Editorial

Plant Immunity and Beyond: Signals from Proteins & Peptides

Plants are the primary and most important source of food for human consumption, besides their ecological importance, since they define the diverse ecosystems worldwide. Because of their position in the ecological chain as primary supplier of biomass and food for other organisms, plants are also fundamental for animals, fungi and microorganisms, and some of them are also beneficial to other plants. Humans rely mostly on plant products for food, and many plants provide important non-food products, including wood, textiles, medicines, cosmetics, soaps, rubber, plastics, paints and other industrial chemicals. Moreover, plants are also fundamental for animal feeding, including not only mammals (*e.g.* cattle, sheep and goats), but also poultry and aquaculture (*e.g.*, fish and shrimp farming).

So, the dependence of human beings from plants is quite high, increasing every day. Also, there are forecasts that the expanding purchasing power in some developing countries associated with the increase in world population should result in significant changes in nutritional habits and acquisition of consumer goods in general, foreseeing an increased demand for food of the order of 60 to 110% of the availability, considering the period from 2005 to 2050 [1, 2], while it has been estimated that the demand for forest products can be even greater [3].

In addition to the augmented demand for products of plant origin, a debate has been initiated on the impact of climate change on crop production in various regions of the world, with major implications in currently fragile areas in terms of of food security, increasing malnutrition and hunger in certain regions, with emphasis to semiarid regions of the southern hemisphere [4]. From the point of view of plant defense it is considered that increased carbon dioxide concentrations associated with higher temperatures should impact on plant-pathogen interactions, since these changes affect both classes of organisms [5]. Such a new environmental requirement may affect the spatial and temporal distribution of plant diseases as well as their severity. So, a change in agro-climatic zones toward the poles is expected, accompanied by a drift in the geographic areas of occurrence of pathogens associated with certain crops [5].

Therefore, understanding how plants safeguard themselves from pathogens and herbivores is essential in order to protect the food, fed and raw material supply from plant origin, as well as developing most resistant plant varieties against diseases. Such a goal is also very important for the protection of still existing natural environments, since areas already occupied by cultivated plants can become more productive, reducing the need for deforestation of still preserved land areas. Furthermore, it should be considered that crop resistance significantly reduces the use of agricultural pesticides, such as fungicides, bactericides or insecticides (important to control disease vectors and feeding by insects) that have negative impacts to the environment.

A deep understanding of the mechanisms of plant resistance against diseases and of the crosstalk between plant response to biotic and abiotic stresses is the fundamental key for the development of strategies to improve resistance and diminish losses by approaches that may involve molecular breeding, crop selection and genetic modified plants. In this sense, omics and bioinformatics offer promising perspectives. The possibility to superpose different layers comparing genomics, transcriptomics, proteomics and epigenomics has driven to an insight in the interaction between different molecular players towards the interactomics, allowing a dynamic view of their roles. In this sense evolution and coevolution assumed a central position, demonstrating that despite intensive efforts, there exists a long way ahead, especially with regard to durable resistance.

This special volume includes different molecular aspects of plant defense against pathogens, including *R*-genes-mediated specific resistance in the context of gene-to-gene interactions (review of **Wanderley-Nogueira *et al.*** [6]). Also considering this topic, a molecular comparison of plant protection strategies and animal defense mechanisms was carried out and described in the review article of **Pontillo and Crovella** [7], highlighting evolutionary aspects and common strategies between both groups of organisms. The potential use of *R*-genes in plant defense led many research groups to consider them as prime candidates for plant transformation, resulting in reports of successes (though not always lasting) and cases of re-emergence of pathogens after a period of resistance, an aspect revised here (**Pandolfi *et al.*** [8]) also considering perspectives of this kind of approach.

Another important aspect involves the defense response mediated by transcription factors, which currently have received special attention due to their role in the orchestration of responses with different intensities and potential role in the simultaneous induction of resistance to different types of stress, an aspect that has been strengthened with interatomic inferences (review of **Amorim *et al.*** [9]).

Considering OMICs implications, for many years there has been an intense focus on polymorphisms of nucleic acids in the genomic and transcriptomic levels, regardless of the epigenetic repercussions, an approach also addressed in the present volume (see review by **Ferreira-Neto *et al.*** [10]), which involves one of the main aspects for a better understanding of questions not clarified yet.

Aspects of the systemic defense are evaluated in this volume, considering two plant antimicrobial peptide classes covered: snakins (review of **Oliveira-Lima *et al.*** [11]) and cyclic peptides (review of **Lima *et al.*** [12]), key defense players but still poorly understood considering their uses as antimicrobial agents and from an evolutionary point of view considering their prevalence in certain plant groups. Plant antimicrobial peptides have been considered as potential agents for agricultural use for plant defense as also to generate new drugs for human consumption. One way of producing peptides for various purposes has been their heterologous expression in microorganisms, which has been impaired precisely because of their efficient antimicrobial activity, as revised in in this volume (**Gazzaneo *et al.*** [13]). Possibilities to overcome existing difficulties and potentialities are also addressed.

Such as for genomics, transcriptomics and epigenomics, a review of aspects of proteomics and peptidomics studies related to plant defense is covered in a specific article (**Silva *et al.*** [14]), confirming the existence of an abundant molecular richness as a result of post-transcriptional modifications, emphasizing the complexity of the plant biological system.

Cutting edge molecular biological methods have been applied to recognize new candidate molecules, including those from genes and proteins without functional characterization or prediction. As shown in the present volume, the analysis of such a multitude of candidates from different sources strongly depends on bioinformatics and systems biology resources, besides network efforts. This is the case of the InterSis network (http://www.lgbv-ufpe.net/index.php?pagina=intersis), for instance, focused on biotic interactions, including plant defense.

Taken together all aspects of plant immunity addressed in the present volume demonstrates the inexhaustible source of bioactive molecules generated by plants, with prospects of important applications not only for agricultural and agroforestry areas, but also in the development of drugs for medical use.

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