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Role of Chitosan in Fruits and Vegetables

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Recently, chitosan has been one of the most preferred biopolymers due to its biocompatibility, antioxidant, anticancer, biodegradability, antimicrobial, and non-toxic properties as well as being an economical material, produced from waste resources such as seafood shells. Structurally, chitosan is a linear polymer, composed of two sub-units as D-glucosamine and N-acetyl-D-glucosamine, linked with each other through 1,4-glycosidic bonds. Since the last decade, chitosan research is increasing due to its significant diverse uses in several fields of life i.e., plant sciences and medical sciences. Chitosan is the *N*-deacetylated derivative of chitin. It is a natural polysaccharide, which can be produced after the alkaline deacetylation of chitin (essential structural polymer, constituting a large fraction of insects and a crustacean's exoskeleton). Briefly, the chitin extracted isolates are refluxed in 60% NaOH solution (*w*/*v* 1:15 or 1:20, where *w* = mass of chitin, *v* = volume of NaOH solution) for 3–4 h by stirring at a temperature of 80–100 ◦C. In order to neutralize the pH level of the isolated chitosan, the samples are washed with deionized, distilled water. Then, the chitosan samples are dried for 24 h in an oven using a temperature of 60–80 ◦C and the chitosan percentage is then calculated. Below we compiled different sources of chitin and chitosan. In plants, the chitosan is largely used to mimic biotic and abiotic stresses. The first study of using chitosan as an antipathogen in plants was reported by Allan and Hadwiger, where they demonstrated the fungicidal effects of chitosan on different cell wall compositions of fungi. The improvement of the defense system after applying chitin and chitosan, both in monocotyledon and dicotyledons is the center of addressing this biopolymer in multi-research area. Chitosan has been a bio-fungicide, bio-bactericide, and bio-virucide, which spurs plant defense system against the pathogen, thus inducing the immune system of plants, fruits, and vegetables. Furthermore, the growing demand for food also stimulated the increased use of industrial fertilizer, which causes serious environmental unbalance and is having catastrophic effects on human health. Therefore, the use of chitosan as a biofertilizer is considered. Chitosan has been reported to have a positive effect on rhizobacteria growth, where Chitosan possesses a symbiotic relation with growth promoting rhizobacteria, thus triggered germination rate and improving plant nutrient uptake.

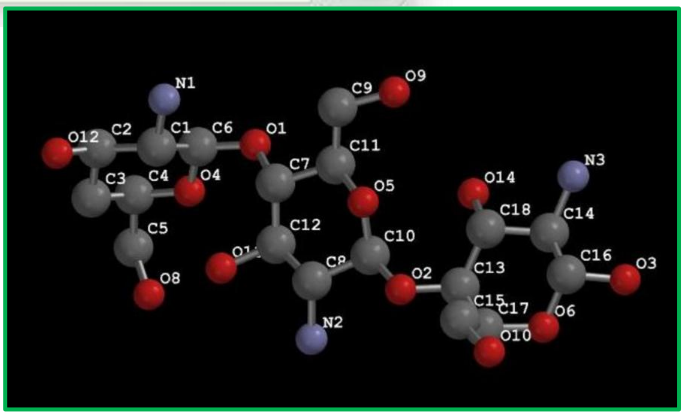

Fig. Structure of chitosan

The chitosan effects on fruit physiology and agronomic traits have been highly studied using different concentrations of chitosan over a variety of fruits. In line with that, foliar spraying of 5 mL L−1 chitosan over mango trees improved the number of fruits tree−1, weight and size of fruit, and vegetative growth. In grapes, chitosan was sprayed at 500 L per hectare during the pre-bunch closure and veraison stage and effectively increased the POX and PAL activities, polyphenol content, and SOD activities. Moreover, an increase in the weight of fresh fruit of the kiwi plant was observed after spraying with chitosan in field conditions. Chitosan in combination with calcium chloride reduced the early swelling of peach trees, maintained freshness and firmness of fruits, and decreased the weight loss percentage. In nectarine, chitosan improved the soluble solid content and also helped maintained the post-harvest firmness of the fruit.

Like in fruits, chitosan also positively affects the agronomic traits of vegetables. Tomato plants were subjected to chitosan treatment, resulting in high phenolic compound and PPO activities, production of phytoalexins, and improvement in fruit weight and overall yield. Application of chitosan in daikon radish triggered the growth of roots and shoots. Similarly, it was reported in sweet basil, grapevine, *Gerbera*, *Dendrobium* orchids, and in cabbage, that chitosan treated plants showed better growth than that of controls. Moreover, the cucumber plant is highly susceptible to low-temperature stress. However, when treated with chitosan, the plants had reduced reactive oxygen species, improved photosynthetic capacity, and the membrane system was strengthened to alleviate cold stress. In chili, seeds treated with chitosan had significantly improved germination rates, germination index, mean germination time, and germination after accelerated aging, as well as high seed quality and enhanced storage life.

Chitosan Effects on Post-Harvest Fruits and Vegetables

The diverse beneficial effects of chitosan in fruit shows great value. Furthermore, a coating of post-harvest mango with edible chitosan showed a reduction in the percentage of rotten tissue, increased ascorbic acid content, increased shelf-life, and maintained freshness. Likewise, in pomegranate, edible chitosan coating enhanced the shelf life and improved freshness for up to 16 days with good chemical and sensory characteristics during post-harvest cold storage, and kept the surface microbial growth under check. Similarly, in post-harvested strawberries, chitosan significantly prolonged the anthocyanins, polyphenol, and antioxidant activities, while inhibiting flesh browning under cold storage conditions. Furthermore, thin-peel rose apples showed a reduction in disease severity, sustained fruit firmness, and a reduction in the weight loss percentage during post-harvest storage.