ASPB Pioneer Member

Gad Galili

Gadi Galili was born in Israel on September 19, 1952, and he grew up at his parents' home in Ramat Gan. He studied at "Nitsanim" for elementary and high school, later attending an agricultural boarding school in "Kfar Hayarok." There, he underwent a significant change both socially and educationally. In "Kfar Hayarok," he specialized in field crops and dairy cattle. After high school, he enlisted in the army as a paratrooper and was also accepted into a pilot's course, which he nearly completed. After his military service, he studied agriculture at the Faculty of Agriculture in Rehovot. He earned a master's degree at the Weizmann Institute in the Plant Genetics Department under the supervision of Professor Karel Jakob, focusing on changes in chromatin structure at the replication fork. He received a Ph.D. at the Weizmann Institute in the Plant Genetics Department under the supervision of Prof. Moshe Feldman, studying gene-dosage compensation of endosperm proteins in hexaploid wheat (Triticum aestivum), and then did postdoctoral research at Purdue University with Brian Larkins.

What Was His Research About

Essential amino acids, the nine amino acid building blocks humans must obtain through their diet, significantly impact health. Staple crops, often deficient in these amino acids, leave populations vulnerable to protein-energy malnutrition. Dr. Galili aimed to resolve this limitation by enhancing their level in staple crops. His strategy involved understanding and manipulating the metabolic pathways that control essential amino acid production and their incorporation into seed proteins. One key achievement was increasing lysine content in seeds by introducing a bacterial enzyme (dihydrodipicolinate synthase, DHPS) the activity of which is not inhibited by lysine. The gene was targeted to the plastid, where lysine biosynthesis occurs, and expressed only in seeds, directing lysine production where it is nutritionally beneficial, while avoiding unintended consequences on the plant's growth.

Dr. Galili's group demonstrated this method's effectiveness in various model and crop plants, all of which showed significant lysine increases in their seeds with minimal growth impact. Dr. Galili explored additional strategies for improving lysine content by suppressing enzymes that degrade the amino acid. His broader studies on lysine and threonine involved engineering their biosynthetic pathways by introducing bacterial genes encoding key regulatory enzymes. These studies led to the discovery that amino acid biosynthesis is regulated not only biochemically but also through complex interactions involving developmental, physiological, and hormonal signals.

Dr. Galili's lab also investigated the three essential aromatic amino acids, focusing on the vital link between their primary and secondary metabolism. Phenylalanine, tyrosine, and tryptophan are crucial for protein synthesis and serve as precursors for a diverse array of secondary metabolites important for plant growth, human nutrition, and health. The shikimate pathway converts primary carbon metabolites into these aromatic amino acids through chorismate. Despite its significance, the regulation of this pathway, particularly concerning aromatic amino acid synthesis, remains enigmatic. Dr. Galili's lab manipulated the flow of these metabolites through the shikimate pathway by expressing a feedback-insensitive bacterial homolog of the first gene in the shikimate pathway (3-Deoxy-Darabinoheptulosonate 7-phosphate, DAHP). The resulting plants showed pronounced changes in metabolic flux through the shikimate pathway and elevated levels of aromatic amino acids. This work demonstrated that enhancing specific metabolites depends on the plant's existing metabolic pathways and the targeted tissue for gene expression. By comparing outcomes across different plants and tissues, Dr. Galili provided valuable insights into plant metabolism. Interestingly, modifying DAHP synthase had an unexpected benefit: it altered downstream phenylpropanoid secondary metabolites, leading to improved aroma in tomato fruits. When applied to other plants, this approach yielded similar results; for instance, petunia flowers displayed a more noticeable floral scent, and grape cell cultures showed increased resveratrol levels. In 2006, Dr. Galili joined the BIOTOV Israeli research consortium, working collaboratively to improve the expression of secondary metabolites in plants to enhance or restore taste and flavor in fruits and vegetables. His group successfully enhanced tomato aroma by increasing phenylalanine levels.

Dr. Galili's interest in the assembly and maturation of seed storage proteins led him to discover a new intracellular route of vesicular transport. Electron microscopy observations of storage protein synthesis in developing wheat seeds suggested a direct transport route from the ER to the storage vacuole, bypassing the Golgi. This novel transport route is similar to the cellular mechanisms of autophagy, which led him to this exciting research area. In the 1990s, Ohsumi and other researchers identified autophagy-related genes in budding yeast, paving the way for studying autophagy in more complex organisms, including plants, which have the ability to target specific organelles and molecules for degradation. Dr. Galili understood the importance of selective autophagy for plant stress responses and development. His lab was one of the first plant labs to investigate Atg8 (a central protein in the autophagy machinery) and its associated proteins. This work led to the identification of the first endoplasmic reticulum autophagy cargo receptors and elucidated mechanisms involved in the turnover of endoplasmic reticulum and chloroplast proteins in response to abiotic stress.

Dr. Galili's research with bread wheat revealed a novel intracellular pathway. In wheat, storage proteins travel directly from the endoplasmic reticulum to vacuoles, bypassing the Golgi apparatus. He observed that these newly formed proteins undergo unique chaperone-assisted folding and assembly. Interestingly, the proteins form insoluble bodies within the vacuoles, an adaptation that allows seeds to withstand dry periods during maturation while ensuring the proteins can be readily rehydrated and utilized upon germination.

A testament to Dr. Galili's scientific impact is manifest by the many students and postdoctoral researchers he trained, many of whom are now making their own scientific contributions in labs worldwide. His mentees laud him as an inspirational, passionate, encouraging, and supportive mentor, as well as a true friend. Gadi's scientific enthusiasm and endless optimism are infectious. As a mentor, he made it his career-long goal to teach generations of students how to navigate the hurdles of an academic career successfully. This dedication resulted in a prolific career both in scientific output and mentorship. A firm believer in "woman power," Gadi placed special emphasis on supporting his female students, many of whom now hold academic positions.

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