Functional and bioactive polymers from renewable feedstocks: the example of phenols

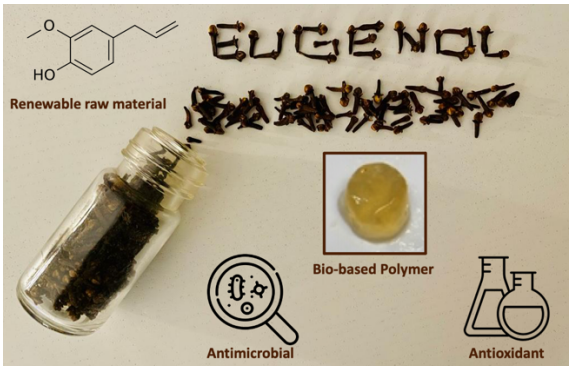
Iolanda Francolini
iolanda.francolini@uniroma1.it

In recent years, the search for sustainable alternatives to petroleum-based materials has become a central goal in materials science. Beyond sustainability, current research increasingly emphasizes the functionality and performance of the resulting polymers. From this perspective, renewable resources can be redefined as functional building blocks that impart specific physico-chemical and biological properties to polymeric materials.

In the presentation, phenolic compounds serve as a representative example of this broader concept, illustrating how renewable aromatic molecules, particularly those obtained from agro-food waste, can act as valuable precursors for the design of functional, bioactive, and sustainable polymers [1].

Phenolic compounds can scavenge radicals, including reactive oxygen species, with effectiveness depending on the number and position of phenolic groups. This intrinsic property makes them particularly attractive for designing functional biomaterials. The use of catechols to synthesize amphiphilic cationic copolymers for medical device coatings will be discussed, highlighting how catechol moieties impart both bioactivity and adhesive properties [2]. The potential of these systems in antimicrobial applications will also be explored, focusing on how the incorporation of phenolic moieties can enhance interactions with microbial membranes and inhibit bacterial growth [3]. Additionally, the use of phenols, particularly eugenol, in constructing 3D hydrogels and nanogels for drug delivery will be illustrated, emphasizing their potential to control hydrogel swelling, rheology and bioactivity [4].

Beyond biomedical applications, the intrinsic hydrophobicity and chemical reactivity of phenolic compounds open further opportunities in industrial contexts, including the development of eco-friendly oligomeric wet-strength agents for paper production. This will show how the phenolic structure not only improves the mechanical stability of paper in wet conditions but also offers a sustainable alternative to traditional petroleum-based additives.



References

[1] Lochab B, Shukla S, Varma IK. Naturally occurring phenolic sources: monomers and polymers. *RSC advances* 2014, *4*(42), 21712-21752.

[2] Taresco V, Crisante F, Francolini I, Martinelli A, D'Ilario L, Ricci-Vitiani L, Buccarelli M, Pietrelli L, Piozzi A. Antimicrobial and antioxidant amphiphilic random copolymers to address medical device-centered infections. *Acta Biomat* 2015; 22: 131-140.

[3] Amato A, Migneco LM, Martinelli A, Pietrelli L, Piozzi A, Francolini I. Antimicrobial activity of catechol functionalized-chitosan versus Staphylococcus epidermidis. *Carbohydr Polym* 2018; 179: 273-281.

[4] Di Consiglio M, Sturabotti E, Brugnoli B, Piozzi A, Migneco LM, Francolini I. Synthesis of sustainable eugenol/hydroxyethylmethacrylate-based polymers with antioxidant and antimicrobial properties. *Polym Chem* 2023; 14: 432-442.