Second Generation ChitosanSas Reliable, Dual-Use Plant Biostimulants

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The term chitosan describes a family of biopolymers and oligomers consisting of varying numbers and ratios of glucosamine and N-acetylglucosamine residues. Depending on the number of residues in the molecule (its degree of polymerisation) and the ratio of the two monomeric units (its degree of acetylation), and possibly also depending on the sequence of the two units within the oligomer or polymer (its pattern of acetylation), chitosans can have different biological activities. Some chitosans can inhibit microbial growth (without being fungicidal or bactericidal, rather being funigstatic and bacteriostatic), some chitosans can induce disease resistance in a plant (either by acting as an elicitor triggering resistance reactions, or by acting as a priming agent enabling plant cells to react more efficiently against pathogens), some chitosans can improve abiotic stress tolerance in plants (e.g. against drought or heat stress), and some chitosans can promote plant growth (e.g. root and/or shoot growth) and/or development (e.g. more fruit and/or earlier ripening).

Modern biotechnological methods of chitosan production and/or modification as well as new techniques for chitosan in depth structural analysis allow to produce well-defined (second generation) chitosans having defined and reliable, specific bioactivities, but lacking others. In this way, it is e.g. possible to produce chitosans which have no antimicrobial activities but which do have plant strengthening (i.e. growth promoting and stress tolerance and disease resistance inducing activities). It will probably also be possible to generate chitosans with more pronounced ability to induce stress tolerance and less marked ability to induce disease resistance, and vice versa. However, it is highly unlike that it will be possible to dissect these activities fully. The reason behind this is the intimate cross-talk of intracellular signal transduction pathways in plant cells. Even if it were possible to identify a specific chitosan oligomer (or any other compound) that is recognised by a specific receptor which triggers a signal transduction chain leading to metabolic answers increasing abiotic stress tolerance, and to identify another chitosan oligomer (or any other compound) that is recognised by a different receptor which triggers a different signal transduction chain leading to different metabolic answers increasing disease resistance - treatment of the plant cell with either of the two chitosan oligomers will invariably lead to a mixed response, possibly with stronger emphasis on one of the two reactions and less pronounced expression of the other, but not with just one answer. Clearly, thus, there is a strong interconnection between abiotic stress tolerance and disease resistance. Consequently, we propose to categorize such compounds, like specific chitosans, which act on the plant cell rather than on the pathogen as plant strengthening agents or dual-use plant biostimulants.