SILVER NANOPARTICLES WITH PECTIN: IDEAL GREEN BIOMATERIAL FOR ANTI-BACTERIAL AND ANTI-BIOFILM APPLICATIONS

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Introduction

Synthesis and biomedical properties of silver nanoparticles (AgNP) have been extensively investigated over the past decades. Their use as additives for wound-healing biomaterials endowed with antibacterial properties has also been documented. A key factor for biocompatibility is the amount of Ag^+ ion released by AgNP: a threshold of 10 ppm should be considered. A further requirement, together with biocompatible reductant agents is a narrow dimensional distribution, a typical bottleneck of many synthesis procedures of AgNP. Here, we report an efficient, simple, green synthesis method of AgNP with citrus peel pectin (p-AgNP), used both as a reductant and coating agent.

Material and methods

Pectin from citrus peel (0.5%,1%,2%) was dissolved at 60°C. Upon cooling, $AgNO_3$ solution was added to a final concentration of 1mM and immediately 0.5M NaOH was added. Vigorous stirring was continued for 12/24 hours.

E. coli PHL628 and *S. epidermidis* RP62A were used as model Gram – and + strains, respectively. Minimum Inhibitory Concentration (MIC) was determined in planktonic condition, as well as effect of p-AgNP was analyzed before and after biofilm formation. 3-[4,5-dimethylthiazol-2-yl]-2,5diphenyltetrazoliumbromide (MTT) test was used to assess viability of bacteria. Confocal Laser Scanning Microscopy observations on bacterial biofilms were also performed.

Results and discussion

The new synthesis method provided an almost complete reduction of Ag^+ to Ag0, together with fast and straightforward procedure. The generated nanocomposite displayed excellent long term stability, narrow dimensional distribution and low Ag^+ release.
Despite this, excellent MIC values were reported for both strains, close to or lower than $AgNO_3$ ones (Figure 1, panel A and B). This effect is due to the weak interaction between p-AgNP pectin coating and bacterial surface. Similarly good properties were reported for their activity on biofilms in the two different experimental settings analyzed (Figure 1, panel C). In both planktonic and biofilm conditions, *E. coli* showed to be more affected, owing to its documented higher Ag^+ sensitivity if compared to *S. epidermidis*.

Conclusion

We have designed a new, simple and green method to generate stable, dimensionally uniform AgNP, with pectin playing the role of both reducing agent during synthesis and coating of AgNPs themselves. Our p-AgNP are the best compromise between good antibacterial and anti-biofilm effect and possible cytocompatibility issues, the former normally requiring sustained Ag^+ release, that is detrimental for human applications because of cytotoxicity.

Acknowledgments

University of Pavia (Fondo Ricerca Giovani) and CIRCMSB (Consorzio Interuniversitario di Ricerca in Chimica dei Metalli nei Sistemi Biologici) are gratefully acknowledged for support. LV would also like to thank COST Action iPROMEDAI TD1305,''Improved Protection of Medical Devices Against Infection (IPROMEDAI)" (2013–2018) (http://www.cost.eu/COST_Actions/tdp/TD1305). We are grateful to P. Vaghi (Centro Grandi Strumenti di Pavia, University of Pavia) for technical assistance in the Confocal Laser Scanning Microscopy studies.

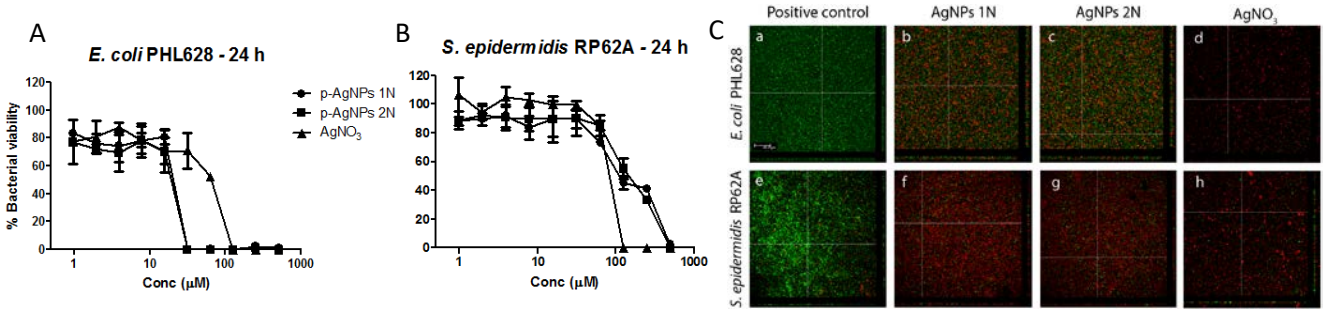

Figure1 – Effect of p-AgNP and $AgNO_3$ on *E. coli* PHL628 and *S. epidermidis* RP62A. MIC determination of $AgNO_3$ and two different preparations of p-AgNP for *E. coli* and *S. epidermidis* (panel A and B, respectively) in planktonic conditions. CLSM images (panel C) of *E. coli* (subpanels a, b, c, d) and *S. epidermidis* (subpanels e, f, g, h) upon addition of two different preparations of p-AgNP and $AgNO_3$ after biofilm formation.