Genetic fingerprinting - a useful method in fruit production

Genetic fingerprinting is a well-known technique used for paternity testing and in forensic science. However, the technique is also used in the field of agriculture. Molecular genetics makes it possible to develop and apply new research and breeding methods to the field of fruit production in order to improve production and quality standards. Dr. Haibo Xuan from the Competence Centre for Fruit Production (KOB) at Lake Constance has been working for eight years on the application of molecular genetics tools for the diagnosis of fruit diseases.

Dr. Haibo Xuan has been producing genetic fingerprints for different types of fruit since 2004. Although rather similar, the analysis of genetic fingerprints in the field of agriculture and forensic science is not completely identical. Molecular genetics analyses can be applied to different areas of agriculture, for example for testing varietal identity, diagnosing fruit diseases, determining ripeness or analysing relationships between organisms and fruit. "Molecular diagnostics opens up greater opportunities in agriculture, particularly fruit production. It also helps to preserve biodiversity," Dr. Xuan says. At present, the KOB is working with researchers from the University of Prague on the development of scab-resistant fruit varieties. The KOB does not carry out experiments with genetically modified organisms.

Chloroplast DNA for clarifying fruit relationships

In the past, only external features were used for the identification and verification of fruit varieties. However, this does not guarantee the reliable determination of a fruit variety, as factors such as location and weather might affect the appearance of the fruit and distort the result. The application of molecular genetics methods allows a far simpler and more accurate determination of the fruit. Molecular markers in the DNA of plants are used to identify different fruit varieties. "This is achieved by comparing known with unknown fingerprints," Dr. Haibo Xuan explains.

Over the last few years, the Competence Centre for Fruit Production has established a comprehensive database with information on known fruit varieties and their respective fingerprints. The competence centre has been using genetic fingerprints for the identification of apple, pear, strawberry and cherry varieties. “We
are currently involved in a project commissioned by the ‘Deutsche Genbank Obst’ (German Fruit Gene Bank), Dresden, which aims to test more than 1,600 sweet and sour cherry varieties for their authenticity using genetic methods,” Dr. Xuan explains.

DNA fingerprints, both those used by KOB researchers and in forensic science, are produced using PCR (polymerase chain reaction) which supplies high quantities of pure DNA, enabling analysis of DNA samples from very small amounts of starting material. “A marker, which is a characteristic DNA sequence, is selected from an international gene bank and the corresponding portion of the genome to be examined is isolated and amplified across several orders of magnitude, generating thousands or even millions of copies,” the geneticist explained. The PCR product can then be used for cluster analyses that lead to the creation of a diagram depicting the relationships among clusters.

The team of researchers at the KOB analyses the relationships between different fruit species using chloroplast markers. “Chloroplast DNA is inherited maternally and enables distant relationships and the origin of a species to be determined,” says Dr. Xuan. Knowledge of the relationship between fruits contributes to the understanding of the evolution and developmental biology of different plants and can be used to preserve biodiversity. In addition, such knowledge has a huge practical importance in fruit breeding. “Carriers of valuable tree and fruit characteristics can thus be identified and used as crossing partners,” says Dr. Xuan.

### Diagnosis of tree and fruit diseases

Tree diseases such as the common fire blight, which mainly infests pome fruits, are spreading epidemically. The southern German states are particularly affected due to their climate. Tree diseases are particularly common in Baden-Württemberg, and timely and accurate diagnosis can save entire harvests.

In breeding, it is essential that plant material used for propagation is healthy. Molecular genetics methods can also be used for the diagnosis of diseases, for example for identifying the DNA material of a particular pathogen in the plant. “Molecular genetics tests that are able to identify fire blight and virus infections are currently being developed,” Dr. Xuan says.

### Gene expression provides information on optimal harvest date

Fruit diseases that develop during plant storage can be identified at an early stage using molecular genetics methods. Such methods enable the identification of stored fruit diseases as well as the ripeness stages as the fruit develop. The method used to determine the ripening of fruit is based on the gene expression profile of ripening-relevant enzymes, ACC oxidase, polygalacturonase and ß-galactosidase. Dr. Haibo Zuan explains: “Determining ripeness is crucial for determining the optimal harvest time, for organising the harvest and for planning storage and sale of the fruit.”

Altered gene expression can also provide information on the onset of ripening at a very early stage, even before the relevant enzymes have been produced and the chemical composition of the fruit and hence quality in terms of fastness, sugar content, etc. alters. The organisation of the harvest can thus be planned accordingly and adapted to the ripeness of the fruit.
"We are always interested in working with partners from academia and industry," says Dr. Xuan. Xuan did her doctoral thesis in the Department of Post-harvest Physiology and Fruit Storage at the University of Hohenheim and has been the head of the Department of Application of Molecular Genetics Methods in Pomiculture at the KOB in Bavendorf since 2004. In future, she hopes to also extend her research to identifying bitter rot and fire blight as well as the application of aroma fingerprinting.

**Further information:**
Dr. Haibo Xuan  
Head of ‘Application of Molecular Genetics Methods’  
Kompetenzzentrum Obstbau-Bodensee  
Schuhmacherhof 6  
D-88213 Ravensburg-Bavendorf  
Tel.: +49 (0) 751-7903-335  
E-mail: haibo(at)kob-bavendorf.de