Correction to: One-pot synthesis and characterization of in-house engineered silver nanoparticles from *Flacourtia jangomas* fruit extract with effective antibacterial profiles

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We the listed author(s) are pointing out some unintentionally leftover irregularities, typos and mistakes which should be corrected to justify and validate the antibacterial evaluation.

Hereby, we bring to your attention the following irregularities, typos and mistakes in [1].

Abstract

Nanobiotechnology is an emerging field among researchers. Currently the development of plant-mediated biogenic

nanoparticles is gaining much attention. It is notable that the biogenic nanoparticles particularly silver nanoparticles are therapeutically more effective than its chemically synthesized form. Thus, here in, the development of silver nanoparticles (Fj-AgNPs) using aqueous extract of ripe fruit of *Flacourtia jangomas* as a reducing agent is investigated. The developed Fj-AgNPs were additionally compared with ammine modified silver nanoparticles (Am-AgNPs), developed through chemical route using the reported approach and confirm the phyto-reduction of Ag⁺ to Ag⁰. UV–visible spectrum has exhibited a peak at 418 nm and FTIR peak profile (at 1587.6, 1386.4, and 1076 cm⁻¹ with corresponding compounds) in addition to the diffraction peak at 38°, 44°, 64°, 78° in PXRD spectrum confirmed the synthesis of Fj-AgNPs with 8.29 nm average crystallite size. Enhanced anti-bacterial effect is observed in the case of Fj-AgNPs as compared to Am-AgNPs. These results refer to the idea that the use of the aqueous extract of ripe fruit of *Flacourtia jangomas* could be a good replacement of EDTA in the synthesis of silver nanoparticles.

In methodology, under the section “**Strains and culture conditions**”, the bacterial strain, i.e., *Escherichia coli* (ATTC 8723) must read as: *Escherichia coli* (ATTC 8739). The strain “*S. enterica*” must read as: *Salmonella enterica*.

In methodology, the section “**Antibacterial activity of Fj-AgNps and Am-AgNps**” must read as:

Antibacterial activity of Fj-AgNPs and Am-AgNPs was determined by using well diffusion method same as used previously [2]. Fresh bacterial cultures were prepared for each experiment. Then, 70 µL bacterial suspension (0.060 OD at 600 wavelengths) was spread on agar plate homogeneously. After air dry (10 min) at room temperature (RT), 5 wells (6 mm diameter) were made using sterilized steel borer on each plate which were loaded with 50 µL of test

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compounds having 0 mg/mL (control), 0.75 mg/mL, 1.5 mg/mL, 3 mg/mL and 6 mg/mL concentrations, respectively. Later, all plates were placed in an incubator at 37 °C for 24 h. Finally, plates were photographed, and zones of inhibition were measured in cm. The same protocol has been employed to access the anti-bacterial effect of dimethyl sulfoxide (DMSO), plant extract, ethylenediaminetetraacetic acid (EDTA), and ciprofloxacin for the better understanding of anti-bacterial nature of synthesized nanomaterials.

In results and discussion, the section “**Antibacterial potential of Fj-AgNPs in comparison to Am-AgNPs**” must read as:

To discuss the comparison between the bacterial inhibition potential of Fj-AgNPs and Am-AgNPs, the antibacterial activities of plant extract (6 mg/mL), EDTA (6 mg/mL), Fj-AgNPs and Am-AgNPs were evaluated against five pathogenic bacteria namely *Escherichia coli* (*E. coli*), *Bacillus cereus* (*B. cereus*), *Staphylococcus pyogen* (*S. pyogen*), *Salmonella enterica* (*S. enterica*) and *Staphylococcus aureus* (*S. aureus*) using well diffusion method. Later, zones of inhibition were measured as a representative of bacterial susceptibility at different concentrations of a test compound [3].

Both Fj-AgNPs and Am-AgNPs showed concentration dependent and bacterial species dependent killing effect as shown in Fig. 1. The anti-bacterial results of DMSO, plant extract, EDTA, and ciprofloxacin have been given in Fig. 2. The antibacterial effect of Fj-AgNPs increases more as compared to Am-AgNPs upon increasing the dose concentration, except *S. pyogen*s as shown in Fig. 1. Although Am-AgNPs posses EDTA as a functionalized character which considered tremendous anti-bacterial agent. The anti-bacterial capability of the Am-AgNPs ought to be higher than biogenic silver nanoparticles. But in this comparative study the lesser efficiency of Am-AgNPs stands for the lesser ammine functionalization on the nanoparticles surface. This phase is verifiable in the FT-IR spectrum where the absorption peak strength of N–H seems suppressed owing to very less functionalization.

The Fj-AgNPs tested concentrations, 0.75 mg/mL, 1.5 mg/mL, 3 mg/mL and 6 mg/mL showed 0 cm, 0.0266 cm, 0.1781 cm, 0.275 cm zones of inhibition against *E. coli*, 0.0172 cm, 0.0703 cm, 0.1438 cm, 0.2438 cm zones of inhibition against *B. cereus*, 0.0281 cm, 0.0625 cm, 0.1156 cm, 0.2188 cm zones of the inhibition against *S. pyogen*, 0.1688 cm, 0.2656 cm, 0.3438 cm, 0.4813 cm zones of inhibition against *S. enterica* and 0.0609 cm, 0.1219 cm, 0.2031 cm, 0.2375 cm zones of inhibition against *S. aureus*, respectively at 24 h incubation. Furthermore, our results confirmed that all tested strains showed susceptibility against Fj-AgNPs with different level however the *S. enterica*

Fig. 1 Antibacterial susceptibility of Fj-AgNPs and Am-AgNPs against pathogenic bacteria

Fig. 2 Anti-bacterial potential of DMSO, plant extract, EDTA, and ciprofloxacin

showed the highest susceptibility at all tested concentrations (Fig. 1). The control having DMSO solvent (0 mg/mL concentration of Ag-NPs) showed no zone of inhibition for all tested strains. It is expected that the silver ions block the functional operations of bacteria and interfere with the disulfide bonds which results in the structural deformation

of protein. The principal achievement in bio-mediated over chemical fabrication is that it is eco-friendly, cost effective, non-toxic and feasible for commercial production without high temperature and high energy pressure and hazardous chemicals. Conclusively, the anti-bacterial potential of Fj-AgNPs is in good comparison with the reported activities of biogenic AgNPs [4–6].

Conclusion

The synthesis of silver nanoparticles (Ag-NPs) in versatile ways has a deep impact on interdisciplinary science due to their various potential applications. With the present study, an extra-strength has been given for the synthesis using aqueous extract of ripe fruit of *Flacourtia jangomas* as it has good reducing power and potential against pathogenic microbes. The synthesized Fj-AgNps show comparatively good anti-microbial activity as equated to Am-AgNps. This enhanced antibacterial activity is due to the *Flacourtia jangomas* phytochemicals functionalization of silver nanoparticles during the synthesis of FJ-AgNPs.

The original article has been corrected.

References

1. Ahmad, F., Taj, M.B., Ramzan, M., Ali, H., Ali, A., Adeel, M., Imran, M., et al.: One-pot synthesis and characterization of in-house engineered silver nanoparticles from *Flacourtia jangomas* fruit extract with effective antibacterial profiles. *J. Nanostruct. Chem.* (2020). <https://doi.org/10.1007/s40097-020-00354-w>
2. Khurshid, H., Rafiq, M., Nazir, F., Ali, I., Ahmed, M., Akbar, B., Ali, A., et al.: Antimicrobial properties of hydrogen peroxide and potash alum alone and in combination against clinical bacterial isolates. *Pure Appl. Biol. (PAB)* **8**(4), 2238–2247 (2019)
3. Han, D.W., Woo, Y.I., Lee, M.H., Lee, J.H., Lee, J., Park, J.C.: In-vivo and in-vitro biocompatibility evaluations of silver nanoparticles with antimicrobial activity. *J. Nanosci. Nanotechnol.* **12**(7), 5205–5209 (2012)
4. Sharma, V.K., Yngard, R.A., Lin, Y.: Silver nanoparticles: green synthesis and their antimicrobial activities. *Adv. Colloid Interface. Sci.* **145**(1–2), 83–96 (2009)
5. Fatimah, I., Hidayat, H., Nugroho, B.H., Husein, S.: Ultrasound-assisted biosynthesis of silver and gold nanoparticles using *Clitoria ternatea* flower. *S. Afr. J. Chem. Eng.* **34**, 97–106 (2020)
6. Rajathi, F.A.A., Parthiban, C., Kumar, V.G., Anantharaman, P.: Biosynthesis of antibacterial gold nanoparticles using brown alga, *Stoechospermum marginatum* (kützing). *Spectrochim. Acta Part A Mol. Biomol. Spectrosc.* **99**, 166–173 (2012)

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