

**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 21 – 25 June 2009
in León, Spain,**

Elisabeth Seigner

The Scientific Commission (SC) of the International Hop Growers´ Convention holds a meeting for scientists and experts from the hop and brewing world every two years. This time, Spain was our host country and we were invited by the S.A. Española de Fomento del Lúpulo. This private organization whose shareholders are Spanish brewers and growers supports hop production and hop trade in Spain.



Therefore, 51 scientists and representatives of the hop and brewing industry from 14 different countries all around the globe came to León, Spain, from 21 - 25 June 2009 to be informed about the latest research works in hop. Mr. Bernhard Engelhard and Dr. Elisabeth Seigner from the Hop Research Center Hüll, Germany, as chairman and secretary of the SC, respectively were involved in the organization of the meeting. In Spain all preparations were in the hand of Mr. José A. Magadan, the technical manager of the S.A. Española de Fomento del Lúpulo.

As always the objective of this event was to support the exchange of information and ideas for the sake of the hop and brewing industry.

In the scientific part 23 papers and 17 posters were presented covering the following topics: hop breeding, DNA-based studies in hop research, hop diseases and pests, chemical analysis of hop compounds and hop production. The excursion at the end of the meeting gave the opportunity to all participants to get comprehensive on the hop production in Spain and on the S.A. Española de Fomento del Lúpulo and its fields of activities.

This meeting of the SC used once again by hop scientists from the various research fields and their partners from the hop and brewing industry to come together to discuss and develop strategies how to cope with future challenges concerning the growers and the hop market.

All contributions of the Proceedings are published online. Please see: <http://www.lfl.bayern.de/ipz/hopfen/10585/index.php>. A list of all papers and posters presented during the meeting of the Scientific Commission can be found below this summary.

Session I: Hop Breeding

Classical cross breeding is still the basis in developing hop cultivars which meet the demands and needs of the hop and brewing industry. Broad resistance to diseases and pest is a major objective in all breeding programs. The development of the aphid-resistant English dwarf cv, "Boadicea" is a big success in this field. Also the Hüll high alpha cultivar "Herkules" represents a considerable progress in breeding. The fast and efficient combination of resistance with other economically crucial traits is only possible if based on comprehensive understanding of the inheritance of the relevant features and the genes involved.

Furthermore a computer-assisted multi-criteria decision making model has been presented for the assessment of hybrids aiming to simplify and accelerate the selection process.

Screening of wild hops with world-wide origin revealed – as so often - a wide genetic variability which holds promise to offer crossing partners with new chemical compounds, stress and disease resistance.

Session II: DNA-Based Studies in Hop Research

Particularly in breeding for resistance to powdery mildew and *Verticillium* classical breeding methods are completed by histochemical and molecular-based studies. Research is focused on the revelation of the various mechanisms involved in resistance reactions and on the identification of sections within the genetic material associated with disease resistance. Meanwhile, cDNA-based studies (gene expression approaches) are highly promising in detecting active defense related genes which are to be verified in their function in subsequent transformations (transient assays). Derived from those pathogen induced gene sequences cDNA markers are elaborated which are much more reliable and highly informative in the selection process in comparison to markers developed so far. In addition, there are efforts to utilize homologous sequences in resistance and regulator genes known from other crops and published in comprehensive data bases in hops to detect similar sequences in the hop genome to design selection markers or to generate gene constructs for transformation approaches. Also proteins ("proteomic approach") are looked for which contribute to pathogen defense.

Similar "genomic" and "proteomic" investigations are being conducted in the field of hop chemical compounds by several research groups. Here they are looking for DNA sequences or proteins involved in the regulation or synthesis of secondary metabolites which are produced in lupulin glands e.g. xanthohumol, desmethylxanthohumol und 8-prenylnarigenine. Clinical and medicinal studies have proven the anti-cancerogenic, anti-inflammatory and anti-oxidative effect of these flavonoids and the estrogenic action of 8-prenylnarigenine. Thus, these hop compounds would be suitable for an alternative, broad application in various pharmaceutical-medicinal fields. Objective of all these studies is to create hops with higher contents of the various bioactive flavonoids – within classical breeding programs supported by molecular assisted selection (MAS) or by genetic engineering. A research groups gave an account on the first transgenic "Tettngang" hop plants possessing an altered phenotype and a modified composition of flavonoids after the insertion of a regulatory factor from *Arabidopsis*.

Using in vitro propagation, *ex situ*-preservation in tissue culture, meristem culture to eliminate virus infections and genetic engineering *in vitro* steps are involved in all cases. Thus, questions are raised concerning the stability of the genetic make-up and the impact of epigenetic effects. Investigations in various laboratories showed that those changes and genetic alteration had to be kept in mind and took place, especially after longer *in vitro* phases. To improve and accelerate the crucial steps during the *in vitro*-regeneration process,

transcriptional and metabolic studies (“transcriptomic and metabolomic approach”) were conducted to learn more about the various genes activated during this developmental phase and the concomitant metabolic changes.

Session II: Diseases and Pest in Hops

Hop scientists showed their multi-faceted systems approaches to control new and also well-known diseases and pests aiming to prevent dramatic loss of yield and quality in hop production. Pathogenicity tests and molecular differentiation of specific fungal pathogens are key elements of a successful disease management. In controlling downy and powdery mildew which are the most important hop diseases these management efforts include the development of model-aided control treatments and their introduction in practice. New findings in the epidemiology of the fungal diseases which have been the result of these research activities in part call for modified cultural practices.

Due to the limited number of effective pesticides and due to ecological and economical aspects as well risk-based control measures are becoming more important and are being used by hop growers more and more. While controlling damson-hop aphids by using a revised control threshold it became obvious that unnecessary pesticide applications can cause definitely evitable loss of yield or of alpha-acids. In addition, various measures to control diseases and pests in organic hops have been presented.



Session III: Chemical Analysis of Hop Compounds

Due to the highly promising wide range of applications of polyphenols and in particular of hop flavonoids in the pharmaceutical-medicinal field the content of these compounds in various hop cultivars is of great interest. In general, hop cones with their huge amount of lupulin glands which produce these substances are examined, on the other hand it seems to be conceivable to produce xanthohumol and the other bioactive flavonoids using alternative ways e.g. in biofermenters with hop suspension cultures. Analytical data concerning the flavonoid content of hop leaves and suspension cultures have been shown.

Hop quality produced in specific well-known hop growing regions is highly estimated and therefore quite expensive on the international market. Thus, hop chemists presented a method based on the typical, region-specific isotope relations to prove the origin and authenticity of a hop sample.

Session VI: Hop Production

Based on meteorological data such as temperature, precipitation and sunshine during the main vegetation period a mathematical model has been presented which allows predicting yield and alpha acid contents. At least for Saaz hops this model has been found statistically significant over several years.

To support hop growers in their striving to produce best quality and high yield irrigation trials have been conducted and moreover, comprehensive findings concerning the right time to harvest aroma or high alpha varieties have been shown. Two contributions with regard to the optimization of hop drying and the improvement of the energy expenditure



By courtesy of Josef Ježek, Hop Research Institute, Zatec, Czech Rep.

during this process completed the palette of scientific studies presented at this meeting.

Excursions and information about hop production in Spain:

The S.A. Española de Fomento del Lúpulo has been founded by the Spanish brewing industry in 1945. Today all work of this private company is focused on the domestic market aiming to support hop production and trade in Spain including hop research. Spanish breweries are the majority shareholders of this company, while the hop growers' share is 20 %.

Approximately 260 hop growers are producing on a total of 470 ha with emphasis on bitter hops. Farms with 2 ha on average are relatively small. The major variety grown is the US cultivar Nugget with 97 % of the Spanish hop acreage, and Columbus, Hallertauer Magnum (approx. 2 %) and Perle are produced to a much smaller extent. The Scientific Commission visited hop yards of all these cultivars. All fields were irrigated by flooding. Plants on the various hop yards were in good condition promising good yields.

The S.A. Española de Fomento del Lúpulo takes on the storage and processing of the hop lots delivered by the growers. In its own plant which has been visited on the excursion 100 % of all hops are processed to pellets type 90.

I hope that all delegates got a lot of useful information in the lecture part as well as in 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.

On behalf of the Scientific Commission I wish to thank the S.A. Española de Fomento del Lúpulo for their hospitality and special thanks are due to Mr. José A. Magadan for his excellent organization on the spot.

The best of luck and success in all fields of hop research.

Dr. Elisabeth Seigner
Scientific Commission, IHGC

July 2009

List of all papers and posters presented:

I. Session: Hop Breeding

The inheritance of resistance to aphids from the new UK variety 'BOADICEA'
Darby, P.

Variability of wild hops
Nesvadba, V., Patzak, J., Krofta, K.

Hop hybrids assessment through implementation of multicriteria decision model
Pavlovic, V., Cerenak, A., Kosir Iztok, J., Rozman, C., Pazek, K., Pavlovic, M.

Hop breeding on high contents of desmethylxanthohumol
Nesvadba, V., Krofta, K.

Herkules – the new Hüll high alpha cultivar
Lutz, A., Kneidl, J., Kammhuber, K., and Seigner, E.

II. Session: DNA-Based Studies in Hop Research

Powdery Mildew on Hops (*Humulus lupulus* L.): Histochemical studies and development of a transient transformation assay

Oberhollenzer, K., Seigner, E., Lutz, A., Eichmann, R., Hueckelhoven, R.

Studies of wilt resistance in hop

Javornik, B., Mandelc, S., Radišek, S., Jakše, J., Čerenak, A., Kozjak, P., Luthar, Z., Šatovič, Z.

Resistance gene candidates in hops

Jakše, J., Kozjak, P., Javornik, B.

Deciphering morphogenesis for hop improvement. A transcriptomic and metabolomic perspective

Fortes, A.M., Batista, D., Santos, F., Figueiredo, A., Serrazina, S., Choi, Y.H., Miersch, O., Lange, P., Wasternack, C., Verpoorte, R. and Pais, M.S.

Preliminary analysis of the hop (*Humulus lupulus* L.) proteome

Howard, E., Lowe, E., Whittock, S., Koutoulis, A.

Characterization of new genes in hop (*Humulus lupulus* L.)

Patzak, J., Matousek, J.

Functional analysis of hop (*Humulus lupulus* L.) regulatory factors from bZIP and bHLH families in transient expression systems.

Matoušek, J., Kocábek, T., Patzak, J., Orctová, L. and Krofta, K.

Modification of the synthesis of bioactive flavonoids in transgenic hop *Humulus lupulus* L. by PAP1/MYB75 from *Arabidopsis thaliana* L.

Aldinger, C., Stanke, M., Alheit, K., Gática, A., Höhnle, M., Matousek, J., Weber, G.

Gene expression, isolation and transformation of hop (*Humulus lupulus* L.) candidate genes of the prenylflavonoid pathway

Maloukh, L., Matousek, J., Matthews, P.D., Schwekendiek, A, Yu, O., Van Bockstaele, E. and Roldán-Ruiz, I.

SSR PCR analysis of Ukrainian varieties of hops (*Humulus lupulus* L.) and in vitro multiplication and field trials of «National» variety

Melnychuk, M., Spyrydonov, V., Dubrovin, V., Overchenko, V., Pariy, M., Kliuvadenko, A., and Kukovenko, V.

Methods of in vitro storage of hops

Faragó, J., Lajchová, Z., Faragová, N., Hudcovicová, M.

Genetic and epigenetic stability of *Humulus lupulus* after in vitro culture

Peredo E.L., Cires E., Arroyo-García R., Revilla M.A.

III. Session: Hop Diseases and Pests

New fungal diseases on hops in Slovenia and Austria

Radišek, S., Leskošek, G., Jakše, J., Javornik, B., de Gruyter, J.

Genotyping of *Verticillium* pathotypes in the Hallertau - basis finding to assess the risk of *Verticillium* infections

Seefelder, S., Seigner, E., Niedermeier, E., Radišek, S., Javornik, B.

A forecasting model for the control of powdery mildew (*Podosphaera macularis*) in hops (*Humulus lupulus*) under climatic conditions in the Hallertau

Engelhard, B., Schlagenhauer, S.

Systems approaches to management of hop downy mildew

Gent, D. H., Nelson, M. E., Farnsworth, J. L., Ocamb, C. M., Grove, G. G.

Prognosis of downy mildew (*Pseudoperonospora humuli* Miy et Tak.) within hop protection management in Czech Republic

Vostrel, J., Klupal, I., Kudrna, T.

Feeding preference of the hop flea beetle (*Psylliodes attenuates* KOCH)

Rak Cizej, M., Milevoj, L.

First steps towards a revised control threshold for the damson-hop aphid *Phorodon humuli*
Weihrauch, F.

Prognosis of damson-hop aphid (*Phorodon humuli* Schrank) within hop protection management in Czech Republic

Vostrel, J., Klupal, I., Kudrna, T.

The resistance of damson-hop aphid (*Phorodon humuli* Schrank) to lambda-cyhalothrine in Czech Republic

Vostrel, J.

Plant protection in organic hops

Solarska E.

Potentially dangerous fusarioid microorganisms associated with rot of hops (*Humulus lupulus* L.) plants in field culture.

Gryndler, M., Krofta, K.*, Gryndlerová, H., Soukupová, L., Hršelová, H., Gabriel, J.

IV. Session: Chemical Analysis of Hop Compounds

Identification of Czech hop varieties by essential oil analysis

Kroupa, F.

Geographical Origin of hops - determination by isotope ratio mass spectrometry (IRMS)

Schmidt, R., Kutsch, A., Roßmann, A.

Relationship between xanthohumol, polyphenols and flavonoids content in hop leaves with regard to vegetation period

Ůrgeová, E., Polívka, L.

Polyphenol and flavonoid contents of hop callus and cell suspension cultures

Pšenáková, I., Gašpárková, L., Faragó, J.

Influence of vegetation period on antioxidant and biocide activity of extracts from hop leaves

Polívka, L., Ůrgeová, E.

V. Session: Hop Production

Mathematical Model for Prediction of Yield and Alpha Acid Contents from Meteorological Data for Saaz Aroma Variety

Krofta, K., Kučera, J.

Utilization of irrigation systems in hop production

Ježek, J.

Recovering hop cultivation in Galicia (NW Spain)

Olmedo, J.L., Valladares, J., Fernández, J., Piñeiro, J.

The right time to harvest optimal yield and quality

Lutz, A., Kneidl, J., Seigner, E., and Kammhuber, K.

Hop Drying: Temperatures inside the layers of hop

García Panchón, R., Castro Abengoza, M.R., Suárez Moya, J.

Drying hops by means of thermal solar power: optimization of the energetic efficiency of the process to obtain a quality product

Castro Abengoza, R., Suárez Moya, J., García Panchón, R.