

**Nanomaterials from waste for a sustainable nano-circular economy.
Biostimulant effect of nanoscaled lignin and biogenic nanoparticles**

Daniele Del Buono, DSA3-University of Perugia, PG

Human activities frequently reveal little or no environmental sustainability, often undermining the quality and health of primary resources. Agriculture is among the activities with the largest environmental footprint due to the adoption of a linear production model centred on a 'take, use and throw away' approach to natural resources. A fundamental change in perspective is essential, which can only be achieved by considering agro-industrial waste as a resource for obtaining bio-based materials that can be reused in various sectors. For this reason, the valorisation of waste from agro-industrial activities is receiving increasing attention. Recently, it has been shown that an intelligent and feasible way to valorise these wastes is to obtain biostimulants or plant growth promoters. Biostimulants play a crucial role in agriculture and are considered an indispensable agronomic tool. Such materials can stimulate crop productivity, plant nutrition, photosynthesis, pigment biosynthesis, and the content of specific substances with antioxidant action and improve primary and secondary metabolism. In addition, a further distinctive feature of these materials is their ability to increase crop resistance to biotic and abiotic stresses. Moreover, waste materials have become attractive for obtaining biopolymers and nanostructured materials that can be used to stimulate crop benefits. In parallel, biogenic synthesis emerges as an interesting bio-fabrication to obtain inorganic nanomaterials, using appropriate plant extracts as capping or reducing agents, thus controlling shape and size. These nanomaterials are currently being investigated for potential application in crops, as they show promising stimulating effects in the treated species.