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Callose Deposition – A Needful Composition in Plants

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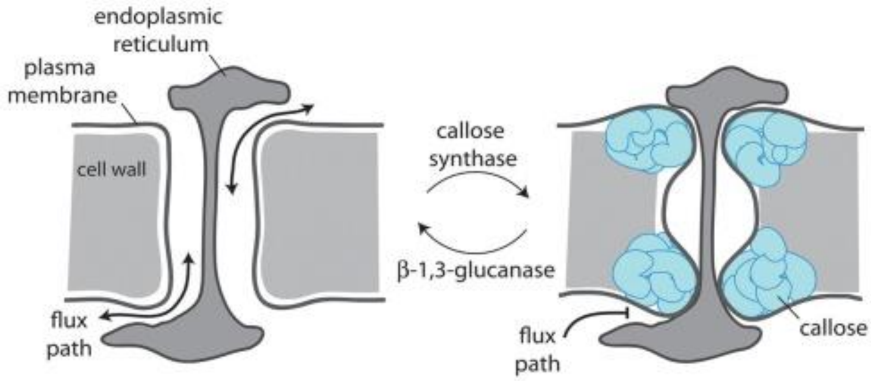
Callose is an important component of specialized cell walls or their associated structures in the growth stages of plant cycles. Callose is involved in the pollen development, cell plate during cytokinesis, plasmodesmatal regulation, in wounding, against the infection of pathogens and physiological stresses. Callose is the linear polymer β-1,3-glucan made up of several hundreds of glucose units united by mean of β-1,3-glycosidic bounds. It can be varied structurally and chemically among the various cell wall types. The multi-subunit enzyme complex catalyzes the callose biosynthesis associated with the plasma membrane. The main component of enzyme complex is callose synthase (catalytic subunit), beside sucrose synthase and UDP-glucose transferase. The UDP-glucose transferase provides the UDP-glucose for the biosynthesis of callose. The callose synthase complex also contains annexin proteins which regulate the switching of callose synthesis to cellulose biosynthesis determined by the calcium level. The subcomponents vary and differ based on their sub-cellular localization and its type.



Regulation

The glucosidic activator is an intracellular component of callose synthesis regulation. It is an allosteric effector molecule to calcium ions which is being transported from vacuoles into the cytosol to regulate the activity and confirmation of callose synthase complex. The activity of callose synthase can be enhanced by the polyamine, chitosan, digitonin and phospholipids. In response to mechanical injury, callose synthesis is mediated by mean of G-proteins. The alteration in the membrane phospholipids adjacent to callose synthase complex to triggers the callose biosynthesis. Secondary metabolites and phytohormones induce the callose synthesis, thus play important role in the pathogen resistance. The deposited callose reduced by the activity of β-glucanases (belongs to pathogenesis related proteins).

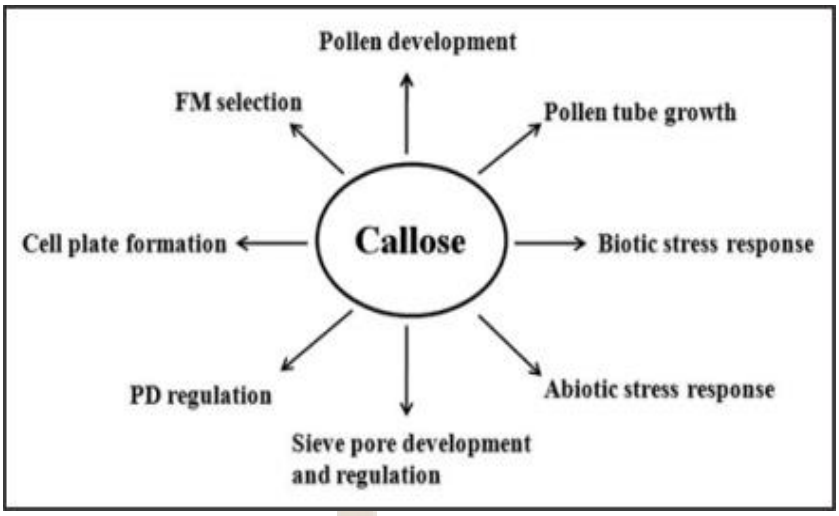
Role in growth and development

Callose plays active role in the cytokinesis (part of cell division). The cell plate formation is initiated by the fusion of raw material rich golgi derived vesicles. The callose joined at the center of phragmoplast where allows the tubular network maturation into the fenestred cell plate. Later on, the callose is degraded, and substituted by the cellulose and other primary parental material of cell wall.

Callose is playing crucial role in micro-sporogenesis, microgametogenesis and pollination (pollen development). The pollen mother cell generates a callose wall in between the primary cell wall and plasma membrane at the time of meiosis. Callose is massively formed as a protective layer around the tetrad and within the tetrad of microspores.

It is the principal regulator to regulate the symplastic continuity in plasmodesmata. For instance, during the dormancy period, the callose deposition results in plasmodesmal sphincters to separate the meristem from its surrounded tissues. Hence, the meristem functions are paused down and development ceases. Once the dormant seed get the signal of germination, the activity of β-1,3-glucanases is increased to remove the callose deposits, and thus meristem regains its functionality. Such reversible regulation of plasmodesmatal gating have role in the sieve plate pores of the phloem element to plug them in autumn and unplug during the spring. In the cotton fiber cells, closing of plasmodesmal channel by callose facilitate to increase the turgor pressure which is required for cotton cell elongation.

Callose is found to play role in the stomatal closure cells of ferns and metasperms. Callose is lying in differentiation area of periclinal walls and ventral walls of stomata pore of *Ophioglossum petiolatum* and A*splenium nidus*. The degradation and synthesis of exterior stomatal periclinal walls coincide with the degradation and synthesis of callose stomatal pore walls.



Role in stress combat

Under the drought stress, the reduction in the transportation of water solutions of the cribiform tubes of phloem and is associated with the callose deposition. In the hypoxia condition, callose intensifying on the secondary walls of *Triculum aestivum* roots. The pericycle cells and endospermal cells in the root fibrils of wheat plantlets have higher callose deposition under hypoxial conditions. Callose deposition in the root also regarded as indicator of heavy metal accumulation in the soil. The callose formation is induced in the epidermal cells after the pathogen attack or under mechanical damages. The intensity varies with the host plant organ or tissue and the pathogen type. Callose papilla is formed to act as mechanical barrier in between cell wall and plama membrane. Callose regulation of plasmadesmata inhibits the pathogen transport from cell to cell.

Conclusion

The literature already laid down the foundation for callose association in the plant growth, development and provides responses against biotic and abiotic stresses. The precise biochemical mechanisms, functional components of callose synthase complex and megaspore selection are needs to be explored. Moreover, the crosstalk between the signaling pathways and callose regulation mechanisms are also required to be studied.

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