Hopsteiner

Passion Quality Research Development

HOPSTEINER. RESEARCH AND DEVELOPMENT. REPORT 2020

History is being made, things are moving forward. And that for 175 years.

Hops have been known for centuries as a cultivated and medicinal plant. The possibilities of its applications in the brewing process, but also the use of its antibacterial and even anticarcinogenic properties in completely different areas inspire us and are the driving force behind numerous research and development activities in our group of companies.

We would like to present this work to you in this edition of the R&D Report 2020. In particular, we would like to give the minds behind the research work a chance to have their say.

For 175 years, it has been our employees who have made the difference. Some of them are presented in this report in front of the curtain - on behalf of each and every one of them in our company.

As this book goes to press, the world is in the middle of the Covid 19 pandemic. Hopsteiner celebrates its 175th anniversary this year. Instead of traditional celebrations, we have decided to enter into a research cooperation dedicated to the fight against Covid19 in the field of the antiviral effect of hop ingredients.

Discover more, experience more.

We use augmented reality to give you interesting and further information about the HOPSTEINER. RESEARCH AND DEVELOPMENT. REPORT 2020. You can obtain this information by scanning the respective QR Code (with QR Code Reader) or by entering the specified short URL in your Internet browser.

1
Breeding

Watch movie

https://bit.ly/3g6uOKp

I try to combine the old traditions and cultures with new research.

Dr. Alexander Feiner
Plant Science and Breeding
at Hopsteiner in Mainburg

Our breeding promises greater consistency and reliability.

Dr. Alexander Feiner
Plant Science and Breeding
at Hopsteiner in Mainburg

Their tool: the computer. Dr Alexander Feiner grows hops in the company's own hop garden in the Hallertau. It takes a long time before this perennial plant, which grows to three times the height of a man, can be examined. During this time he spends his hours mainly in front of the computer screen in his office.

"Without IT, breeding hops would no longer be possible," - something which Alexander Feiner and his US colleague Nicholi Pitra are very well aware. Using high-performance computers, the plant scientists are able to access all the relevant analytical data used in their breeding programme; for instance those on flavouring and bitter substances in their plants, their DNA sequence data, and the genetic background. Which parents produce a good cross? Which of them will be strong and productive, and which has been proven too weak? And those these are only a few of the questions that keep the scientists busy every day.

"Our company is a global leader in research," says the agricultural scientist, who heads the breeding department at Hopsteiner Europe. The primary objective in this field is to develop competitive hop varieties to enable efficient, resource-saving hop cultivation, and to establish these in the appropriate markets. The precise objectives of breeding are oriented towards agronomic issues and aim to satisfy not only the constantly changing demands of both customers and the environment, but also those of processing.

One thing is certain, and that is that all the challenges that hop breeding faces can only be overcome by applying the latest research methods. The American and German scientists at Hopsteiner play a leading role in this internationally.

More specifically, they make use of molecular genetics to study certain characteristics in the hop genome. Fragments in the DNA which are linked to a specific property can be identified using this method. This means that new cross-pollination partners and their progeny can be selected at an early stage.

The gain in time pays off, because this molecular marker facilitates the researchers' work, shortens the lengthy process by several years, and makes planning easier.

Not a lot happens from one moment to the next where breeding hops is concerned. It takes ten years for a new variety to become a marketable product – if all goes well.

**You want to know more about breeding?
We have three interesting articles for you right here.
In the enclosure you will find more articles and
more detailed information.**

01/01 DOWNY MILDEW RESISTANCE IS GENETICALLY MEDIATED BY PROHYLACTIC PRODUCTION OF PHENYLPROPANOIDS IN HOP: Resistance in hop against downy mildew is conferred by the constitutive abundance of protective phenylpropanoids. The co-localization of the resistance loci and the phenylpropanoid pathway markers indicate that these molecules contribute to the principle downy mildew defense mechanism in hop.
https://bit.ly/3mxYELK

Emphasis is also placed on the stability of a hop variety when stored between harvesting and the time of processing. The aim is to breed varieties whose chemical ingredients can stay constant for as long as possible; that is, to ensure that the raw hops can be stored for several months before they are processed, with minimum loss of quality.

The growers, naturally, always focus on greater consistency when it comes to expected yield and alpha content despite severely fluctuating weather conditions. “What is crucial here is that known and prized characteristics of established varieties are not severely altered or affected in new varieties. Nevertheless, unique new flavours are always in demand in the brewing industry.” Dr. Feiner agrees with his US colleagues Dr. Paul Matthews and Nicholi Pitra on this point. For this reason, Hopsteiner is conducting research aimed specifically at developing reliable varieties with established variety profiles.

One is prepared for this at Hopsteiner. In 2013 the research programme in Mainburg, which was developed several decades ago in the USA, was expanded to specifically breed high-performing varieties for hop cultivation in Europe.

Feiner and his colleagues have been dedicated to this and, in close collaboration with partners, they have successfully ensured that the first few varieties will be available to growers in the next few years.

01/02 NEW TOOLS FOR HOP CYTOGENOMICS: Identification of Tandem Repeat Families from Long-Read Sequences of Humulus lupulus: Hop (Humulus lupulus L.) is known for its use as a bittering agent in beer and has a rich history of cultivation, beginning in Europe and now spanning the globe.
https://bit.ly/3jzDsTH

01/05 NON-MENDELIAN SINGLE-NUCLEOTIDE POLYMORPHISM INHERITANCE AND ATYPICAL MEIOTIC CONFIGURATIONS ARE PREVALENT IN HOP: To better understand the transmission genetics of hop, we genotyped 4512 worldwide accessions of hop, including cultivars, landraces, and over 100 wild accessions using a genotyping-by-sequencing (GBS) approach.
https://bit.ly/3aqNmnB

“We are very much influenced by climate change and are constantly seeking new approaches,” says Dr. Paul Matthews, molecular biologist and Senior Research Scientist at Hopsteiner.

The statistics underline the urgency of this. As the Bavarian Environmental Report has illustrated, the number of dry days is going to increase during the vegetation phases of the hop plant. The aim is to compensate for this using genotypes with a better tolerance for stress. Plant material from all over the world is therefore being studied and tested at Hopsteiner, in order to develop varieties that can continue to be productive at high temperatures and when there is a shortage of water.

The primary goal is that future hop varieties must deliver a yield that is both stable and high, so as to enable efficient and competitive production. At the same time, resistance to diseases, pests and changing climate conditions is of prime importance. Since the approval process for plant protection products is unlikely to become easier in the future, disease resistance needs to be bred in new hop varieties.

The scientists at Hopsteiner are of the opinion that it will take nothing less than a revolution to make the ancient cultivated plant that is the hop fit, for the future. Over the last few years, demand for a fruity flavour has increased, primarily as a result of the trend towards craft beers. Demand for the classic varieties, however, remains stable. These, specifically the "Perle" and "Hallertauer Tradition" varieties are among the most extensively grown varieties in the Hallertau today. Ironically it is, however, these traditional varieties that are suffering most from the changes to the climate that are manifesting themselves ever more rapidly.

"We identified this development early at Hopsteiner, and started at precisely that point." Joachim Gehde, Managing Director of Hopsteiner Germany also confirms the research team's results.

Alex Feiner anticipates great things of the new variety, Akoya,and with him a grower community around the world that is keeping a close eye on the advances under Feiner's development.

"Our breeding promises greater consistency and reliability." Feiner is proud to state.

As far as taste goes, Akoya also leaves nothing to be desired. At the BrauBeviale trade fair in Nuremberg in 2018 Feiner allowed more than 300 test subjects to taste beer brewed with both the classic Perle and its successor, Akoya. The result showed no difference.

"That was exactly the result we wanted", says Feiner.

Watch movie

https://bit.ly/3aF4DcP

Without IT, nothing would work in hop breeding.

Nicholi Pitra
Lead Scientist Variety Development and Bioinformatics
at Hopsteiner in Yakima

Feiner devoted his doctoral thesis entirely to basic research on the topic of resistance; specifically that of hops to downy mildew. This plant disease leads to substantially lower harvests and diminished cone quality. Feiner's investigation provided science with significant metabolic and genetic markers that will enable hop plants to become far more resistant in the future. "By basic research we get from 'know-why' to 'know-how'," says Feiner. In other words, only when he knows how it works, or it doesn't, can he make the right decisions in the future.

"What makes the mixture for success at Hopsteiner is the combination of science and our instinct for plants."

Watch movie

https://bit.ly/2FCVfem

We are highly influenced by climatic change and are constantly looking for new approaches.

Dr. Paul Matthews
Senior Research Scientist
at Hopsteiner in Yakima

2
Research

Watch movie

https://bit.ly/326H6gR

To do research, I first have to know the state of the art to develop new ideas.

Dr. Martin Biendl
Research & Development
at Hopsteiner in Mainburg

We want to be the ones
who develop this product and
then market it the best.

Dr. Martin Biendl
Research & Development
at Hopsteiner in Mainburg

Their tool: specialist scientific literature. In the past, Dr Martin Biendl says, he found whatever he needed to know in the library. Nowadays, in the era of the smartphone and WiFi, the internet can deliver every new study at the push of a button. And, on top of that, unprecedented opportunities to network with colleagues around the world.

If you don't stay on the ball you will quickly be be left behind. The Doctor of Chemistry, who was born in Cham, heads the department for Research & Development and Analytics at Hopsteiner in Mainburg. Three fields which, for Biendl, are inextricably linked.

He and his team are especially interested in practical implementation. "In our field one must always run the risk that an idea might get rejected. However, this also often results in important partnerships that carry us further forward." On this Dr Biendl and his US colleagues Jeremy Leker and Bob Smith all agree.

Hopsteiner has been working closely with the most important institutions in the brewing and food industry, including the Fraunhofer Institute and the Technical University of Munich Weihenstephan, for years. Longstanding collaborations with prestigious research facilities such as the Linus Pauling Institute at Oregon State University in Corvallis and the UIC/NIH Botanical Center of the University of Illinois in Chicago are looking into medical applications for hops. Biendl and his colleagues are also active on international analysis committees and specialist bodies in the hop and brewing industry, and organise hop symposia.

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more detailed information.

02/01 THE IMPACT OF DIFFERENT HOP COMPOUNDS ON THE GROWTH OF SELECTED BEER SPOILAGE BACTERIA IN BEER: To investigate the impact of seven different hop compounds on the growth of six major beer spoilage bacteria, two concentrations (10 and 25mg/L) of each hop substance were added to unhopped beer.
https://bit.ly/2JhYfyC

One of the highlights for Martin Biendl was the second EBC Hop Symposium in Nuremberg in September 2018, where more than a hundred scientists working in the hop and brewing industry from Germany and other countries exchanged information on the latest scientific developments. Under Biendl's scientific leadership.

For all their scientific precision, the researchers at Hopsteiner live in anything but an ivory tower. It is not only in relation to product development that they stand with both feet firmly on the ground of practical usability.

Their objective is, as far as possible, to use the entire hop plant. "Efficiency is our contribution to sustainability," says Biendl.

Recent example: a hop extract that is similar to one from rosemary may in the future be used as an ingredient that improves the shelf life of a variety of foodstuffs.

We want to be the ones to develop this product and then, ideally, to market it," is Biendl's stated ambition.

In practical terms, this involves combining the ingredients from the hops with very specific co-substrates in order to protect, for instance, a sausage from germs as effectively as possible. And, in addition, it is necessary to achieve a balance so that the bitter-tasting hops have a minimal impact on the natural taste.

02/04 XANTHOHUMOL – A MILESTONE IN RESEARCH: Die erste Publikation über eine gesundheitlich positive Wirkung von Xanthohumol erschien 1997, also vor exakt 20 Jahren. Damals berichteten japanische Forscher über die Hemmung eines Enzyms, das den Fettstoffwechsel negativ beeinflusst.
https://bit.ly/3fVZY7e

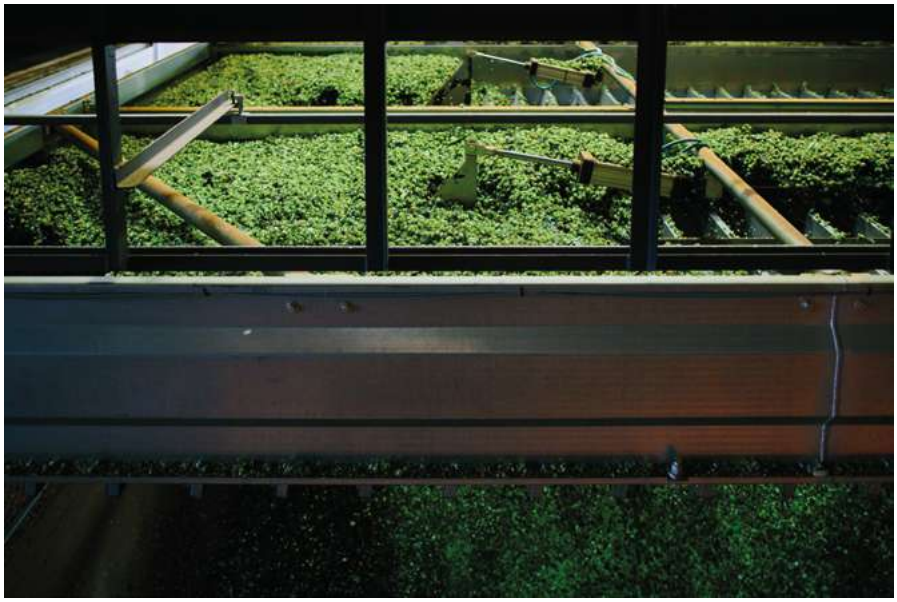
02/05 LC-MS-MS ANALYSIS OF HOP FLAVONOIDS IN DRYHOPPED BEERS: To monitor selected hop flavonoids in dry-hopped beers, an in-house HPLC-MS/MS method was developed. Dry-hopped beers produced with different hop varieties showed significant differences in their hop flavonoids pattern.
https://bit.ly/30Tv4s2

Or where development of the process is concerned. The Hopsteiner researchers in Germany and the USA are completely committed to making hops sustainable, and are dedicated to making the most efficient use possible of the green cones. Besides the potential application as a food supplement and in pharmaceuticals, the focus is primarily on the antimacrobial effect of some of the ingredients - for example xanthohumol, a natural constituent of hops, which is purported to have great potential in healthcare.

"The research in this area is already very advanced, and at the moment the first human studies are being carried out. If the authorities officially recognise the effect, we will be able to start," says Biendl.

Then Hopsteiner will once more be at the forefront of research. In order to be able to isolate xanthohumol in large quantities in the future, and to get the ingredient ready for marketing, the team at Hopsteiner are working to develop a completely new process.

It is not yet known whether it will be possible to turn the brittle chemical compound into an economically successful product. Specifically, it is certainly not that easy to make "Hopsteiner XanthoFlav". Either way, appropriate extraction trials on a pilot scale have been intensified over the last few months.



Martin Biendl adds, "That's research: when we begin we don't know what the end result is going to be."

In one area alone, the scientists at Hopsteiner place no reliance on mere luck and intuition. Their analyses are highly regarded and coveted throughout the entire industry. Ultimately, the basis of research is reliable analysis.

In this, too, international networking is of immense importance. If a research team in, for instance, the USA finds evidence that hops have the potential to help against a disease such as diabetes, Biendl calls his team together. The aim then is to discover in which variety the ingredient in question can be found in high concentration, where it grows, and how Hopsteiner can react to demand.

The absolute safety of their hop products is of particular importance to Hopsteiner. Because there are strict limits imposed throughout the world on residues from pesticides, Hopsteiner's laboratory carries out meticulous tests.

"We prefer to carry out analyses ourselves rather than rely solely on third parties. In this area we have managed to become the benchmark in the industry," says Biendl proudly. "We don't just close our eyes and hope for the best."

Watch movie

https://bit.ly/3gadtAk

Hops are very complex, but for me the sensory impression is still the most essential.

Dr. Christina Schmidt
Food Chemist
at Hopsteiner in Mainburg

3
Brewing and Technical Support

Watch movie

https://bit.ly/2Q5z16F

Hops, that's what gives it that extra something.

Frank Peifer
Technical Director
at Hopsteiner in Mainburg

We analyse and evaluate
a lot of sensory information
about the smell.

Frank Peifer
Technical Director
at Hopsteiner in Mainburg

Their tool: their noses. For Frank Peifer, working with hops is, from time to time, definitely akin to a sensuous experience. He and his team have to rely on their sense of smell and taste on a daily basis. "The first thing a brewer does is to stick his nose into a glass," he says.

Every year hundreds of samples of beer from all the corners of the earth find their way to Hopsteiner in Mainburg, including many different varieties of raw hops in the form of cones or pellets. Long before a beer is tasted, Peifer and his team seek out flavourings and bitter substances using their trained sense of smell. "We carry out a lot of sensory analysis and assessment through smelling," he says.

Peifer, who actually originates from the traditional Moselle wine-growing area and was trained in Duisburg and Weihenstephan, has headed the Brewery department at Hopsteiner Europe as Technical Director since 2015. Because breweries from Argentina to Japan put great store in Hopsteiner products, "the whole world is my workplace," stresses Peifer. Every year, his travels take him, among other places, to the west coast of the USA, to South and Central America, then finally to Africa. There's scarcely a single development in the worldwide brewing trade that Frank Peifer or one of his colleagues has not been involved with right from the start. Hopsteiner's brewery customers around the world really value this - a knowledgeable technical support team at their disposal to respond to any issues involving hops.

And yet there are still moments that have the power to amaze even an acknowledged expert in his field. In Mexico, together with his US colleague Richard Shaye, he visited the largest brewery in the world, with a beer output of 35 million hectolitres per year. "We have seen a lot over the course of our careers," both colleagues concur, "but this was a huge experience and eye opener for us."

Because Hopsteiner products are used there too, the consultants from Mainburg and New York train employees on site, answer questions, and are ready to provide advice, for instance about dosage quantities, formulations, yields and hop compositions. One typical problem is that, whether the beer is a tangy Pils or a fruity IPA, the bitter substance from the hops and its products is one of the key criteria. "It makes the work much more efficient if this is successfully optimised," explains Peifer. The experts generally have a master plan at the ready when it come to hop flavouring agents as well. And to

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03/01 INNOVATIVE TECHNOLOGY TO REDUCE BEER LOSSES AT DRY HOPPING: The BrauKon HopSteiner (already presented as BeerCleaner) is an economical alternative for the separation of hop trub particles.
https://bit.ly/2G8WC59

keep the balance, always turn the screws as gently as possible. “We are talking about a few grams per hectolitre.” After all, says Peifer, “I want the flavours that I add with the hops to be found in the beer afterwards”. The current trend is to extract the maximum possible flavour and the citrus note that is intrinsic to craft beers.

03/02 THE IMPACT OF DRY HOPPING ON SELECTED PHYSICAL AND CHEMICAL ATTRIBUTES OF BEER: The scope of this study was to investigate how incrementally increasing dosing rates for dry hoping up to 1500 g/hl with type 90 Cascade pellets affects selected chemical and physical characteristics of beer.
https://bit.ly/2YOKkI7

03/04 HIDDEN SECRETS OF THE NEW ENGLAND IPA: New England India Pale Ale (NEIPA), also known as hazy IPA or juicy IPA, is a relatively new beer style being brewed by craft breweries across the United States.
https://bit.ly/3iGRLWe

But Hopsteiner's portfolio also holds extremely practical innovations for the brewing industry. The developers belonging to the team led by former Technical Director Willi Mitter, Frank Peifer's predecessor, have been tinkering for two and a half years, and the result is a technical innovation that is now not aimed at only the craft beer sector, but should soon become standard in the entire brewing industry. The Hopsteiner BrauKon Beer Cleaner may even give new life to beers characterised by a noticeable flavour of hops, generally as a result of cold dry hopping.

The problem hitherto faced, in particular by small US micro-brewers, which use an average of 500 grams of hops per hectolitre, is that hop particles, regardless of whether these come from natural hops or pellets, absorb so much beer during the brewing process that heavy losses are recorded. The Beer Cleaner acts like a sieve and is able to separate the hop particles from the liquid; no moving parts are involved, so there are no energy costs. Even maintenance couldn't be easier, because the beer that flows through the filter, which is three metres high and weighs 700 kilos, produces a self-cleaning effect and the slots do not get blocked. "In the craft beer sector in particular it is always a matter of cost-effectiveness; our invention helps this section of the industry to work as efficiently as possible," explains Peifer. Ultimately, the best ideas come about in practice.

Watch movie

https://bit.ly/3hbX5R9

I believe customers are gonna buy from you, because they trust you.

Richard Shaye
Manager of Exports and Transactions
at Hopsteiner in New York

4
New Product Development

Watch movie

https://bit.ly/2FtxViX

One of our formulas for success is the great experience that our team members bring with them.

Joachim Gehde
Managing Director
at Hopsteiner in Mainburg

No other raw material is as variable and unique as hops.

Joachim Gehde
Managing Director
at Hopsteiner in Mainburg

Their tool: their ears. Knowing today what will be in demand when it comes to innovative hop products for the brewing industry tomorrow and beyond; this is the goal of the Hopsteiner product developers. For example, according to Joachim Gehde, Managing Director of Hopsteiner Germany and former Chairman of the newly founded International Innovation Team, this involves always keeping their ears open. "First of all we need to listen," stresses Gehde, a graduate in business studies. "A keen instinct is required, to recognise the trends of the future in the here and now."

There is certainly a lot of hard work involved. The nine-member team of experts from the USA, Germany and Great Britain, who are responsible for planning Hopsteiner's future business, have three top priorities: marketing intelligence, customer contact and many discussions. The aspiration behind this is undoubtedly ambitious. "We want to implement a product, from the initial idea right through to market maturity, efficiently and as swiftly as possible," says Gehde. A smooth interaction between sales, marketing and technology allows the interdisciplinary team to collect ideas from which new products can be developed, to accompany these, and finally to position them on the fiercely competitive world market - right through to the marketing tools. "We also consider how to design product declarations, manuals and web portals so that they remain fit for the future."

Since the Innovation Team was founded in the summer of 2019 they have come up with countless ideas that are now in various stages of implementation.

The focus is always on the practical applicability of the product. "Our innovative hop extract, HopFlow, is more fluid than a comparable CO2 extract, which makes it more user-friendly in, for example, the craft beer sector," says Gehde. The innovators at Hopsteiner also wish to step up their work with hop oils even further in the future, for instance looking at combining them with hemp oils. "We want to work on blending varieties so we can investigate the synergies in the impressions made by flavours." The entire team is agreed on this.

Richard Shaye has worked for Hopsteiner since 2002, but his fascination for beer goes back even further. "There is no other resource that is as versatile and unique as hops," he enthuses. He has been brewing his own beer at home for seven years - purely as a hobby, he explains - and he now has six taps in his private bar.

“Becoming a hobby brewer has brought me closer to my customers than it would otherwise have been possible for me to be,” he says. The thing that the Venezuelan-born brewer values most in his role in Hopsteiner Export Management is the international network.

He is also responsible for a wide range of other tasks. “Whether we are developing a new function in our inventory management system or a new online tool to help our employees to become more productive, I see myself as the element that links our customers and our programmers,” he says. But his highlight was the Hop Congress in Argentina in February 2019, which had more than 600 attendees. Shaye, together with his German colleagues Willi Mitter and Frank Peifer, introduced Hopsteiner’s newest innovations there. “We received a standing ovation at the end,” he says proudly.

Watch movie

https://bit.ly/2EiwvHo

I work with an incredible Team and we're all about hops.

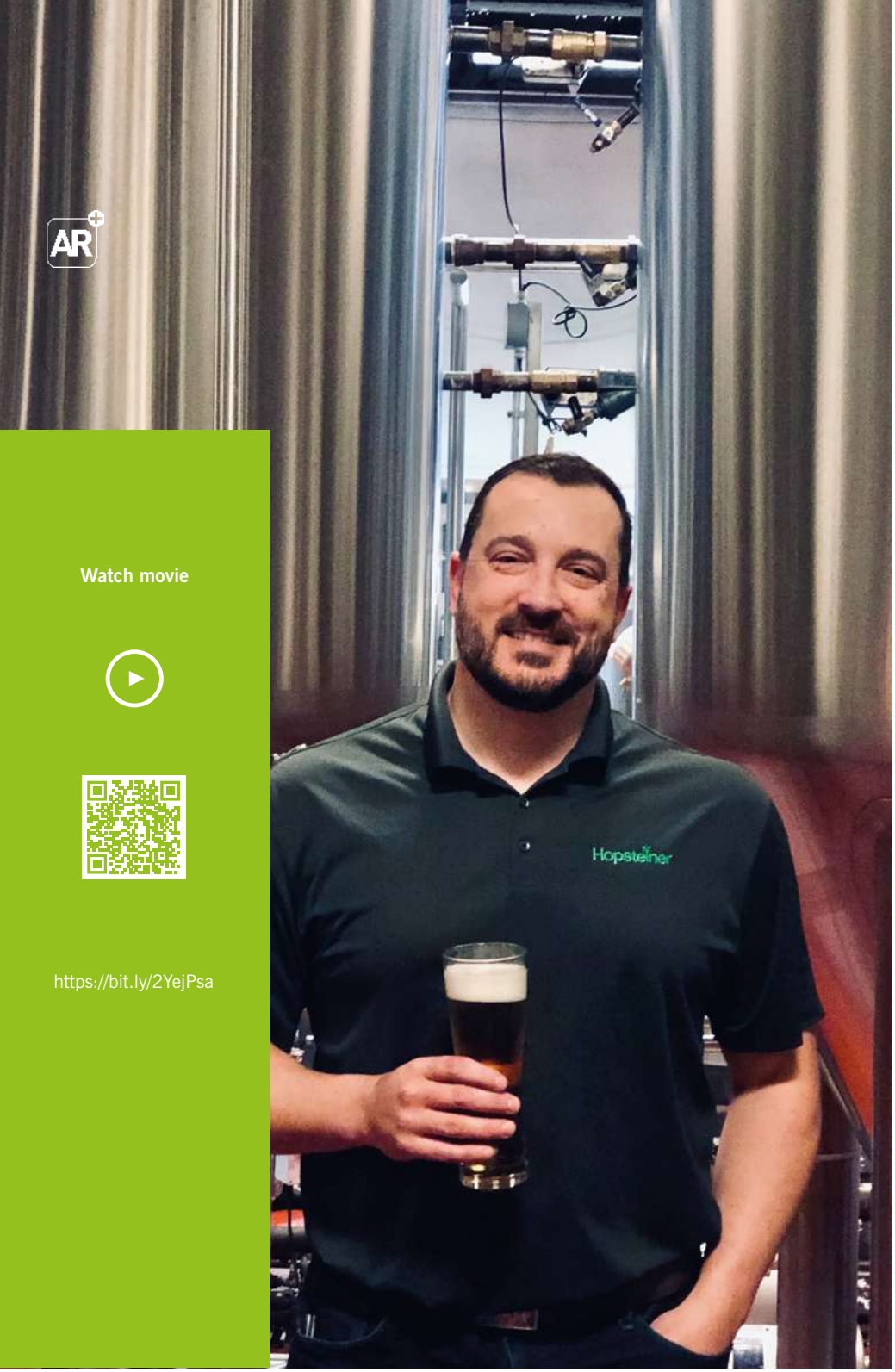
Dave Dunham
General Manager of Hop Processing
at Hopsteiner in Yakima

The best ideas come about in practice – this is how Doug Wilson sees it. The native of Chicago became Regional Sales Manager for the Midwest Region at Hopsteiner in the USA in 2015, and was promoted to Director for Sales and Marketing there in 2018. Wilson is a former Finance Manager who can look back at extensive experience in the brewing industry. Before his move to Hopsteiner he worked at a malt company, and was involved in the practical side of brewing craft beers for a Brewpub chain in his home country. In 2011, his "Münchner Helles" won the silver medal at the Great American Beer Festival.

“My love for hops comes from my love for beer,” he confirms. “Our team brings new aromas, new tastes, new products and new solutions to the world of brewing. Being a part of that still fascinates me today.” He quotes the example of the new “Lotus” hop variety that he, together with his team, are introducing onto the market. Since taking up responsibility for the Hopsteiner USA sales and marketing agendas, Wilson had also belonged to the newly created Innovation Team headed by Joachim Gehde.

Just like Dave Dunham, General Manager of Hop Processing for Hopsteiner in Yakima. In his broadly based area of responsibility, chemists, technicians and master brewers work together.

But, above all, the attitude at Hopsteiner is second to none, enthuses Dunham. “We love hops!”



Watch movie

https://bit.ly/2YejPsa

Our hop allows you to be different and to make a better beer.

Doug Wilson
Director of Sales & Marketing
at Hopsteiner in New York

5
Collaborations

Watch movie

https://bit.ly/2Q5JL51

One of our priorities is the constant optimisation of the products already marketed.

Harald Schwarz
Director of Business Development
at Hopsteiner in New York

Research and development at Hopsteiner does not end with the introduction of a product, but also includes its continuous improvement.

Their tool: the telephone. When it comes to bringing the latest findings from in-house research into the wide world of breweries, the first thing we do at Hopsteiner is to pick up the phone. For example, Sandro Cocuzza, has been the Head of Technical Support in Mainburg since 2008, as well as responsible for collaboration with universities and the technical departments of the breweries, and acts as a link between Hopsteiner researchers and developers and customers. This collaboration can also be world-wide via personal conversations or during the seminars he holds on the subject of hops and brewing. Whatever is researched at Hopsteiner, Cocuzza and his colleagues around the world act as a mouthpiece for the transfer of know-how. In cooperation with universities and research institutes, expertise is expanded and passed on.

If a new product is developed, Sandro Cocuzza and the Technical Support Team, not only provide analytical and sensory support for its introduction, but also take care of its optimal use – often personally on site. Cocuzza then acts as an interface to the brewing technicians, sometimes for many years. This is all on a very personal basis, as he is aware that: "When you look after a customer for several years, you begin to understand the philosophy of a brewery and know how to help to successfully implement the objectives."

His PC, which he always has with him on business trips, provides him with the right tools for each case: from a short, general outline to a two-day seminar. Depending on what the customer needs, Cocuzza takes care of each personalised information package. "Sometimes, in passing, you just meet two people in a brewery, and then before you know it, twenty brewing technicians seize the opportunity to talk to you, because you have flown overseas especially," he says from experience.

Regardless of who asks, whether a committed craft beer brewer or an international corporation, the Hopsteiner experts have the answers, thanks to their close interlinking with in-house research. Sandro Cocuzza has learned that "Whether this results in an open dialogue or a classic lecture also depends heavily on the respective culture". What all seminars have in common is that they are also fed directly from the data and results of in-house research.

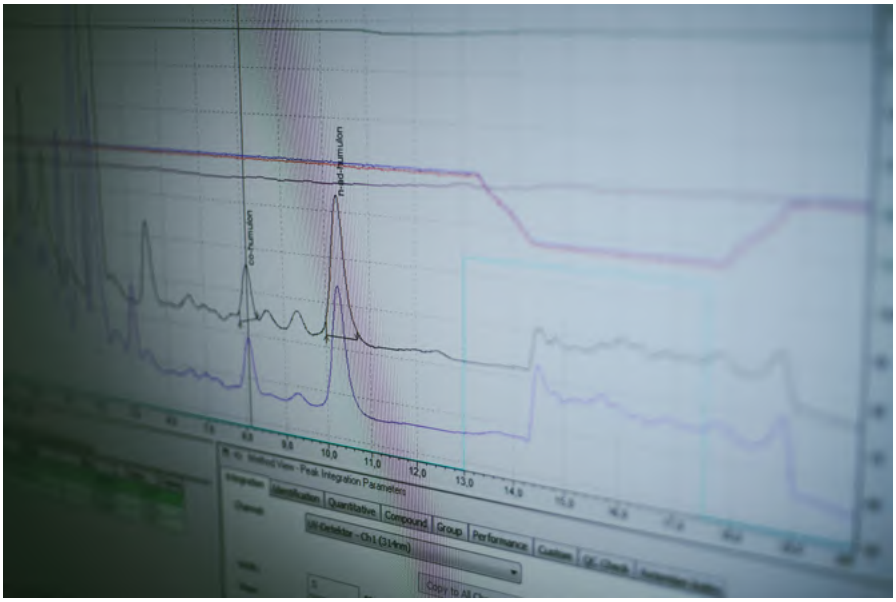
Russell Falconer, who works and researches for Hopsteiner in Great Britain, is also passing on his knowledge to the younger generation. The biotechnologist visited Ethiopia in 2019 and presented the latest in-

novations in the Hopsteiner brewing world at a conference of African brewers: “It was a great opportunity to give something back to the industry,” he recalls. “I can use my technical back-ground to support our research teams in breeding new varieties using genetic markers. This means we can develop plants that are higher yielding and more disease-resistant, and at the same time have an exciting aroma and, in terms of climate, are particularly sustainable.” As a member of the UK Southern Section Management Committee, Falconer regularly presents his findings to the Institute of Brewing and Distilling and writes articles in the institute’s own magazine.

The very specific reference to brewery practice is what readers and seminar attendees all over the world appreciate about the Hopsteiner expertise. For example in the area of special beers or non-alcoholic beers. Here, explains Sandro Cocuzza, it is often a matter of generating the most authentic taste possible using dry hopping. “Our test series provide us with information that we can use to respond to customer requests or at our seminars.” Topics such as dosage, filtration, pasteurisation and the ageing behavior of dry hopped beer are also regularly on the agenda. “What makes a beer ultimately ‘better’ is a matter of individual taste,” admits Cocuzza, “but with our experience and the analytical data obtained from in-house tests, we want to create awareness of the changes that current trends are bringing with them.” Instead of persuading, he prefers to convince his customers. He is helped by the experience he has gained in direct exchange with brewers and the various test series, some of which have been continuously expanded over the years.

Cocuzza and his colleagues at Hopsteiner can also build on their long and close cooperation with the most well known university institutes in the field of brewing technology, such as those in Weihenstephan. Willi Mitter, who previously worked as technical director at Hopsteiner, has held countless lectures during his long career at the TU there, as well as at the TU Berlin and at the Test and Training Institute for Breweries in Berlin (VLB), where Mitter's successor, Frank Peifer has taken over the teaching activities. To this day, Mitter has been training microbrewers at the Institut Français des Boissons et de la Malterie in Nancy, eastern France, and gives regular lectures at the "Salon du Brasseur". Peifer, who has meanwhile advanced to technical director himself, gives lectures at the VLB, worldwide from South Africa to Argentina and at the Weihenstephan Research Centre for Brewing and Food Quality (BLQ), at the University of Ghent in Belgium, the brewery school in Ulm, and at Kiesbye's beer culture house in Obertrum near Salzburg. Mike Sutton, Vice President at Hopsteiner USA in Germantown, Tennessee, shares his knowledge and experience when he lectures on hop products and the art of dry hopping at the University of Wisconsin at Madison as part of the Master Brewers Association of the Americas (MBAA).

This close connection to universities has also shown very concrete results: Under Sandro Cocuzza's leadership, for example, in the summer of 2019, in collaboration with Weihenstephan scientists, they investigated how dry hopping affects the chemical-physical properties of beer. For this purpose, the in-house pilot brewery produced six hectolitres of pale ale, which were dry hopped using various amounts of pellets and checked for criteria such as bitter substances, alpha acids, xanthohumol, alcohol content, pH value and foam stability. An important finding was in addition to the positive effects on the aroma, dry hopping with pellets also has an influence on the non-volatile matrix; the composition of the bitter substances shifts, for example, and losses of iso-alpha acids could be linked to the plant material introduced. "The side effects of dry hopping have been little researched so far, and we were able to close such a gap," says Cocuzza happily.



Another pillar is the constant optimisation of products that are already on the market, for example with respect to the issue of best before date. “Our realtime storage attempts are sometimes similar to openheart surgery,” says Cocuzza with a laugh. At Hopsteiner, research and development do not end with the introduction of a product, but also include its continuous improvement.

This also applies to sustainability. If a product leads to more efficiency in a brewery, this not only increases customer satisfaction, but also leads to a more economical use of resources and creates an incentive to deal with new approaches, says Cocuzza. It is also about being as open-minded as possible. The philosophy behind his approach has a lot to do with respect for the brewing art of his customers: “We don't want to tell anyone how to brew their beer.” But it is always important to have a sympathetic ear. After all, according to Cocuzza, “many of the best ideas come to us quite simply in conversation.”

Watch movie

https://bit.ly/3I2B4XA

We have a global innovation team, that helps us to share ideas and to go further.

Russell Falconer
Managing Director
at Hopsteiner in Epping

You want to know more about breeding, research, brewing, development and our way of working together? Here in the enclosure we have provided interesting articles and more detailed information for you. You can easily access this information via the attached short links.
Please also visit our special page for the R&D Report report.hopsteiner.de, to discover more.

1

Breeding

01/01 **DOWNY MILDEW RESISTANCE IS GENETICALLY MEDIATED BY PROHYLACTIC PRODUCTION OF PHENYLPROPANOIDS IN HOP: Resistance in hop against downy mildew is conferred by the constitutive abundance of protective phenylpropanoids. The co-localization of the resistance loci and the phenylpropanoid pathway markers indicate that these molecules contribute to the principle downy mildew defense mechanism in hop.**
https://bit.ly/3mxYELK

01/02 **NEW TOOLS FOR HOP CYTOGENOMICS: Identification of Tandem Repeat Families from Long-Read Sequences of Humulus lupulus: Hop (Humulus lupulus L.) is known for its use as a bittering agent in beer and has a rich history of cultivation, beginning in Europe and now spanning the globe.**
https://bit.ly/3jzDsTH

01/03 **AKOYA – AN ANSWER TO CLIMATE CHANGE?: Due to its yield stability and resistance, the new hop variety Akoya is nothing less than an important answer to climate change, which opens up new perspectives for growers, marketers and breweries. Besides variety characteristics, more information of our breeding program also tasting results from BRAU BEVIALE 2018 are shown.**
https://bit.ly/31RdDIs

01/04 **HOPSTEINER BREEDING ACTIVITIES - GERMANY: We are developing new hop varieties suitable for efficient and sustainable hop growing and introduce them in both the established & dynamic Craft market. The breeding objectives are based on agronomic aspects and are bred to meet the continuously changing demands of customers, changing environment as well as innovative processing & products.**
https://bit.ly/2PPcUBp

01/05 **NON-MENDELIAN SINGLE-NUCLEOTIDE POLYMORPHISM INHERITANCE AND ATYPICAL MEIOTIC CONFIGURATIONS ARE PREVALENT IN HOP: To better understand the transmission genetics of hop, we genotyped 4512 worldwide accessions of hop, including cultivars, landraces, and over 100 wild accessions using a genotyping-by-sequencing (GBS) approach.**
https://bit.ly/3aqNmnB

01/06 **3D MOLECULAR CYTOLOGY OF HOP (HUMULUS LUPULUS) MEIOTIC CHROMOSOMES REVEALS NON-DISOMIC PAIRING AND SEGREGATION, ANEUPLOIDY, AND GENOMIC STRUCTURAL VARIATION: To explore the role of meiosis in segregation distortion, we undertook 3D cytogenetic analysis of hop pollen mother cells stained with DAPI and FISH.**
https://bit.ly/3fYoS68

01/07 **LEMONDROP - THE NEW HOPSTEINER AROMA VARIETY: Hopsteiner has released an exciting new hop variety bred and trialed in the Yakima Valley of Washington State - U.S.A. Lemondrop has been planted to commercial production for the 2014 growing season, and contracts can now be made for the 2015 crop year and forward.**
https://bit.ly/2Y07ace

01/08 **NEXT GENERATION SEQUENCING FOR A PLANT OF GREAT TRADITION: Application of next generation DNA sequencing technology to hops yielded an unprecedented, large number of novel single nucleotide polymorphisms (17, 128 SNPs). The markers were detected and then validated for use in genotyping and control of quality for hops.**
https://bit.ly/3iATrk0

2

Research

02/01 **THE IMPACT OF DIFFERENT HOP COMPOUNDS ON THE GROWTH OF SELECTED BEER SPOILAGE BACTERIA IN BEER: To investigate the impact of seven different hop compounds on the growth of six major beer spoilage bacteria, two concentrations (10 and 25mg/L) of each hop substance were added to unhopped beer.**
https://bit.ly/2JhYfyC

02/02 **MICROBIOLOGICALLY IMPORTANT COMPONENTS IN HOPPY BEERS - PART 1: Hops as raw material contribute significantly to microbiological stability of beer. In the present contribution, determination of a socalled hopbased inhibitory power is described in order to assess the antimicrobial potential of beer.**
https://bit.ly/2PUFdyI

02/03 **MICROBIOLOGICALLY IMPORTANT COMPONENTS IN HOPPY BEERS - PART 2: In the second part of this publication, the relevance and significance of this inhibitory power based on commercial-scale tests is discussed.**
https://bit.ly/2PP7beM

02/04 **XANTHOHUMOL – A MILESTONE IN RESEARCH: Die erste Publikation über eine gesundheitlich positive Wirkung von Xanthohumol erschien 1997, also vor exakt 20 Jahren. Damals berichteten japanische Forscher über die Hemmung eines Enzyms, das den Fettstoffwechsel negativ beeinflusst.**
https://bit.ly/3fVZY7e

02/05 **LC-MS-MS ANALYSIS OF HOP FLAVONOIDS IN DRY-HOPPED BEERS: To monitor selected hop flavonoids in dry-hopped beers, an in-house HPLC-MS/MS method was developed. Dry-hopped beers produced with different hop varieties showed significant differences in their hop flavonoids pattern.**
https://bit.ly/30Tv4s2

02/06 **SYSTEMATIC MONITORING OF RESIDUES: In order to assure sufficient high-quality harvests, use of some pesticides is required in agriculture. Quantities and times of application are subject to strict legal stipulations, with the objective of having as little residues as possible on harvested goods and on food prepared with same.**
https://bit.ly/3gXpP01

02/07 **HEADSPACE TRAP GC-MS ANALYSE DER HOPFENAROMASTOFFE IN KALTGEHOPFTEN BIEREN: Die anhaltende Beliebtheit kaltgehopfter Biere und die dafür unerlässlichen besonderen Hopfensorten mit vielfältigem Aroma erfordern eine analytische Charakterisierung des Hopfeneinflusses auf das Aroma von kaltgehopften Bieren. Die Methodik der Headspace Trap Gaschromatographie Massenspektrometrie (HS Trap GC-MS) wurde entwickelt, um dieser Fragestellung gerecht zu werden.**
https://bit.ly/3anIJMh

02/08 **HEADSPACE TRAP GC-MS ANALYSIS OF HOP AROMA COMPOUNDS IN BEER: A headspace (HS)-trap gas chromatography (GC)-mass spectrometry (MS) method was developed to investigate dry hopping aroma in beer. Analysis of monoterpenes, sesquiterpenes, terpene alcohols, esters, and ketones was performed.**
https://bit.ly/31Twnau

02/09 **MIKROBIOLOGISCH BEDEUTSAME INHALTSSTOFFE TEIL 1: Der Rohstoff Hopfen trägt wesentlich zur mikrobiologischen Stabilität von Bier bei. Im vorliegenden Beitrag wird die Ermittlung einer sogenannten hopfenbasierten Hemmkraft zur Einschätzung des antimikrobiellen Potentials von Bier beschrieben.**
https://bit.ly/2DIzOYN

02/10 **MIKROBIOLOGISCH BEDEUTSAME INHALTSSTOFFE TEIL 2: Nun werden Relevanz und Aussagekraft dieser Hemmkraft auf Basis von Praxisuntersuchungen diskutiert.**
https://bit.ly/31Ss9Pn

02/11 **HUMULINONE FORMATION IN HOPS AND HOP PELLETS AND IST IMPLICATION FOR DRY HOPPED BEERS: Humulinones are a natural hop bitter acid that can be found in leaf hops, and their concentration can increase over several days following hop pelleting.**
https://bit.ly/3kKkVWn

Winner MBAA Annual Conference 2015 for Best Paper Honorable Mention

02/12 **INFLUENCE OF PICKING DATE ON THE INITIAL HOP STORAGE INDEX OF FRESHLY HARVESTED HOPS: The aim of this study was to focus on the varietal and seasonal differences found in the initial hop storage index (HSI) of freshly harvested hops.**
https://bit.ly/310zWvD

02/13 **HARTHARZE - NEUE ERKENNTNISSE ÜBER EINE ALTBEKANNTE HOPFENFRAKTION: In den letzten Jahren wurden bei Xanthohumol und anderen Prenylflavonoiden des Hopfens diverse physiologisch und pharmakologisch positive Eigenschaften entdeckt. Diese Verbindungen liegen alle im Hartharz von frischen Hopfen vor und bilden sogar dessen Hauptbestandteile.**
https://bit.ly/2DR7YcM

02/14 **HARD RESINS: New findings about a familiar hop fraction in recent years, diverse positive physiological and pharmacological properties have been discovered in the xanthohumol and other prenylflavonoids in hops. All these compounds are in the hard resin of fresh hops and are even their main components.**
https://bit.ly/2DR7YcM

3

Brewing

03/01 **INNOVATIVE TECHNOLOGY TO REDUCE BEER LOSSES AT DRY HOPPING: The BrauKon HopSteiner (already presented as BeerCleaner) is an economical alternative for the separation of hop trub particles.**
https://bit.ly/2G8WC59

03/02 **THE IMPACT OF DRY HOPPING ON SELECTED PHYSICAL AND CHEMICAL ATTRIBUTES OF BEER: The scope of this study was to investigate how incrementally increasing dosing rates for dry hoping up to 1500 g/hl with type 90 Cascade pellets affects selected chemical and physical characteristics of beer.**
https://bit.ly/2Y0KkI7

Winner Ludwig Narziss Award 2020 (Brewing Science)

03/03 **INFLUENCE OF FILTRATION ON DRY-HOPPED BEERS: Dry hopping has become popular due mainly to the craft beer boom in recent years. New hop varieties that bring special aromas to beer can be optimally exploited via the process of dry-hopping.**
https://bit.ly/2TMbZUp

03/04 **HIDDEN SECRETS OF THE NEW ENGLAND IPA: New England India Pale Ale (NEIPA), also known as hazy IPA or juicy IPA, is a relatively new beer style being brewed by craft breweries across the United States.**
https://bit.ly/3iGRLWe

Winner MBAA Brewing Summit 2018 for People's Choice for Best Paper at the Conference

03/05 **DRY HOPPING POTENTIAL OF EUREKA! A new hop variety: To monitor the dry hopping potential of the new hop variety Eureka! Brewing trials were performed and observed in detail.Static dry hopping was done for 1, 2, 4, and 8 days.**
https://bit.ly/2PYuJhb

03/06 **EINFLUSS DER FILTRATION AUF HOPFENGESTOPFTE BIERE: Ziel des Hopfenstopfens ist es, den Bieren ein besonderes Hopfenaroma zu verleihen. Die so eingebrachten Aroma- und Bitterstoffe durchlaufen jedoch kontinuierliche Veränderungen. Auch die Filtration spielt hier eine wichtige Rolle.**
https://bit.ly/33ZbUTt

03/07 **DRY HOPPING AND ITS EFFECTS ON BEER FOAM: To better understand the impact dry hopping can have on beer foam, a series of dry hopping experiments were performed and foam measurements were made to see what factors effect beer foam stability.**
https://bit.ly/3fSeCwd

03/08 **AUF DER SPUR VON HARTHARZKOMPONENTEN: Die Kalthopfung ermöglicht einen effizienten Übergang dieser Substanzen aus dem Hopfen ins Bier. Um welche Verbindungen es sich handelt und welchen Geschmacksbeitrag sie zur Bierbittere leisten, beschreibt dieser Artikel.**
https://bit.ly/3anHcEG

03/09 **DRY HOPPING AND ITS EFFECTS ON BEER BITTERNESS, THE IBU TEST, AND PH: Dry hopping is very popular among craft brewers, however, few realize that it can significantly alter the hop acid composition of beer which can effect a beer's bitterness and interfere with the IBU Test.**
https://bit.ly/33WQk1W

03/10 **BAG OPENED AND THEN ... ?: What will happen to bitter and aroma substances once the bag has been opened? And does the temperature at which the open bag is stored has have a significant effect?**
https://bit.ly/2JhUYiL

03/11 **SIMPLE, YET EFFECTIVE: The extraction of essential oils from hops flowers is a lot more difficult than from pellets, which dissolve more readily, even in cooled brew. Both materials present the same problem of particles binding a significant quantity of beer, leading to volume loss. This article attempts to address the issue of reducing these losses through the proper deployment of a Beer Cleaner.**
https://bit.ly/2Yhwjj9

03/12 **HOW TO PREDICT THE HOP AROMA PROFILE IN DRY-HOPPED BEERS?: The present study investigated the possibility of cold water extraction of hop pellets for predicting the hop aroma composition in dryhopped beers. Therefore a lab scale evaluation method for the determination of the dry hopping potential of different varieties was tested.**
https://bit.ly/30VDTS3

03/13 **EINFACH ABER EFFEKTIV: Die Extraktion der Hopfenöle ist bei Dolden wesentlich schwieriger, während sich Pellets auch im kalten Bier relativ leicht auflösen. Bei beiden Produkten stellen die Hopfenpartikel das gleiche Problem dar. Diese adsorbieren eine nicht unerhebliche Menge an Bier. Die Folge sind hohe Bierverluste, die mithilfe des in diesem Artikel beschriebenen Beer Cleaners deutlich reduziert werden können.**
https://bit.ly/3iGS3wi

03/14 **REDUCTION OF BEER LOSSES AFTER DRY HOPPING: With a special sieve, herafter referred as „Beer Cleaner", even very small particles can be seperated from the beer and removed. Consequently, only the beer, which was absorbed by the hops is lost. The function of the Beer Cleaner is described below.**
https://bit.ly/3an9m2y

03/15 **DRY HOPPING AND BARREL AGING - A COLLISION OF AROMAS OR SYNERGISTIC HARMONY?: Inspired by a lecture they attended at the Bierkulturhaus in Obertrum, Austria, the authors of this article decided to delve deeper into the subject of combining maturation on oak with dry hopping. The particular challenge, in this case, was to discern what influence the oak has on the beer and to find a hop variety or a hop product that would complement the aromas and flavors imparted by the wood.**
https://bit.ly/3at54aa

03/16 **DIE BITTERE HOPFENGESTOPFTER BIERE: Aktuell werden vermehrt Biere produziert, bei denen der Hopfen im Kaltbereich eingesetzt wird, um spezielle Biertypen herzustellen. In diesem Artikel werden einige Erkenntnisse bezüglich des Verhaltens der wichtigsten Bitterstoffe in hopfengestopften Bieren vorgestellt.**
https://bit.ly/31MwrrE

03/17 **HOPFENSTOPFEN UND HOLZFASSLAGERUNG - KONKURRENZ ODER ZUSAMMENSPIEL UNTERSCHIEDLICHER AROMEN?: Angeregt durch die Einladung zu einem Vortrag über Hopfenstopfen und Holzfasslagerung im Bierkulturhaus, Obertrum/Österreich, befassten sich die Autoren dieses Artikels eingehender mit dieser Materie. Die besondere Herausforderung war hierbei, den Einfluss von Eichenholz und passender Hopfensorte bzw. Hopfenprodukt zu finden. Darauf aufbauend wurde in einer zweiten Versuchsreihe der Einfluss der dosierten Hopfenmenge sowie der Lagerzeit des Bieres genauer beleuchtet.**
https://bit.ly/2PU9b5n

03/18 **HERKULES AND POLARIS - A COMPARISON OF QUALITY OF BITTERNESS: The licensing fee for the hop variety Polaris will be dropped with effect from crop 2015 onwards. Consequently, Polaris may now be considered as an alternative bittering variety. Therefore, at this year's Hopsteiner Forum in July 2015 a selection of two Pils beers were presented to an audience of brewers and brewing scientists to show the impact on bitter quality by using either Polaris or Herkules.**
https://bit.ly/3fQDKUg

03/19 **WELL-ROUNDED SENSORY EVALUATION: Both the multifaceted aroma of new hop varieties and the increasing popularity of dryhopped beers mean that the definition of the sensory characterisation of how hops influence beer aroma and beer flavor needs to be revised.**
https://bit.ly/3iDX8FM

03/20 **FLAVORRA(T)D BEI SENSORISCHER VIELFALT: Das vielfältige Aroma neuer Hopfensorten einerseits sowie die zunehmende Beliebtheit kaltgehopfter Biere andererseits erfordern eine Anpassung der Deskriptoren zur sensorischen Charakterisierung des Hopfeneinflusses auf das Bieraroma und den Biergeschmack. Das Hopsteiner Flavorrad wurde mit dem Ziel entwickelt, dieser Fragestellung nachgehen zu können.**
https://bit.ly/30WqKZ6

03/21 **A NATURAL FOAM ENHANCER FROM HOPS: This study shows that alpha acids can enhance the foam stability and lacing of beers, similar to tetrahydro-isoalpha acids and better than isoalpha acids or propylene glycol alginate (PGA). Foam stability measurements were made using the NIBEM-T foam tester via EBC test method 9.42.**
https://bit.ly/30SF1WC

03/22 **INFLUENCE OF DIFFERENT HOP PRODUCTS ON THE CIS/TRANS RATIO OF ISO-α-ACIDS IN BEER AND CHANGES IN KEY AROMA AND BITTER TASTE MOLECULES DURING BEER AGEING: Ilsomerization of α-acids from hops can result in different ratios of cisto trans-iso-α-acids. In contrast to oxidative degradation processes, the conversion of iso-α-acids to tri- and tetracyclic compounds during beer ageing is only possible in the trans form.**
https://bit.ly/2G7Fw7A

Winner Eric Kneen award for Best Paper published in JASBC in 2014

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