**Toxicity of inhaled gold nanoparticles in the pest species *Blattella germanica***

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## Abstract

The widespread application of engineered nanoparticles and nanomaterials in the development of new products raises as many doubts about environmental hazards as any new technology. Understanding and assessing the toxicity and potential environmental risks of nanomaterials, preventing thus adverse effects [1,2], is necessary to ensure the responsible development of new nano-products. Unfortunately, in most cases the *in vivo* toxicity profile of many manufactured nanoparticles and nanomaterials remains still unknown.

In our study we investigated the toxicity effects of inhaled gold nanoparticles that could be used in the development of functionalized nanoparticles for insecticide application in the treatment of pest insects. In our case we have studied the german cockroach *Blattella germanica*, which is an important pest in the urban environment and represents a serious threat to public health [3].

AuNPs (average size of 21,8 nm) were synthetized as described in the article by Bastús *et al*. [4] and were characterized by UV-Vis and Transmission Electron Microscopy (TEM). A nebulizer based system was used to deliver 1mL and 2mL solution of AuNPs in sodium citrate ($2{,}2 \cdot 10^{-4} \pm 7 \cdot 10^{-6}$ g Au/L) to the respiratory system of adult cockroaches with times of total exposure ranged between 15 to 90 minutes (figure 1). Each bioassay was replicated three times using 30 insects (15 females and 15 males) aged 1-6 days from the same laboratory-reared population. Mortality rates were monitored post-treatment at 24h intervals during 4 days. In order to bring out possible sub-lethal effects of inhaled AuNPs, glutathione *S*-transferases (GSTs) and esterases (*p*-NPA) enzymatic activities, related to oxidative stress and insecticide resistance [5], were measured in insects frozen immediately after nebulization (table 1) and 96h post-treatment for every bioassay. The activity rates thus obtained were later compared with the results of our previous studies in tarsal contact toxicity bioassays. Finally, inductively coupled spectroscopy (ICP-OES) was performed to check inhaled AuNPs intake in treated insects and if these nanoparticles remained inside the insects' body 96h after exposure to nebulized AuNPs.

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## References

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## Figures

**Table 1. Au content in treated insects with nebulized AUNPs;** Au content was measured at times 0h and 96h post-treatment by ICP-OES. Au was not detected at 96h after treatment with nebulized nanoparticles in any of the bioassays.

| | Au µg /g wW [a] (±SD) | |
|---|---|---|
| Duty [b] (%) | 1mL[c] | 2mL[c] |
| **100** | 0,762±0,378 | 1,999±0,590 |
| **75** | 1,041±0,585 | 1,902±0,281 |
| **50** | 0,729±0,386 | 1,499±0,663 |
| **25** | 1,402 | 1,821±0,931 |
| **10** | 1,114 | 3,076±1,033 |
| **5** | 0,639±0,106 | 2,700±1,370 |

**a,** wW, wet weight
**b**, % of nebulized solution per cycle, 1 cycle equals 6 seconds
**c,** Volume of AuNPs solution ($2{,}2 \cdot 10^{-4} \pm 7 \cdot 10^{-6}$ g Au/L).

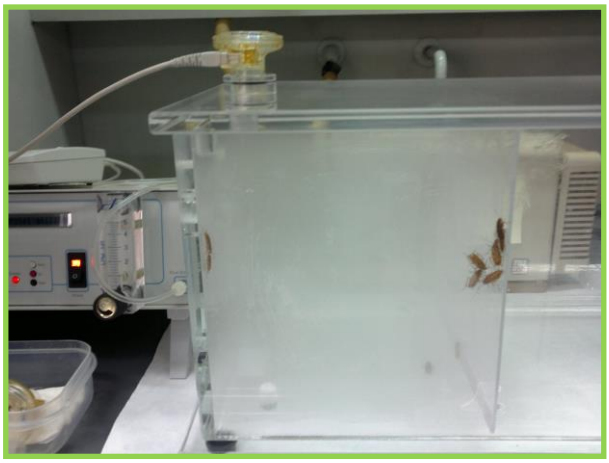

**Figure 1.** Adult individuals of *Blattella germanica* inside the nebulization chamber during the AuNPs inhalation bioassay.