DGF Normann-Medal Lecture:
From Genes to Plants:
Molecular Breeding for a Better Rapeseed Quality

Wolfgang Friedt

Department of Plant Breeding, Research Centre for BioSystems, Land Use and Nutrition, Justus-Liebig-University, Heinrich-Buff-Ring 26-32, D-35392 Giessen, Germany

The market value of oil crops like oilseed rape (*Brassica napus*) is mainly determined by its oil content and oil quality trait. The quality of the seed oil and its use for food or non-food purposes is primarily dependent on the respective fatty acid (FA) composition. In addition, seed oils contain valuable secondary compounds such as tocopherols (TOC). Therefore, the FA and TOC biosynthesis and their genetic modification are important objectives of basic and applied breeding research. In particular, molecular breeding approaches offer the possibility to modify storage lipids and secondary seed compounds of plants like rapeseed in order to meet specific demands, for nutritional, non-food or even therapeutic purposes. Respective activities aim at improving the competitiveness of seed oils for different segments of the vegetable oil market.

We have genetically engineered *B. napus* aiming at an improvement of the non-food usefulness of oilseed rape and have developed rapeseed progeny that accumulate saturated medium-chain fatty acids (MCFA) in the seed oil. For that purpose, relevant genes from the plant genus *Cuphea* encoding steps of MCFA synthesis have been selected for *Agrobacterium*-mediated transformation. Gene constructs harbouring the β-ketoacyl-acyl carrier protein synthase III gene either from *C. lanceolata* or *C. wrightii* under the control of the seed-specific *napin* promoter were used alone or in combination with different *Cuphea* thioesterase genes involved in MCFA biosynthesis. The best transgenic progeny revealed a significantly modified FA pattern.

Today, commercial double-low rapeseed (00, canola) is a highly valued source of dietary fat due to its favorable fatty acid composition. However, further enhancement of its nutritional value and health effects would be welcome. In particular, TOC are important phytonutrients in edible oils possessing bioactivity as vitamin E and reducing the autoxidation of unsaturated fatty acids, the production of off-flavours and rancidity. Normally, TOC content of rapeseed oil varies around 600 mg kg^{-1} oil. In the course of a metabolic engineering approach, we aimed at elevating TOC levels by increasing the

flux through the pathway by heterologous overexpression of enzymes that catalyse relevant steps in TOC biosynthesis, such as 4-hydroxyphenylpyruvate dioxygenase, homogentisate phytyltransferase and tocopherol cyclase genes. The seed oil of transgenic plant progenies bearing different gene constructs showed significantly increased levels of TOC up to two-fold of the corresponding wild-type control plants.

In order to improve the entire value of the rape seed, the protein content should be increased and the fibre (polyphenolics) content reduced simultaneously. We have been able to show that this is possible by developing yellow-seeded types of *B. napus*. However, such high-value genotypes are characterized by a reduced seed yield. A better understanding of the genetic control of polyphenolic biosynthesis will ultimately allow a more efficient breeding of high-performing and high-quality rapeseed varieties.