Silver nanoparticles (AgNPs) are a commonly used nanomaterial because of their antibacterial and antifungal properties that are exploited in numerous consumer products and agriculture. Increased AgNPs utilisation results in their significant discharge into the environment and many studies have already revealed their toxic effects on living organisms. Plants, with an important role in bioaccumulation and distribution of environmentally released substances, could serve as a potential route for AgNPs into the food chain. In this study we compared the effects of two differently coated AgNPs (polyvinylpyrrolidone (PVP) and cetyltrimethylammonium bromide (CTAB)) on oxidative stress parameters of tobacco (Nicotiana tabacum L.) seedlings. To examine whether the toxic effects of AgNPs originate from dissolved Ag⁺ or nanoparticles themselves, cysteine, a strong silver ligand, has been applied.

### RESULTS

**Figure 1.** TEM images of AgNPs-PVP (A) and AgNPs-CTAB (B).

**Figure 2.** Content of ROS (A), MDA (B) and protein carbonyls (C) in tobacco seedlings treated with AgNPs. Values are means ± SE of two different experiments, each with six replicates. Among each Ag-treatment asterisks denote significant difference from control and hash sign denotes significant differences among treatments with and without cysteine.

**Figure 3.** Specific activities of APX (A), PPX (B), CAT (C) and SOD (D) in tobacco seedlings treated with AgNPs. Values are means ± SE of two different experiments, each with six replicates. Among each Ag-treatment asterisks denote significant difference from control and hash sign denotes significant differences among treatments with and without cysteine.

### CONCLUSION

- Compared to control, AgNPs induced significant silver uptake and elevated ROS levels in tobacco seedlings.
- No significant difference in content of MDA and protein carbonyls was detected in AgNP treatments.
- AgNPs-PVP decreased APX and PPX activities, but had no significant effect on CAT and SOD activity.
- AgNPs-CTAB increased CAT activity and decreased PPX activity, but no significant change in SOD and APX activities was detected.
- Cysteine significantly reduced silver uptake in the plant tissue, decreased ROS formation in both AgNP treatments, elevated MDA content and alleviated antioxidant enzyme activities in combined AgNP and cysteine treatments.
- This result shows that AgNPs phytotoxicity at least partially derives from dissolved silver.

### REFERENCES

8. Babić S. and University of Zagreb [grant number IP-2014-09-6488] and University of Zagreb [grant number 20281122]