease and nutrition, but he has enjoyed none of these quite as much as probing the small-molecule content of local Fort Collins brews.

O-19

Enhancing the concentration of 4-vinylguaiacol in top-fermented beers—A review

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Despite being considered undesirable in bottom-fermented beers, 4-vinylguaiacol (4VG) is well known to be a characteristic aroma contributor to top-fermented beers, for example, Belgian white beers (brewed with unmalted wheat), German *Weizen* beers and *Rauch* beers (brewed with malted wheat). This compound has a lower sensory threshold value of 0.3 mg/L, which is often described by the terms clove-like, spicy, smoky, or BBQ. It is produced by enzymatic decarboxylation or thermal decomposition of the precursor, ferulic acid (FA). Most published papers enhancing the concentration of 4VG are from the University Leuven, Belgium, and have paid much attention to the brewing technology, such as choice of barley and wheat variety, determination of wheat or wheat malt proportion, optimization of mashing parameters (FA release optimal at pH 5.8), increase in boiling time, selection of Pof⁺ brewing yeast strains, and improvement of fermentation temperature, in which the brewing yeast strains are crucial. In contrast, the reports on genetic engineering of yeast strains are comparatively sparse. In fact, cloning the phenylacrylic acid decarboxylase gene (*PADI*) and the phenolic acid decarboxylase gene (*PADC*) is an efficient way to enhance the concentration of 4VG in top-fermented beers. Specifically, this review will focus on describing the gene clone of yeast strains. By far, although the *POFI* (*PADI*) gene has successfully been cloned and transformed into the Pof⁺ yeast, the functional *POFI* shows lower activity. Accordingly, cloning the phenolic acid decarboxylase gene (*PADC*) will have the greatest potential to enhance the concentration of 4VG in top-fermented beers. In addition, we will briefly review the influence on top-fermented beers' aroma of 4VG. It is noted that this 4VG appropriate concentration (2.2–3.5 mg/L) will help to increase aromatic pleasantness. If the 4VG concentration is beyond 4 mg/L, it could negatively affect the organoleptic qualities of top-fermented beers.

Guangtian Zhou is a professor in bioengineering and also a director of China-Germany Brewing Technical Service Center in the Shandong Institute of Light Industry. Guangtian received his B.S. degree in bioengineering from Shandong Institute of

Light Industry in Jinan, China. He worked in the Jinan Beer Group from 1982 to 1987 as a brewer. From August 1987 until November 1988, he studied at Doemens Brewing Akademie in Munich, Germany, as a scholar. Next, he worked in the Jinan Beer Group as a chief engineer. Since 1994 he has been working in Shandong Institute of Light Industry as a professor. He is now the director of the China-Germany Brewing Technical Service Center. Guangtian is also an editor of China Brewing (a famous journal in China) and a council member of the Microorganism Association of Shandong, China.

O-20

Excretion of bioactive compounds from yeast induced through maltreatment in the brewing process

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Yeast used in the brewing process (*Saccharomyces cerevisiae* spp. *Carlsbergensis*) is known to contain several health-beneficial bioactive compounds. Especially, vitamins from the B-group are present in large quantities in yeast. But, yeast also could be a dietary fiber source, as yeast cell walls are built from β -glucan. Yeast cells are not affected by the human digestive system and pass through unchanged. For this reason, it would be important, if a yeast preparation is made with the objective to create a health-beneficial food, to destroy the yeast cells in order to liberate the functional substances. In this work the influence of a bad yeast treatment in the brewery on bioactive compounds on the one hand and on β -glucan levels in wort and beer on the other hand was investigated. β -Glucans from the yeast cell walls could contribute to increased wort viscosity and, thus, lead to problems during lautering and filtration. In order to simulate a bad yeast treatment, yeast was pumped with a cleaning pump through a spray head for several hours in a fermentation tank. Additionally phosphoric acid was added to some trials to simulate residues of cleaning processes. The resulting β -glucan levels were analyzed by enzymatic hydrolysis, followed by determination of the monosaccharides by HPAEC/PAD. Vitamins B₁ and B₂ were measured by HPLC and B₁₂ by microbiological growth tests. Yeast viability decreased from 93.5 to 90.6% during the pumping process of 10 hr. Addition of phosphoric acid resulted in a decrease to 65%. The ion chromatographic analysis showed that even through such bad treatment no significant amounts of β -glucans or other sugars were liberated from the yeast cells. The highest concentrations of thiamine and riboflavin were found in the untreated samples, the levels decreased by 35% during pumping and by 76% when phosphoric acid was added. The detected amount of vitamin B₁₂ was similar in all samples. Thiamin levels decreased by 25% during the pumping step and by 67% if treated with phosphoric acid. This work shows, that an increase in wort or beer viscosity cannot be the result of a bad yeast treatment, and functional substances are not released. However, a bad yeast treatment will result in lower beer quality and flavor stability.

Moritz Krahl was born in 1980 in Schwetzingen, Germany. After attaining a German Abitur (A-level certificate) in 2000, he started studying brewing and beverage technology at the Technical University of Munich in Weihenstephan. In 2005 he graduated with a Diplomingenieur degree and has since then

been working as a Ph.D. student at the Chair for Technology of Brewing 1 (Professor Werner Back) in Weihenstephan.

O-21

Identification of yeast strains by a PAGE method using mismatch-specific endonuclease

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Many methods are used to distinguish yeast strains. Pulsed field electrophoresis has been widely used. However, the results are sometimes ambiguous. PCR/RFLP is fast and reproducible, but it can only classify the species level. PCR fingerprinting is easy and requires only simple equipment, but the fingerprint patterns can vary between laboratories. As single nucleotide polymorphism (SNP) is the difference in the DNA sequence between individuals, the yeast strains can be identified by SNPs. This time, we have developed a new yeast strain identification method that is reproducible and does not require expensive equipment. Brewing yeasts are usually diploid or tetraploid. Therefore, SNPs can exist not only between the strains but also in one strain. A certain DNA base on one chromosome may be different from the correspondent base on the other chromosome. The PCR amplicons at such regions are annealed with partly mismatched base pairs after heat denaturing. The DNA fragments with mismatched base pairs can be cut by the mismatch-specific endonuclease. The yeast strain can be determined by the PAGE pattern. We can design the primers and the patterns of PAGE depending on the SNPs of yeast strains. The genome DNA was extracted from the yeast cell using a DNA extraction kit. Several primers were applied to the genome DNA, and the fragments were amplified by PCR. The PCR amplicons were denatured at 95°C for 2 min. The denatured single-stranded DNA fragments were annealed while the DNA solution temperature was gradually lowered. The annealed DNA solution was incubated with mismatch-specific endonuclease at 42°C. After 20 min of incubation, the stop solution was added to terminate the reaction. The loading buffer was added, and it was applied to the polyacrylamide gel electrophoresis. After the electrophoresis was completed, the gel was stained with ethidium bromide and photographed under UV. The five bottom-fermenting yeast strains and the three top-fermenting yeast strains were able to be distinguished one another using three PCR primer pairs. The PAGE results corresponded to the fragment length calculated from SNP information. For example, the PCR amplicon size of primer No. 30 is 479 bp. As the two bottom-fermentation strains do not have the heterogeneous points, only the 479-bp intact fragment was present. The other three strains have one heterogeneous base pair at 162 bp from the 5' end in this amplicon. Then three fragments with 479 bp, 317 bp and 162 bp were present. To add a new yeast strain to the series, new PCR primers can be designed freely based on the DNA sequence.

Masahito Muro received a B.S. degree in agricultural chemistry from the Tokyo University of Agriculture and Technology in Japan. He received a M.S. degree in biochemistry from the Tokyo Institute of Technology. He began employment with

Kirin Brewery in April 1991, as a chemist in the analytical laboratory of the Technical Center. His specialty is chemical analysis. He has developed many microanalysis methods for beer and other foods. Since 2000, he has been working in the Laboratories for Brewing. From September 2004 until July 2006, he worked in the laboratory of the Technical University of Munich in Germany. His current work is research on yeast and fermentation.

O-22

A novel method for measuring total package oxygen

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When it comes to the product life and flavor stability of beer and beverages, oxygen remains detrimental. Preventing (even low) oxygen pick-ups during the entire production and packaging process is of paramount importance to brewers and beverage manufacturers. As a result, beer and beverages are produced with very low dissolved oxygen (DO) levels, achieving consistent quality and high flavor stability during their complete shelf life. Through a TPO measurement, the brewery is able to determine the critical parameter for the sustainability of beer quality. Directly after filling, packages are prepared for TPO measurement that should be performed as quickly as possible to avoid product oxidation and consumption of oxygen. A quick determination, without sample preparation, requires separate measurement of the O₂ content in the headspace and dissolved oxygen. This results in the total package oxygen and enables the determination of whether the O₂ is coming from the headspace or from the liquid.

Frank Verkoelen studied mechanical engineering at HTS Venlo and finished in 1982. Frank has worked for Haffmans BV since 1984 in several positions: project engineer for CO₂ recovery; R&D; R&D manager; product manager QC; and senior product manager responsible for sales of QC equipment and in-line equipment.

O-23

The influence of chemical disinfectants for cold aseptic filling on oxygen permeation of PET bottles

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(1) VLB Berlin, Germany

The importance of plastic packaging for the beverage industry is widely accepted. The particular success of PET as a packaging for beverages is based on factors like flexibility and weight. There are reasons though why PET has not replaced glass or can packaging completely. Here the permeability for gases has to be mentioned first. Especially if it comes to pure monolayer PET, oxygen-sensitive beverages such as beer are in danger of quickly building up stale flavors and becoming flat due to CO₂ loss. Many different methods are being used to determine the permeability of the material for oxygen. The VLB Berlin has established a method to measure the ingress of oxygen into the PET bottle using a real-time method. This method also works non-destructively so that the measurement over a storage period can be carried out with the same bottles. The measuring principle involves an optical chemiluminescence measurement.

Another fact that is commonly accepted as a disadvantage of PET is that it is very difficult to use high temperatures on the material. To be able to inactivate possible spoilage microorganisms within the beverage, temperatures must be applied that are higher than PET can withstand. For this reason micro-biologically vulnerable beverages are often filled according to the cold aseptic-filling principles. Among other steps, this method of filling includes sterilization of the packaging material using chemical disinfectants. Since these are quite aggressive substances, an interaction with the plastic material might take place. What is more, peracetic acid, for example, disinfects by using oxidation reactions. These are unspecific, and it, therefore, might be that scavenging substances within the PET material are exhausted or damaged during the disinfection step. In the presented research work, the influence of common chemicals used for disinfection on oxygen ingress into different PET bottle systems is investigated. The bottles are treated with the disinfectants and then filled with a special medium. Subsequently, oxygen ingress is determined using the VLB real-time method.

Roland Pahl was born in 1972 and began his career as an apprentice for a brewer and maltster in Berlin in 1992. After that, he began employment as a brewer in the Schultheiss Brewery in Berlin, Germany. After finishing his studies as a graduate engineer for brewing technology at the University of Technology in Berlin (diploma thesis "Influence of Different Barley and Malt Varieties on the Nonenal-Potential of Wort and Beer), he was employed as a scientific assistant at the VLB Berlin in the Research Institute for Technology of Brewing and Malting. In 2004 he changed to the Research Institute of Engineering and Packaging of the VLB, which he has headed since 2007.

O-24

A novel dissolved carbon dioxide analyzer

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A novel dissolved CO₂ analyzer is described. The analyzer measures partial pressure of CO₂ by measuring the infrared absorption within an optical cell separated from the process fluid. An optimized optical cell design minimizes the dead volume and allows rapid equilibrium between the process fluid and optical cell. The instrument exhibits unparalleled sensitivity and accuracy, rapid response, and a very wide dynamic range. The system can be used for dissolved CO₂ content measurement in many different applications, such as carbonation measurement in beer or soft drinks, water quality monitoring, and environmental science. By coupling with appropriate chemistry stations, one can accomplish trace carbon analyses (organic, inorganic, and free CO₂) in aqueous systems.

Murthy Tata is the founder and president of QuantiPerm, LLC. QuantiPerm has developed innovative instrumentation and methods for rapid, accurate, and highly sensitive analytical techniques related to barrier packaging development. QuantiPerm operates a testing laboratory and consults for the food, beverage, and consumer products industries. Murthy was at Miller Brewing Company between 1994 and 2000, working

in all areas—brewing, fermentation, beer processing, and packaging. He was responsible for the development of a suite of protocols and test methods that enabled the launch of the first commercial plastic beer bottle for the North American market. Subsequent to his tenure at Miller, Murthy worked at Motorola Life Sciences between 2000 and 2002 in the development of CodeLink DNA biochip microarray platforms for gene expression and genetic polymorphism analyses. Murthy received a Ph.D. degree in chemical engineering and M.S. degree in cell and molecular biology from Tulane University. Murthy has authored numerous peer-reviewed journal articles and holds several patents.

O-25

The influence of the wort boiling system on the concentrations of miscellaneous flavor components from malt and hops in wort and beer

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The concentrations of flavor components derived from malt and hop have a great influence on the flavor and the flavor stability of beer. In the last decades, a large pattern of wort substances have been identified that have a significant influence on the aging of beer. Many of these components are aldehydes, resulting from fatty acid metabolism during malting or from strecker modification, as well as ketones and higher alcohols. In the last few years, systematic analyses of beers in Europe showed a broad decrease of those substances that cannot be explained by raw material improvements alone. Another reason could be that in this period of time new plants were integrated in the brewhouses, which caused lower thermal stress during wort production and continued minimization of oxygen load in wort production. In 2005 a new trial- and research brewery was introduced in Weihenstephan and was designed to integrate several boiling systems, including special process features like vacuum application. By means of this equipment, it is possible to carry out wide-spread research on the impact of different wort boiling systems on the concentrations of flavor components in wort and beer. Four different boiling systems (internal, external heater, VarioBoil, and vacuum solutions [SchoKo]) have already been tested in several trials. All trials included analysis of volatile aroma substances from malt and hop in wort and beer. This paper compares different modern boiling systems and gives an overview of the influence of the boiling system on the described components, as well as some new findings on their influence on flavor stability.

Udo Kattein received a Diploma Engineer degree at the Technical University of Munich–Weihenstephan in 1972; afterward he performed an economic study at the University of Munich, completing a Diploma Merchandiser degree in 1976. At this time, he started his doctoral thesis and employment at TU Munich, where he was in charge of the technical leadership of the Trial and Research Brewery Weihenstephan. Udo served as head brewer and was responsible for production of commercially sold malts and top-fermented beers. In addition to these tasks, he was involved in the development of new beer types and the training of students. In 1984 he received a Ph.D. degree in engineering sciences, with a thesis on investigation

of sulfur compounds in malt, wort, and beer. Since 2002 he has been responsible for the construction of the new malting and brewing facilities of the research brewery, which started in 2005.

O-26

Isomeric 4,5-epoxy-2E-decenals in beer: Novel (off) flavor and highly reactive compounds—Formation pathways and accurate determination

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cis-4,5-Epoxy-2E-decenals and *trans*-4,5-epoxy-2E-decenals result from the peroxidation of linolenic acid and subsequent cleavage of hydroperoxide. They are highly flavor-active compounds with extreme low odor thresholds of approx. 0.01 ppb retro nasal. They are members of a reactive epoxy group, have a conjugated double bond, and have an aldehyde function; therefore, their accurate analysis requires isotope standards. Deuterated and C-13 labeled reference standards of *cis*- and *trans*-4,5-epoxy-2E-decenals were successfully performed. Carbon chain elongation with C-13-labeled potassium-cyanide of 1-bromo-3-nonyne and saponification of the nitrile gave methyl 1-13C-4-decyneate. The triple bond was reduced to the *cis* double bond with deuterium gas, and the ester group was reduced to the aldehyde. Epoxydation of the double bond and desaturation at C2-C3 yielded 1-13C-4,5-2H₂-Z-4,5-epoxy-2E-decenal. The *trans* isomer was synthesized by a different strategy. A beer sample work up was performed with Kutscher-Stuedel extraction and Solvent Assisted Flavor Evaporation (SAFE) sample preparation. Analysis was performed by GC-MS in the negative chemical ionization (NCI) and selected ion monitoring (SIM) mode. A simple way for the synthesis of high reactive *cis*- and *trans*-4,5-epoxy-2E-decenals was established and used to achieve isotope standards. The beer work-up procedure was optimized, and GC-MS analysis with NCI mode enabled limits of detection for epoxydecenals with 10 ng/L (0.01 ppb) in beer. The content of epoxydecenals in beer (fresh) varied from 0.02 ppb (fresh beer) to 0.4 ppb (40°C, 3 days). The flavor of the *cis*-epoxy-2E-decenal was confirmed to be metallic, while the *trans*-epoxide was classified as malt-like. The new synthesis method allows the easy introduction of isotopic labels in nearly all positions of the epoxydecenals, and therefore, an isotope dilution assay was successful. Optimized sample work up, especially the use of SAFE and NCI-MS enabled the quantification of the target epoxydecenals at ultra-trace amounts (ppt).

Leif-Alexander Garbe is a professor and the head of the TU Berlin Chair for Bio Analysis/Molecular Analysis and since 2002 also been the head of the VLB Research Institute for Spezialanalytik. Leif graduated from TU Berlin (TUB), Germany, with a diploma in chemistry in 1996. Next, he worked at the Research and Teaching Institute for Brewing in Berlin (VLB). From 1997 to 2002, he worked on his Ph.D. thesis and received his Dr.Rer.Nat. in April 2002 from the Institute of Biotechnology, TUB. His work included supervision of students in biotechnology and brewery. In 2002 he established a new research group at the TUB focusing on trace analysis, bio transformations, and bio catalysis. Since July 2008 he has been

the head of the TUB Department for Bio Analysis/Molecular Analysis.

O-27

Mechanism of 3-methyl-2-butene-1-thiol production during fermentation

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Off-flavors, such as burnt and light-struck flavors, occur occasionally in beer, especially during the brewing of low-malt beers known as *happoshu*. At the 2006 ASBC Annual Meeting, we reported on the contribution of 3-methyl-2-butene-1-thiol (MBT) to the burnt aroma of beer and on the factors affecting the formation of this compound during the brewing process. However, the mechanism of MBT formation is not fully understood. The current study examined the main factors that affect the formation of MBT and proposed a new pathway for its synthesis. Previous investigations at certain breweries using gas chromatography/mass spectrometry and gas chromatography/flame photometric detector analyses showed that MBT and hydrogen sulfide had similar profiles during fermentation, although a case in which MBT increased notably during the middle stage of fermentation was documented in one brewery. To clarify the factors contributing to MBT production, the fermentation tests were carried out under the same conditions at a laboratory scale using wort from the breweries. The results showed that the production of MBT was greatly increased using turbid wort mixed with hot trub. In addition, there was a strong correlation between the amount of MBT at the end of the main fermentation and the concentrations of particles in the wort. To confirm the effects of the hot trub on MBT production, we divided it into three fractions—the water-soluble fraction, the lipid-soluble fraction, and the other (solid-particle) fraction—and studied the effects of the addition of each fraction during fermentation. The production of MBT was significantly increased only by adding the solid-particle fraction. This finding revealed that the concentration of solid particles in the wort greatly influenced the formation of MBT. Moreover, the production of MBT was greatly increased by adding prenylcysteine to the wort. This result suggested that MBT is produced from an S-cysteine conjugate, such as a prenylcysteine, by β -lyase in the yeast. The mechanism of MBT production by solid particles in the wort was discussed, therefore, in relation to sulfur metabolism in yeast.

Minoru Kobayashi is a scientist at the Research Laboratories of Brewing Technology, Asahi Breweries Ltd. He received his M.S. degree in applied biological chemistry from Tokyo University in Japan, where he majored in analytical chemistry. He has been engaged in the analytical technology laboratory since 1998, specifically in the analytical chemistry section. Since September 2003, he has worked in the brewing science section, specifically in beer flavors.

O-28

A quantitative study on the influence of transport and storage variables on the flavor stability of Pilsen beer

RUBENS MATTOS (1)

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There is a global trend to produce Pilsen beers that are not exactly like the original type: they have less bitterness, less body, and a paler color. A challenging problem for breweries at the moment is to guarantee the freshness of this beer during its shelf life. Global sales and markets result in beers being distributed longer distances, and this demands a longer shelf life with high flavor stability. Consumers easily detect minimum off-flavor contents because the low bitterness, low alcohol content, and low body are not capable of masking them. In this work the influence of important variables on Pilsner beer flavor stability was studied. The impact of temperature, exposure to light, and shaking during transportation, as well as the interaction between them, were quantified and, for the first time, statistically compared. According to the results obtained here, temperature plays a major role compared to shaking and light exposure. In fact, the former two effects had low or even no effect on the stability of the product. Both a trained panel from a commercial brewery and regular consumers statistically validated this conclusion. In contrast, the formation of *trans*-2-nonenal was more influenced by light exposure and shaking than by temperature. This reinforces the theory that the content of *trans*-2-nonenal is, alone, not enough to express beer flavor stability. A unique sensory tool is also presented to be used by brewers to decide whether a supposedly oxidized beer can or cannot be dispatched to market. Judging how much a beer is oxidized is not a simple task, and most of the time this is done by only some brewers (sometimes only one), which increases the risk. Acceptance by consumers is related here to beer oxidation, represented by the attributes papery, caramel, and metallic. Subjects were trained to judge the contents of these attributes in the beer using the Quantitative Descriptive Analysis (QDA) technique. The statistical combination of the results of beer acceptance and the results of the QDA allowed the construction of a mathematical model for deciding objectively about whether or not to sell a beer. With this tool, the subjective decision of the taster is eliminated. Concerning the beer attributes used to describe beer oxidation, the intensity of the attribute “papery” is the one that is more strongly correlated with the flavor stability of the product. The attributes “caramel” and “metallic” do not correlate either with the opinion of the trained panel or with acceptance by consumers.

Rubens Mattos graduated and received a M.S. degree in Brazil in chemical engineering. He joined the Brahma Brewing Company in 1994 as a master brewer trainee and attended the University of California–Davis to complete its Master Brewer Program. Rubens passed with distinction the Associated Membership Examination of the Institute of Brewing in 1996. He left AmBev (formerly Brahma and now part of AB-InBev) to start his Ph.D. research in beer flavor stability in the Food Technology Department of the State University of Campinas (UNICAMP–Brazil). In 2004 Rubens started working with technical sales of PVPP to breweries in the Americas. He joined Kerry Ingredients and Flavors in 2007, where he is responsible

for the technical sales of finings, enzymes, antifoaming agents, and stabilizers in the Americas.

O-29

Novel malt-based beverages

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In recent years a number of novel, innovative beverages have been launched. Due to growing consumer awareness of the negative impact of malnutrition in Western countries, novel drinks based on natural raw materials have attracted growing interest. Specially malted grains and natural fruit juices are suitable for the production of such beverages, as they are generally considered positive and healthy food ingredients. A huge variety of malted cereals, such as barley, wheat, spelt wheat, rye, oats, triticale, and others, may be used. In addition, rice, sorghum, and corn and pseudocereals like buckwheat, quinoa, and amaranth can be utilized and are of special interest as they are gluten-free, and their products can be consumed by people suffering from celiac disease. A new approach to the production of beverages is the use of lactic acid fermentation. Wort is produced using existing brewing equipment and is subsequently fermented by selected strains. The resulting fermentation products are mixed with different fruit juices and carbonated, resulting in well-balanced, refreshing drinks. For the evaluation of the sensory properties of these beverages, a new tasting scheme was created. The effects of aging, pasteurization, and flash pasteurization on flavor and flavor stability can be described similar to beer using some of the same lead substances. These are measured using GC and GC-MS. Most of the detected staling flavors result from the malt component, but some are specific for each fruit used. The produced beverages show good flavor stability, although losses in olfactory attributes do occur during heating and aging.

Moritz Krahl was born in 1980 in Schwetzingen, Germany. After attaining a German Abitur (A-level certificate) in 2000, he started studying brewing and beverage technology at the Technical University of Munich in Weihenstephan. In 2005 he graduated with a Diplomingenieur degree and has since then been working as a Ph.D. student at the Chair for Technology of Brewing I (Professor Werner Back) in Weihenstephan.

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A comparison of the antioxidant potential of beer and wine polyphenols

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Wine, especially red wine, is touted for its antioxidant “prowess,” yet beer also contains antioxidants. The questions are (a) How do these antioxidants compare molecule for molecule in their potential? (b) How much antioxidant does your body need, and is there enough from beer and conceptually too much from red wine? (c) How readily do the antioxidants from beer and wine actually get into the body? Here we address item (a) and discuss items (b) and (c).

Michael DiPietro is pursuing his M.S. degree studies in food science at the University of California, Davis, where he obtained his B.S. degree.

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Beer maturation in presence of cherries (*Prunus cerasus*)

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The use of the cherry perfume to flavor drinks is an old practice and is currently used in some beer types too. It is very difficult to reproduce the true flavor obtained by applying the fruit maceration technique, although a lot of possibilities are available in the fragrance market in order to aromatize alcoholic beverages such as beer. Very often consistency, mouthfeel, throat coating, and the subtle retro-nasal scent are missing. As in the case of dry-hopping, β -glucosides play a key role in the transmission and understanding of the evolution of the typical natural cherry flavor. The evolution of the essential aliphatic, aromatic, terpenoid, and norisoprenoid volatiles was quantified by SPME-GCMS after addition of 200 g/L of whole cherries, pasteurized cherry juice, cherry pulp (cherries without stones), and cherry stones. The study emphasizes fruit digestion over 20 days, both in lager beers and in sour beers, during maturation, using *S. cerevisiae* and *Brettanomyces custersii* as fermentation microorganisms. The final cherry beers were evaluated by a trained sensory panel. The beer produced with whole cherries obtained the best overall appreciation and was described as fruity, spicy, almond, and sour. The highest spicy notes were found in the beer produced with cherry juice. Further, it became clear using only grind stones that some unpleasant flavors, such as bitter, cardboard, woody, and nut notes, dominated. In spite of the high concentration of benzyl compounds, this latter beer was not recognized as having a cherry flavor, indicating that compounds like eugenol, isoeugenol, linalool, geraniol, α -ionol, and β -damascenone also probably contributed to the flavor of the cherry beers. When beer refermentation was performed in the presence of a β -glucosidase active *Brettanomyces* sp., the glycosidase activities were also at least partially responsible for the increase in a variety of cherry-related flavor compounds.

Guy Derdelinckx (born 1954) graduated from the Catholic University of Louvain (Belgium). He obtained his Ph.D. degree (1985) by studying the depolymerization of flavanoids during mashing. He became an international brewery expert through 10-years of experience (1994–2003) traveling between Russia and Madagascar. Basically, he was always interested and specialized in the positive aspects of beer microbiology. He studied with Professor Emeritus Hubert Verachtert on mixed fermentation and published during the last decade roughly 10 papers regarding the mixed fermentation, beer refermentation, and β -glucosidase activity of yeasts on crude hops and cherries. He is also the promoter of five Ph.D. thesis students.

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Withdrawn

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Cardiolipin influence in lager beer dimethyl sulfide levels: A possible role involving mitochondria?

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Dimethyl sulfide (DMS) is an important flavor compound in American and European lagers, so brewers strive to control levels in their products. Although the main approach to controlling DMS lies within judicious selection of malting and wort production regimes to control one of its precursors, namely S-methyl methionine (SMM), DMS formation during fermentation by the yeast enzyme dimethyl sulfoxide (DMSO) reductase cannot be overlooked. In a series of replicated incubation experiments aimed at altering cardiolipin content in yeast, it was found that beer DMS levels at the end of fermentation were moderately higher (about 10 μ g/L) under incubation conditions that would promote cardiolipin formation, namely incubation in glycerol and L-thyroxine. Comparatively, conditions that would limit cardiolipin formation (control and inositol incubation) resulted in lower DMS levels ($P < 0.05$). Assuming equal losses during fermentation, these results suggest a possible role involving yeast mitochondria. To provide further evidence supporting this claim, beer DMS levels were tracked before and after modifications to wort carbohydrate levels where the predominant wort sugar was altered from maltose to glucose, resulting in statistically significant lower mean DMS levels ($P = 0.05$). Since it is known that glucose also inhibits cardiolipin formation and mitochondrial development, these results implicate some association with this organelle, of which we speculate its involvement could be related to prosthetic iron-sulfur clusters that could be part of yeast DMSO reductase protein.

Bob Foster received his B.S. degree in chemistry in 1972 from Rockhurst College in Kansas City, MO, and joined the Coors Brewing Company in 1974, where he has worked in brewing services, research, and quality assurance. Additional education in 1984 included advanced organic, analytical, and electrochemistry courses at the University of Colorado at Denver. From 1992–1994, Bob attended Heriot-Watt University in Edinburgh, where he received a Ph.D. degree in brewing biochemistry in 1997. Currently, Bob is a manager of flavor stability and chemistry in the Brewing Services Department and is involved in hops; flavor stability; brewhouse, malting, and brewing projects; and packaging oxidation studies. He is a member of the ASBC, the Institute and Guild of Brewing Scottish Section, the Master Brewers Association of the Americas, and the Society for Free Radical Biology and Medicine. Bob has published reports on hops and flavor research in the ASBC Journal, the MBAA Technical Quarterly, the Journal of Agricultural and Food Chemistry, and for the International Brewers Symposium. Bob holds a U.S. patent on a process for the isomerization of α -acids and received the 2002 Eric Kneen Memorial Award from ASBC for his World Brewing Congress 2000 paper. Currently, Bob is working on beer shelf life using electron paramagnetic resonance (EPR) technology. Bob has served on the ASBC Technical Committee since 2002 and began his term as senior advisor to the Technical Committee in 2007.

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Control of 3-methyl-2-butene-1-thiol production during fermentation

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The compound 3-methyl-2-butene-1-thiol (MBT) is a well-known cause of “skunky” or “light-struck” flavors in beer. The flavor threshold of MBT is slightly less than 2.0 ng/L. MBT is generally believed to form in bottled beer due to a reaction between photo-cleaved radicals of hop-derived compounds and hydrogen sulfide. These reactions were previously thought to arise only after bottling. In recent years, it has been reported that MBT can also be generated during beer fermentation. We reported some possible factors affecting the formation of MBT during fermentation at the 2006 ASBC Annual Meeting. However, the mechanism of MBT formation and methods for controlling its production during fermentation are not well understood, thus variability in beer quality remains. Therefore, we attempted to clarify the factors contributing to the production of MBT and develop a method for controlling the amount of this substance generated during fermentation. Through an exhaustive series of experimental and production-scale fermentations, we confirmed the hypothesis that fermentation rate and the influx of boil trub into fermentation tanks affect the production of MBT during beer fermentation. By carefully controlling the factors that affect fermentation rate, such as the initial yeast concentration and amount of secondary aeration, we were able to reduce variability in the amount of MBT formed. Similar results were obtained by preventing boil trub from being mixed into fermentation tanks. We conclude that these methods control the production of MBT during beer fermentation.

Hiroshi Mukumoto is a chief technician in the R&D promotion office, Asahi Breweries, Ltd. He received his M.S. degree in biological science from the Nara Institute of Science and Technology in Japan, where he majored in microbial bioscience. He has been engaged in the packaging section in breweries since 2001 and has been engaged in the R&D promotion office since 2005. Since October 2007, he has worked in the brewing section of the office.

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Detection of aflatoxin B1 in barley, corn, and rice by ELISA using a heavy-chain IgG2b isotype monoclonal antibody

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A rapid and sensitive indirect competitive enzyme-linked immunosorbent assay (ELISA) method using heavy chain IgG2b isotype monoclonal antibody for measuring aflatoxin B1 (AFB1) in barley, corn, and rice has been developed. One monoclonal antibody was isolated and characterized after fusion

of myeloma cells with spleen cells isolated from BALB/c mice that had been immunized with AFB1 carboxymethyl oxime conjugated with bovine serum albumin (BSA). The antibody was IgG_{2b} antibody with λ light chain. Cross-reactivities of the anti-AFB1 monoclonal antibody clone were 100, 1.4, and <1% against AFB1, aflatoxin M1 (AFM1), and deoxynivalenol (DON), respectively. The limit of detection and concentration required for 50% inhibition of binding were 0.001 and 0.01 ng/mL AFB1. The linear range for developed indirect competitive ELISA was 0.005–5 ng/mL AFB1. Assays of cereal extract samples mixed with AFB1 ranging in concentration from 0.1 to 10 ng/mL gave mean ELISA recovery of 93.7%. A total of 53 samples of barley, corn, and rice were collected from fields in northeastern China. The concentrations of AFB1 in all the samples collected were less than 1 ng/g. The average AFB1 infection rates were 58% in barley, 66% in corn, and 42% in rice. The results indicate that the necessary precautions will have to be taken to minimize AFB1 contamination in brewing grains.

Shi Chun Pei received a Ph.D. degree in food science from Kangnung National University, Korea. He joined Heilongjiang August First Land Reclamation University, China as an associate professor in the College of Food Science in 2005, where he has participated in several research projects related to antibody production for the detection of mycotoxins in brewing grains.

P-36

Determination of lipoxygenase in barley and malt: A novel high-throughput screening method

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Lipoxygenase is an undesirable enzyme in barley and malt that affects the flavor stability of beer, due to the enzymatic oxidation of linoleic acid to *trans*-2-nonenal by the LOX pathway. Therefore, elimination of lipoxygenase from barley and malt will greatly reduce the formation of *trans*-2-nonenal in final beer and improve the flavor stability of beer. Barley breeders are trying to identify barley germplasm that lacks lipoxygenase to improve barley and malt quality. The major obstacle is to set up a fast and reliable lipoxygenase activity assay method. However, it is very difficult to achieve high-throughput screening with lipoxygenase, as the reaction products (lipid hydroperoxides) are extremely unstable. In this research, we established a new high-throughput screening method for lipoxygenase activity assay, which was based on the determination of lipid hydroperoxides by ferrous oxidation-xylene orange (FOX) assay. The new method is able to measure over 100 barley or malt samples per day. We feel it will be of great interest to barley breeders, maltsters, and brewers.

Yin Li is a research assistant professor in the Department of Plant Sciences at North Dakota State University. He received his Ph.D. degree in the area of malting and brewing in 2006 and started his post-doctoral research work with Professor Paul Schwarz. He has published more than 30 papers in international peer-reviewed journals. Recently, he is interested

in lipoxygenase, antioxidant activity of barley and malt, arabinoxylans, extract, and organic acids.

P-37

Evaluation of three different yeast propagation methods and their effects on fermentation performance

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(1) White Labs, Inc.

The method of yeast propagation may affect yeast health, viability, vitality, and, thus, fermentation performance and repitchability. This study investigates the propagation of a popular ale strain using three different methods: a 40-bbl Frings aeration system, modified Carlsberg flask system, and microbrewery's 3-bbl propagation unit. During propagation, cell counts, viability, vitality, and glycogen levels were monitored. Microbiological testing was also performed to detect any aerobic and anaerobic bacteria, as well as wild-yeast, contamination. The fermentation performance of each propagation style was evaluated via laboratory-scale 1.5-L fermentation vessels. Their gravity was tracked daily, and cell growth/decline was noted. The major differences between the propagation systems were their growth factors, viabilities, and vitalities. The Frings aeration system, modified Carlsberg flask, and microbrewery's 3-bbl systems yielded the highest growth factors, respectively. The modified Carlsberg flask and 40-bbl Frings aeration systems had similar viability and vitality and were higher than that of the microbrewery's propagated yeast. A higher rate of attenuation is usually seen in systems with higher viability and vitality; therefore, yeast propagation method can greatly affect fermentation performance.

Sharon Fernandez graduated with a B.S. degree in biology from the University of California San Diego and started out at White Labs in the summer of 2007 as a part-time student lab technician. Sharon became a full-time employee a year later and began her study of yeast propagation in hopes of developing a propagation method that will maximize yeast viability and vitality. While studying the various methods of propagation, Sharon also specializes in bacteria and Brettanomyces culturing at White Labs. In her first year at White Labs, Sharon revolutionized viability testing with her work on EDTA and highly flocculent yeast strains. Look for more on this method in upcoming conferences.

P-38

Gene-expression analysis of brewing yeast during high-gravity brewing

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High-gravity brewing is an effective method for the production of beer. However, this technique subjects the brewing yeast to various stresses, including those caused by osmotic pressure, nitrogen starvation, and ethanol exposure. Here, we used microarray-expression analysis to identify the yeast genes that showed altered expression in response to stress during high-gravity brewing, and we explored the application of this

finding to yeast management, breeding, and selection. The bottom-fermenting brewing yeast *Saccharomyces pastorianus* is a hybrid of *S. cerevisiae* and *S. bayanus*. Gene-expression microarrays are commercially available for laboratory *S. cerevisiae*, making it relatively easy to analyze, but not for bottom-fermenting brewing yeast. We, therefore, determined the entire genome sequence of the bottom-fermenting brewing yeast and created an original gene-expression microarray that included both *S. cerevisiae* and *S. bayanus* genes. Using this microarray, we analyzed the gene expression. We placed the bottom-fermenting brewing yeast under stress induced by osmotic pressure (1M sorbitol) during the logarithmic phase. After 1–3 hr, we conducted a gene-expression analysis and identified *HSP12* and *GPD1* as genes the expression of which changed under osmotic pressure. Moreover, using normal-gravity wort (12%) and high-gravity wort (20%), we performed a fermentation test in a 2-L tall tube and analyzed gene expression by sampling the yeast during fermentation. The results identified the genes that showed altered expression during high-gravity brewing compared with normal-gravity brewing. These included some genes that changed under osmotic pressure.

Hiromi Yamagishi graduated from Chiba University and began employment with Asahi Breweries, Ltd. in 1985. From 1985 to the present, she has been engaged in research and development in brewing science, specializing in fundamental research on yeast physiology.

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Improvement of nitrogenous content in wort produced from rice malt

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Generally, the soluble nitrogen and FAN content in wort are important for fermentation and beer quality. Although rice malt containing 10% (wt/wt) protein was selected for beer production, FAN and soluble nitrogen in wort from standard mashing were lower than needed. Therefore, the objective of this work was to improve the nitrogenous content in wort produced from black rice malt. The infusion and decoction mashing program were developed by determining the optimal temperature needed to improve soluble nitrogen and FAN in wort. The selected mashing program was used for determination of the mashing-in pH (5.8, 5.6, 5.2, and 4.8) and divalent cations supplementation (Ca^{2+} , Mg^{2+} , Zn^{2+}) using a laboratory mashing bath with a grist/water ratio of 1:8. The selected condition was used to mash in a Braumaister mashing pot with a grist/water ratio of 1:5, and then the wort was fermented by top- and bottom-fermenting yeast. The extension of mashing temperature in a range of 50–60°C was selected to produce wort. The soluble nitrogen, in the form of FAN, was increased when mashing-in pH was reduced to pH 4.8, whereas the maximum soluble peptides was found at pH 5.2 with the maximum fermentability. The divalent Ca^{2+} at a concentration of 150 ppm incorporated with pH adjusted to 5.2 gave a satisfactory quality wort. The

Lundin fraction suggested that the small peptides accounted for most of the protein in the wort and beer (approx. 80%, wt/wt), and the sharp band of 11 kDa found in every sample was proposed to be rice LTP1 protein, which contributed to foam formation in rice beer. Consequently, both types of beer had similar a result of good foam stability (360 sec for bottom fermentation and 340 sec for top fermentation). The hydrophobic property of protein in rice and beer plays a more important role in foam formation and stability than the size of the protein.

Ulaiwan Usansa graduated with a B.S. degree in food technology from Suranaree University of Technology, Thailand, in 1997. From 1997 to 2000, she was employed as a teaching assistant at the same school. She is interested in fermentation technology and transferred to pursue her masters and doctoral degree studies in biotechnology at Suranaree University of Technology in 2004.

P-40

Issues regarding residual iso- α -acids in reduced hop products and the formation of detectable 3-methyl-2-butene-1-thiol

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(1) John I. Haas, Inc., Yakima, WA; (2) John I. Haas, Inc., Washington, DC

Brewers are justifiably concerned about the potential for 3-methyl-2-butene-1-thiol (3-MBT) in their beer. 3-MBT is the compound responsible for the dreaded “light struck” or “skunky” aroma in beer resulting from the exposure of hop iso- α -acids to light. A number of studies have been conducted establishing the minimum sensory threshold of 3-MBT in beer, which have now set that limit near 7 ng/L (parts per trillion). However, the producers/suppliers of chemically reduced hop extracts, designed in part to prevent the formation of 3-MBT or at least greatly reduce the risk of sensory detection, generally set their maximum specification limit for residual IAA near 0.1–0.2% (1,000–2,000 mg/L) of the finished hop product weight. With flavor studies indicating a sensory detection level for 3-MBT for beer as low as 7 ng/L, are these current specification limits set by hop product manufacturers prudent? This study reviews the risks associated with residual IAA in light-protected hop products and the potential for the formation of sensory detectable 3-MBT, as well as HPLC quantitation of IAA in examples of light-protected hop products.

Mark Bossert is the father of three and husband to one. Mark graduated from Central Washington University in 1996. He holds B.S. degrees in chemistry, biochemistry, biology, and microbiology. Mark was an Advanced Products Division assistant plant manager for John I Haas (1996–2008) and is now in product and process development (2008–2009).

P-41

Practical application of ESR/EPR for process improvement in a brewery

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The objective of the paper is to provide a practical guide for those who perform ESR in a brewery environment. Most literature currently covers the applicability of ESR for a specific process applications. The paper, however, covers specific topics like sampling technique, instrument set-up, variation in spin-trap reagent from different vendors, precision and accuracy of the technique, and evaluation of processes at different stages that may provide opportunities for improvement. The aim is to help highlight, and hence prevent, issues faced at the onset of testing.

Amina Daar received a B.S. degree in industrial chemistry from the National University of Somalia in Mogadishu, Somalia. She began employment with the Urea Production Plant, Mogadishu, in 1983 as a laboratory chemist. Amina moved to the United States in 1988. She was employed at Pfizer Inc, Milwaukee, WI, as a laboratory technician in 1989. In 1990 she worked at American Bio-Synthetics as an analytical chemist (Milwaukee). In 1993 Amina joined Pabst Brewing Company in Milwaukee, until 1996. She joined the Miller Brewing Company in 1999 as a lab technician. From 2001 to 2005 she served as a quality engineer microbiologist. From 2005 she has been the quality engineer/ESR specialist. Amina is a new member of ASBC.

P-42

Preparation of cross-linked carboxymethyl modified corn starch and adsorption of heavy metal ions in brewery wastewater

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Heavy metal pollution is one of the most important environmental problems today. Brewing industries discharge wastewater and sludge containing different heavy metal ions into the environment, although the concentration of heavy metal ions is normally low. Recently, biosorbents, which contain a variety of functional sites, including carboxyl, imidazole, sulphhydryl, benzyl, and hydroxyl moieties, have received increasing attention for heavy metal ion removal. In this work, cross-linked carboxymethyl modified starch (CCMS) was tested to remove heavy metal ions from synthetic aqueous solution. The CCMS adsorbent was prepared by reaction of corn starch with monochloroacetic acid under the dry condition and subsequent reaction of carboxymethyl starch with epichlorohydrin as a cross-linking agent under the ethanol water condition. The effects of reaction time, CCMS content, and pH on the absorption property for Pb^{2+} , Cd^{2+} , and As^{3+} in aqueous solution were studied on the basis of the results of single-factor tests, according to the Box Behnken factorial design principle, and the regression equation of the modification parameters was established. The CCMS adsorbent was characterized by infrared spectrometer and scanning electron microscope. The optimum adsorption conditions were confirmed as follows: the CCMS content 2.2 g/L, pH 6.6, and absorption time 32.9 min.

The maximum loading capacities for Pb²⁺, Cd²⁺, and As³⁺ were up to 44.7, 44.0, and 43.6 mg/g, respectively; and the maximum removal rate could reach 98.4, 96.8, and 96.0%, respectively. When 0.6N HCl aqueous solution was used in the desorption process, the maximum recovery percentages of Pb²⁺, Cd²⁺, and As³⁺ reached 95.8, 94.3, and 94.2%, respectively. From these results, it can be concluded that CCMS could be a good adsorbent for heavy metal ions from wastewater in the brewery.

Dongjie Zhang received a Ph.D. degree in food science from Jilin University, China. He joined Heilongjiang August First Land Reclamation University, China, as a professor in the College of Food Science in 1989, where he has participated in several research projects related to food safety. Currently, he is the dean of student affairs at HLJ August First Land Reclamation University.

P-43

The impact of turbidity on wort color measurement

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Color is one of first perceptions consumers have of a beer, and therefore, it strongly affects consumer preference, making it a key quality parameter for the brewer. The color of Congress worts is used to predict final beer color. However, the standard method for measuring wort color, calculated from an absorbance reading at 430 nm, can be compromised by the turbidity of the wort and requires all worts to be filtered with Celite (diatomaceous earth) prior to absorbance measurement. Several types of membrane filters have been proposed as alternatives for removing wort turbidity. Collaborative studies have indicated good repeatability for individual filter materials, resulting in their widespread use in commercial-quality laboratories. However, more rigorous comparisons between the methods are warranted over a larger range of color and turbidity levels that are often encountered when evaluating research samples. In this experiment, wort color was determined for a series of malts with a wide range in both turbidity and color. Congress worts were prepared and filtered using one of three popular membrane filter materials: 0.45 µm PTFE, 0.45 µm PVDF, or 0.45 µm cellulose acetate. The efficiency of turbidity removal and its impact on color measurement were assessed by nephelometry on worts prior to and after clarification. The PTFE and cellulose filters were found to be equivalent to the reference method in their ability to remove haze when used to clarify worts with a turbidity of <5 NTU. However, both PTFE and cellulose filters were significantly less effective than Celite in removing haze from worts with a turbidity >5 NTU. The PVDF filter material was significantly less effective in removing haze than the reference method in all cases. Nephelometric measurements also revealed that the turbidity of unfiltered worts increased with time, emphasizing the importance of timeliness in color analysis.

Dennis Langrell received a diploma in biochemical technology in 1975 from Red River College and a B.S. degree in chemistry in 1985 from the University of Winnipeg, both located in Winnipeg, MB, Canada. He began employment with the Canadian Grain Commission's Grain Research Laboratory (GRL) in 1975 and has held several positions involving malting barley quality analysis and research. Since 1993, he has been employed as a malt quality chemist in the Applied Barley Research Unit of the GRL, reporting to Michael J. Edney. He has been a member of the ASBC since July 2000.

P-44

Wine flavor analysis by comprehensive two-dimensional gas chromatography with time-of-flight mass spectrometry (GC×GC-TOFMS)

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(1) LECO Corporation

Wine flavor and aroma analyses are challenging due to the complexity of the samples and also because some compounds may contribute significant odor at trace levels. For example, methoxypyrazines supply a characteristic aroma in certain wines at the ng/L level. Attempting to measure such low level components, especially when they exist in the presence of more concentrated compounds, requires a high degree of selectivity. One way to provide that selectivity is to use comprehensive two-dimensional gas chromatography with time-of-flight mass spectrometry (GC×GC-TOFMS). GC×GC provides high peak capacity, and TOFMS offers not only identification of compounds by mass spectrometry, but also the power of spectral deconvolution for those cases where GC×GC fails to resolve components. This paper will present results from GC×GC-TOFMS analysis of wines, including Sauvignon Blanc and Cabernet Sauvignon. Solid-phase microextraction will be used to isolate aroma compounds prior to their introduction to the GC×GC-TOFMS. Wines will be spiked with methoxypyrazines at odor-significant levels to determine whether GC×GC-TOFMS will provide the selectivity necessary to permit their measurement in complex samples. Additional characterization of the wines via automated peak find and deconvolution algorithms will also be shown.

Mark Libardoni completed his B.S. degree in chemistry at California State University and also holds M.S. and Ph.D. degrees in chemistry from the University of Michigan–Ann Arbor. Mark's thesis focused on the design, development, and evaluation of a novel thermal modulator for comprehensive two-dimensional gas chromatography (GC×GC). His current research interests include high-speed and multi-dimensional techniques for the analysis of complex samples, as well as the detection of biomarkers and metabolomics precursors in human breath. Prior to working for LECO Corporation, Mark held positions in the business sector as a senior manager and financial analyst. His current position as managing director of separation science at LECO Corporation includes the global direction of research encompassing time-of-flight mass spectrometry (TOFMS). Mark has authored over 25 publications and is the co-inventor on two patents.

P-45

The influence of fluid mechanical process design during mashing on attenuation degree

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The mashing process is primarily dependant on enzyme-catalyzed reactions. For the regulation of enzyme-catalyzed processes, different parameters are normally used, including temperature, pH value, hydrostatic pressure, and concentrations of enzymes and substrates. Additionally, the mixing of the mashing vessel has an effect. Our research focuses on the influence of fluid mechanical process design during the mashing process on the final attenuation degree of the resulting wort. All experiments are carried out in model vessels with a volume of 200 mL. Three different malts are used for mashing. The enzymatic reactions are characterized by saccharification time measured with a photometrically determined iodine value. The resulting worts are characterized by original gravity. Additionally, the resulting worts are fermented to determine the final attenuation degree. The photometric iodine value does not appear to be an appropriate measurement to monitor the process of saccharification during mashing. This is due to the fact that the necessary filtration before photometric measurement also filters out the starch particles, which are of crucial interest. Mixing wort with a different stirrer design does not significantly influence the original gravity or final attenuation degree. However, an increasing stirrer speed correlates with decreasing final attenuation degree. The differences of up to >4% seem to be the result of a higher oxygen intake due to stronger stirring. This indicates again the importance of avoiding oxygen intake at any stage in the brewhouse.

Peter Ferstl studied brewing and beverage technology at the Technische Universität München in Weihenstephan from 1998 until 2003 and graduated with a Dipl.-Ing. degree. Since June 2007, he has been working at the Chair for Process Systems Engineering at the Technische Universität München as a research assistant. His research focuses on fluid mechanical process design in biotechnological processes in the beverage industry.

P-46

A comparison of barley malt amylolytic enzyme thermostabilities as indicators of malt sugar concentrations

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This study was conducted to determine the relationship between barley malt amylolytic enzyme thermostabilities and malt sugar concentrations after a short period of mashing. Seeds of four

two-row and four six-row North American elite barley cultivars were steeped and germinated in a micromalter for 6 days. At 24-hr intervals throughout germination, green malt was removed and kilned. Malts were assayed for individual amylolytic enzyme activities, and thermostabilities and malt sugars were extracted at the same temperature that thermostabilities were tested (70°C for 30 min). The 70°C thermostability test was chosen because this is the temperature used to produce wort for the ASBC malt extract measurement. In malts from day 1 of germination, and to a lesser extent from days 3–6 of germination, α -amylase activity after treatment at 70°C was enhanced over the Megazyme α -amylase assay temperature of 40°C, indicating that there was no α -amylase thermostability at the assay temperature used to test thermostability. Malt β -amylase and limit dextrinase activities were less thermostable at day 1 of germination than on subsequent days of germination, suggesting that seedling development influences the subsequent malt thermostability at 70°C of these amylolytic enzymes. For all cultivars combined, over all days of germination, malt β -amylase and limit dextrinase thermostabilities correlated negatively and highly significantly with total malt sugars ($r = -0.656$, $P < 0.0001$, $r = -0.767$, $P < 0.0001$, respectively) and with individual malt sugars with degrees of polymerization < 4 (e.g., maltose and maltotriose: β -amylase, $r = -0.668$, $P < 0.0001$, $r = -0.675$, $P < 0.0001$, respectively; limit dextrinase, $r = -0.732$, $P < 0.0001$, $r = -0.770$, $P < 0.0001$, respectively). Six row cultivar β -amylase and limit dextrinase thermostabilities correlated slightly better than two-row cultivar thermostabilities with total and individual malt sugar concentrations (e.g., total sugars: two-row β -amylase and limit dextrinase, $r = -0.645$, $P = 0.0007$, $r = -0.770$, $P < 0.0001$, respectively; six-row β -amylase and limit dextrinase, $r = -0.686$, $P = 0.0002$, $r = -0.808$, $P < 0.0001$, respectively). Malt α -amylase thermostability at 70°C did not correlate significantly with total or individual malt sugars ($r = 0.197$, $P = 0.179$) for all cultivars combined or with two- or six-row cultivars analyzed separately over 6 days of germination. Maltodextrins with increasing degrees of polymerization, from maltotetraose to maltoheptaose, correlated positively and highly significantly with β -amylase and limit dextrinase activities in all cultivars combined (e.g., β -amylase: maltotetraose, $r = 0.687$, $P < 0.0001$, maltoheptaose, $r = 0.791$, $P < 0.0001$; limit dextrinase, maltotetraose $r = 0.868$, $P < 0.0001$, maltoheptaose, $r = 0.767$, $P < 0.0001$) and in two- and six-row cultivars analyzed separately. These data suggest that with a short period of heat treatment at 70°C starch degradation in a malt extract is significantly limited by the thermostabilities of β -amylase and limit dextrinase.

Cynthia Henson is a supervisory research plant physiologist with the USDA-Agriculture Research Service and an associate professor of agronomy at the University of Wisconsin-Madison. She received her Ph.D. degree in agronomy from the University of Wisconsin-Madison and subsequently joined ARS. She is the research leader of the USDA-Agriculture Research Service Cereal Crops Research Unit in Madison, WI.

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A laboratory fermentation method that can determine the influence of micro-nutrient levels on wort fermentability

Blanca G. Gomez (1), AARON MACLEOD (2), Michael J. Edney (2)

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Fermentability is an important malt quality parameter, as it predicts potential beer production. The standard EBC method for measuring a malt's fermentability uses Congress wort, high pitching rates, and continuous stirring to achieve results in 24 hr. Tests in our laboratory demonstrated that a 100% maltose solution could be fermented to completion under such conditions, suggesting micronutrients, such as amino acids and minerals, are not required at such high pitching rates. As a result, the standard laboratory fermentation method limits our ability to understand how these micronutrients affect fermentability. The present study investigated a laboratory fermentation method using maltose syrup as adjunct and reduced pitching rates as a means of better determining the influence of micronutrients. Four-day fermentations using

different levels of adjunct and pitching rates were compared by measuring the density every 24 hr. Using a 60:40 ratio of Congress wort to maltose syrup (8°P) with a pitching rate of 60 million cells/mL, differences in the supply of micronutrients were reflected in the progress of the fermentation after 24 hr. A study of four malts with significant differences in quality showed that fermentable sugars were the only limiting factor to fermentability as measured with the standard EBC test. Only when the adjunct was used with the lower pitching rate did significant differences in FAN become a limiting factor to fermentability. The modified method is now being used to study the effects of individual amino acids and availability of minerals on fermentability.

Aaron MacLeod is the analytical malting technician in the Applied Barley Research Unit of the Grain Research Laboratory in Winnipeg, MB, Canada. The unit conducts research on factors affecting malting barley quality and measurement methods. Aaron earned a B.S. degree in chemistry from the University of Western Ontario in 2004. He is currently a member of the ASBC Methods of Analysis Review Subcommittee. Aaron also serves as secretary of the Canadian Prairie Section of AACC International.



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The winners of the 2009 ASBC Eric Kneen Memorial Award are D. Evan Evans, Anne Surrel, Megan Sheehy, Doug Stewart, and Louise Robinson for their article, "Comparison of Foam Quality and the Influence of Hop α -Acids and Proteins Using Five Foam Analysis Methods." The article was published in the *Journal of the American Society of Brewing Chemists* (Vol. 66, No. 1, pp. 1-10). The winners will receive \$1,000, and each person will receive an engraved plaque.

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