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Antibacterial amino acid-Schiff base copper(II) complexes synthesized by alternative techniques

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PURPOSE OF THE ABSTRACT

Copper-based compounds, nanomaterials or materials are now well-known for their ability to exhibit antimicrobial activity. Amongst them, some copper-based Schiff bases can exhibit SuperOxide Dismutase (SOD) mimetic activities, which catalyzes the dismutation of the superoxide anion into hydrogen peroxide and molecular oxygen. This SOD is one of the most important antioxidative enzymes (Joseph et al., 2013). Moreover, bacterial proteins using a cysteine-rich four helix bundle is able to store large quantities of copper (Dennison et al., 2018). All the copper taken up by a typical GRAM(+) or GRAM(-) bacterial cell is now known to be actively exported into the periplasmic/extracellular space and accordingly, bacterial cuproenzymes, including SOD, are generally extracellular, and not cytoplasmic (Besold et al., 2016).

As a result, antimicrobial effect could be induced by ROS (Reactive Oxygen Species) production or cuproenzymes competition. To solve this mechanistic action hypothesis, 20 L-amino acid derivative Schiff base copper(II) complexes were successfully synthesized using eco-friendly methods (Otani et al., 2021). Indeed, the One Health concept implies that there is a strong dependence between Human, Animals and Environment (Marais et al., 2012). For example, environmental pollution promotes food chains contaminations and microbial resistances.

That is why, as resource-, time-saving and environmentally friendly synthetic methods, two alternative techniques were employed for the synthesis of these L-amino acid derivative Schiff base copper(II) complexes. The first method employed was microwave, having merits as faster reaction speed by controlled heat transfer, safety, improved reactivity, high yield, selectivity of heating, and reproducibility. The other one was mechanochemistry, which can be carried out under solvent-free or small amounts of solvent. In our case, these two methods were found to promote faster reactions and smaller amounts of solvents needed, especially for mechanochemistry, and compared to conventional heating.

These 20 compounds were successfully tested against model bacteria such as Escherichia coli (rod-shaped GRAM(-) bacteria), Staphylococcus saprophyticus (round-shaped GRAM(+) bacteria), Bacillus subtilis (rod-shaped GRAM(+) bacteria) and Micrococcus luteus (round-shaped GRAM(+) bacteria) thanks to a fast optical density measurement method and leading to MIC95 values (Minimal Inhibitory Concentration for at least 95% inhibition rate) down to 6.25 µg/mL. Some structure-activity relationship were also determined.

FIGURES

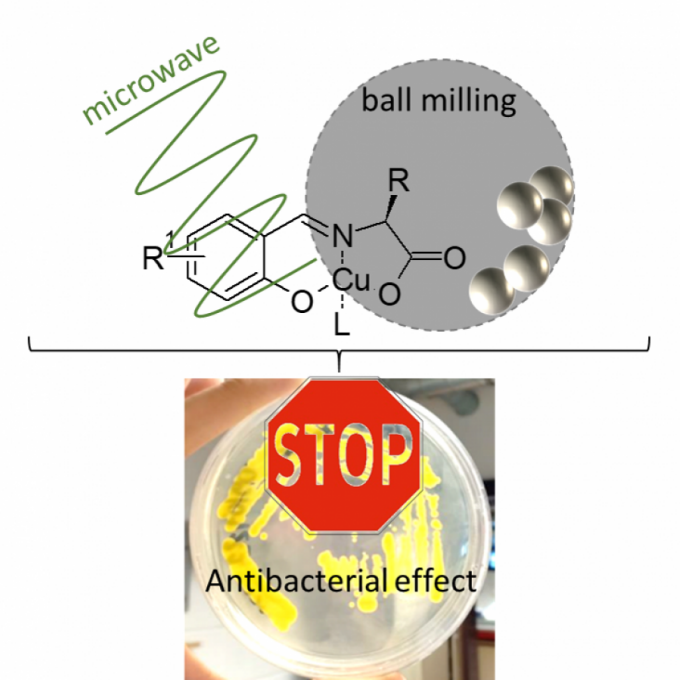

FIGURE 1

Graphical abstract

Alternative techniques for the synthesis of amino acid Schiff base copper complex inhibiting bacteria

FIGURE 2

KEYWORDS

Alternative techniques | copper-based aminoacid Schiff base | antibacterial

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