SCIENTIFIC COMMISSION OF THE INTERNATIONAL HOP GROWERS´ CONVENTION

COMMISSION SCIENTIFIQUE DU COMITE INTERNATIONAL DE LA CULTURE DU HOUBLON

WISSENSCHAFTLICHE KOMMISSION DES INTERNATIONALEN HOPFENBAUBÜROS

Report on the meeting of the Scientific Commission of the I.H.G.C. from 24 – 29 June 2007 in Tettnang and the Hallertau region, Germany

Elisabeth Seigner

58 scientists and representatives of the hop and brewing industry from 14 different countries all around the globe joined the meeting of the Scientific Commission in Tettnang, Germany from 24 - 28 June 2007.

The hop scientists presented 23 lectures and 21 posters covering the following topics:

- Hop breeding
- Developmental physiology
- Hop chemistry
- DNA-based methods in hop research
- Hop diseases and pests
- Hop production
- US Hop Research Council

This meeting of the SC has proven once more to be a valuable forum for bringing together hop experts with different backgrounds and responsibilities with their partners from the hop and brewing industry to discuss and develop strategies how to cope with future challenges concerning the growers and the hop market.

At the beginning of the meeting Dr. Johann Pichlmaier, President of the Association of German Hop Growers, Dr. Reinhold Kugel from Joh. Barth & Sohn as well as Dr. Willy Buholzer from Anheuser-Busch presented their views on the impact of hop research on their sectors of the economy from the perspective of the hop growers, the hop traders and processors and the breweries. All speakers clearly emphasized the importance of hop research to constantly improve the world market product “hops”.

Session I: Hop Breeding

High yield, excellent brewing quality and an increased level of resistance to diseases and pests are the objectives in all hop breeding programs. From the economical point of view high alpha varieties are imperative, however aroma varieties are increasingly demanded by brewers for beers of the premium sector. Thus, breeding for aroma varieties has regained importance, as the breeding programs from England, New Zealand and the Czech Republic have shown. Dwarf hops are the basic requirement for growing hops on low trellis systems which offer markedly lower production costs and many environmental benefits.

Therefore breeding of dwarf hops which are adapted to this new trellis system is crucial so that growers can exploit the advantages of this new growing system in order to increase their competitiveness on the international markets. A strategic important aim is the development of hop varieties with high beta acids contents or specific prenylflavonoids such as Xanthohumol which opens alternative, non-brewing applications in the pharmaceutical section or others. In addition, these hops rich in polyphenolics are demanded by the brewing industry due to their special impact on beer quality.

Broad disease resistance is first priority in all varieties. Thus, various methods for selection of resistance to the most important fungal diseases have been presented and discussed in detail.

The extension of genetic resources for breeding and in particular the search for new sources of disease and drought resistance have been the incentives to screen wild hops collected from various regions of origin throughout Europe, Asia, Australia and North America.

Wild hops have been assessed comprehensively for disease resistance, bitter and aroma quality and for agronomic performance as well over several years. In this way especially for resistance to powdery mildew new, so far unexploited sources have been detected. Moreover, a large pool of different adaptation abilities to other pathogens and to dryness have been found. Wild hops are the crucial supplement of the existing hop germ plasm consisting of cultivars and breeding lines. This reservoir has to be conserved, maintained and permanently increased in order to be able to ensure the adaptation of hop varieties to the constantly changing demands from the hop and brewing industry on resistance and quality characteristics by hybridization. Furthermore, a broad germ plasm also allows to adapt to climatic changes.

Session II: Developmental Physiology

Hormonal changes which induce the switch from the vegetative to generative phase in hop have been elucidated till the start of flowering. Sound knowledge is necessary to understand the developmental processes in order to be able to control the formation of cones in the future.

Session III: Hop Chemistry

Prenylflavonoids have aroused public interest. Among them in particular Xanthohumol has shown a multitude of health promoting effects in medical studies. Its anticarcinogenic properties have been investigated in detail. The first commercial hop extracts rich in Xanthohumol (up to 95 %) are available.

Also in the brewing process polyphenols which encompass the above mentioned prenylflavonoids have got more attention. Due to their high antioxidative activity they are providing stability to beers. Therefore it was investigated in detail at which step from hop drying till pelleting and long-term storage polyphenols and with them antioxidative potential gets lost.

In another paper the chemical data of bitter acids and Xanthohumol of some hop cultivars has been compiled and statistically evaluated. Using chemometrics the classification of hop cultivars has been conducted and in this way the authenticity of hop samples could be confirmed.

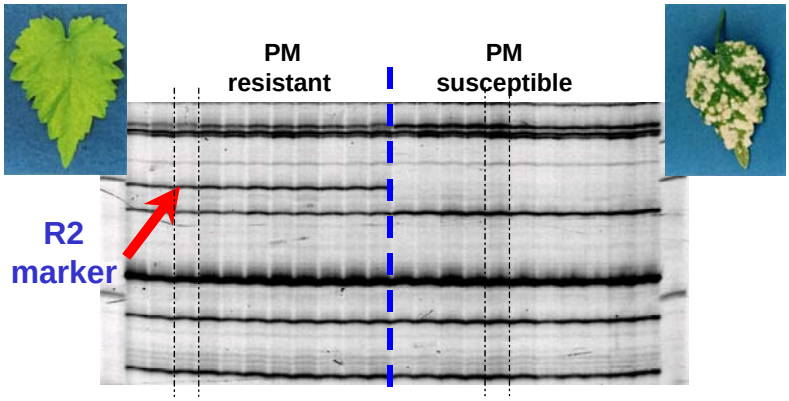
Further knowledge has been presented concerning the biosynthesis of bitter acids. Profound knowledge about the various enzymes and key precursors involved in the biosynthesis of beta and alpha acids is of great interest for breeders and molecular biologists.

Session IV: DNA-based Techniques in Hop Research

The molecular characterization of the hop genome progresses rapidly. Genetic maps of hops from all sorts of genetic background encompassing American, European and Japanese/Chinese germ plasm have been generated using the AFLP (amplified fragment length polymorphism) and SSR (simple sequence repeats) techniques. Only recently also the Diversity Array technology (DArt) has been established for genotyping *Humulus lupulus*.

The abundance of data produced here is crucial in evaluating the genetic variability, breeders are interested in, and in controlling the quality of hop samples for hop traders and brewers. Furthermore, genome analytical work is focused on the identification and mapping of loci conferring resistance to powdery mildew or *Verticillium* spp. and of sex specific markers. At a progressive rate also QTLs are developed for alpha acids content.

Molecular markers in breeding are either already in practical use or are just before being applied. Since the benefits of marker assisted selection are obvious: Molecular markers simplify the selection step and thereby the whole breeding procedure by allowing a reliable, efficient and rapid selection of crossing partners and breeding lines within the progenies.



genetic fingerprints

Based on the findings that resistance genes in all crops share similar or equal DNA sequences in hops new ground has been broken to develop reliable, highly informative selection markers for disease resistance. Applying the cDNA-AFLP analysis in combination with the so-called “differential display” genes can be detected which are directly involved in pathogen defense and subsequently reliable markers for these resistance-related genes can be produced. In addition, using specific (degraded) PCR primers the genetic material of hop has been screened for similarities to resistance genes (R) with other plants which may be involved in pathogen defense. These homologous sequences to R genes will provide highly informative resistance markers in the future.

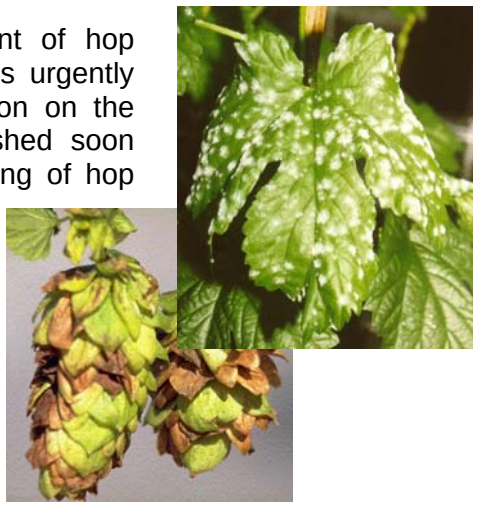
Molecular techniques were used to study the sequences and the expression of functional genes involved in resistance processes, but also to elucidate metabolic processes in which the brewing or pharmaceutical industry are interested. So – for example - the real-time PCR has been applied to verify candidate genes which possibly are part of the biosynthetic pathway to Xanthohumol and other prenylchalkones.

Gene transfer may be a perspective for the future. The first transgenic hop plants carrying newly introduced resistance genes like stilbene synthase from vitis and hop or bacterial derived chitinases could be developed. Improved, more durable disease resistance and the switch of specific pathways – e.g. to increase the amounts of alpha and beta acids or Xanthohumol which meets the demands of the market – are objectives for the future which can only be achieved via gene transfer.

Taking the chalcone synthase, a key enzyme in the biosynthesis of bitter acids and prenychalcones (like Xanthohumol) hop researches examined the complex regulatory processes. Comprehensive knowledge on the various regulatory elements pave the way for controlling the biosynthesis of economically important substances through gene transfer in the future. This would be the first step towards a “tailored” hop variety.

Session V: Diseases and Pests in Hop

The climatic changes which occurred more and more significantly in recent years were conducive for the occurrence of pests like *Psylliodes attenuata* which was hardly a problem in hop yards in former times.



There is consensus that for an efficient management of hop diseases and pests information as much as possible is urgently needed. A compendium with comprehensive information on the various hop diseases and pests which will be published soon provides support in this field. Moreover, a precise typing of hop pathogens is necessary to select the right and appropriate control strategy. Following this objective powdery mildew, downy mildew, *Verticillium* strains, *Fusarium* species and also various hop viruses have been identified and characterized using conventional, biochemical (e.g. protein pattern) and molecular techniques (PCR), respectively.

Investigations clearly showed that aphid populations in the Czech Republic and in other countries have already evolved resistance to Imidacloprid, the main substance to control aphids. Especially in hot summers aphids cause severe damage in hop yards. This clearly shows that the registration of new, fully effective aphicides is urgently needed. In organically produced hops Quassia is a very promising means to control aphids. The official EU-wide registration of a standardized Quassia-based product it still missing, but would be highly appreciated also as alternative control for conventionally grown hops.

The harmonization of the registration of pesticides in order to reduce trade restrictions on the international hop market is urgently needed. One key point to promote the EU wide registration of new pesticides is the mutual acceptance of efficacy studies in all EU countries. Standardized methods for the application and dose specifications were compiled in a paper presenting the basics which should be fixed in the EPPO guidelines.

Measurements of pesticide residues conducted each year with randomly taken hop samples confirm that residues of registered pesticides are well below maximum residue levels which means that for hops and hop products food safety is guaranteed at the highest level.

Session VI: Hop Production

Two presentations provided new findings how irrigation can stabilize hop yield and quality and how a modified trellis system can effect stability and the economic efficiency.

Session VII: US Hop Research Council (www.hopresearchcouncil.org)

A report on the mission and current Hop Research Council (HRC) projects has been given to enhance communication between the HRC and the Scientific Commission of the IHGC. The US Hop Council encompassing brewers, hop dealers and hop growing organizations supports research that meets the needs of its members. Current priorities include improvement of agronomic and quality traits, lower cost of production and processing, and elimination or control of diseases and pests of U.S. hops.

Excursions and information around the hop growing regions of Tettnang and the Hallertau:

On their excursions to a hop farm and to the hop research field Strass and during their visits of the hop museum in Tettnang and Wolnzach the participants of the meeting learned a lot about structure, special features and the tradition of hop growing in the Tettnang and Hallertau region.

Guided tours at the Hop Research Center, at the Hallertau hop processing firm of Hopsteiner as well as in the pellet plant in St. Johann, which is jointly operated by J. Barth & Sons and the HVG Hopfenverwertungsgenossenschaft e.G., completed the picture of hop growing in Germany. Furthermore, the delegates were guests at the “House of Hops” and could learn more about the HVG in its task and obligations as hop producer association.

In all visits and guided tours the close connections of practice-oriented research, hop growers and hop processing firms became quite obvious which are the key elements for the success of German hop and hop products on the international market.

I hope that all delegates got a lot of useful information in the lecture part as well as the excursion part of the meeting. So that the abundance of information and new ideas can be taken home together with possibly already existing concepts in mind to conduct joint projects with partners from the hop and brewing world.

The Scientific Commission wishes the best of luck and success in all fields of hop research.

Dr. Elisabeth Seigner July 2007
Secretary, Scientific Commission, IHGC