Toxicity assays of nebulized gold nanoparticles with potential applications in the development of nanopesticides

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Abstract

In recent years, nanotechnology applications in agriculture had led to the development of a wide range of plant protection products described as nanopesticides: these products include polimer based formulations [1], formulations containing inorganic nanoparticles [2] and nanoemulsions [3]. The main reasons for the development of these products are the growing need for alternative pesticides to prevent damage on non-target organisms and delay the development of resistances [4]. Moreover, some of these alternative pesticides can benefit from these nanoformulations, which can provide delivery systems for active ingredients with reduced solubility, as well as increase stability and protect them from premature degradation [5].

The toxicity of nebulized gold nanoparticles (AuNPs), which could be functionalized for the formulation of nanopesticides, was tested in two laboratory reared insect species, the german cockroach *Blattella germanica*, considered an important urban pest with serious implications in public health [6], and the milkweed bug *Oncopeltus fasciatus*. AuNPs were synthetized following the methodology described by Bastús *et al*. [7] and characterized by UV-Vis and Transmission Electron Microscopy (TEM). Adult insects (15 females and 15 males, aged 1-6 days) were exposed to 1mL and 2mL of AuNPs in sodium citrate with the aid of a nebulizer based system (figure 1), with times of total exposure ranged between 15 to 90 minutes (table 1). Mortality rates were monitored 24, 48, 72 and 96 hours post-treatment, and enzymatic activities related to oxidative stress and insecticide resistance [8], such as glutathione *S*-transferases (GSTs) and esterases (*p*-NPA), were measured in exposed insects frozen immediately after nebulization and insects frozen at 96h post-treatment. Also, a comparison between the obtained activity rates and results from our previous studies in tarsal contact toxicity bioassays were made for the two insect species. Finally, in order to study the persistence of nanoparticles in treated insects, inductively coupled spectroscopy (ICP-OES) was performed in insects frozen at times 0 and 96 hours after AuNPs exposure.

References

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Figures

Table 1. Total exposure time to nebulized AuNPs

Treatment	Volume (mL)	Duty (%)[a]	Exposure time (h:m:s)			
			Blattella germanica		*Oncopeltus fasciatus*	
			Mean	SD	Mean	SD
AuNP	1	100	0:15:15	0:00:05	0:14:53	0:00:17
		50	0:16:59	0:00:13	0:16:19	0:00:08
		5	0:46:01	0:01:51	0:46:15	0:00:31
AuNP	2	100	0:16:50	0:00:06	0:16:55	0:00:34
		50	0:20:26	0:00:03	0:20:02	0:00:03
		5	1:14:40	0:02:15	1:18:27	0:02:15

[a] % of nebulized solution per cycle (1 cycle equals 6 seconds)

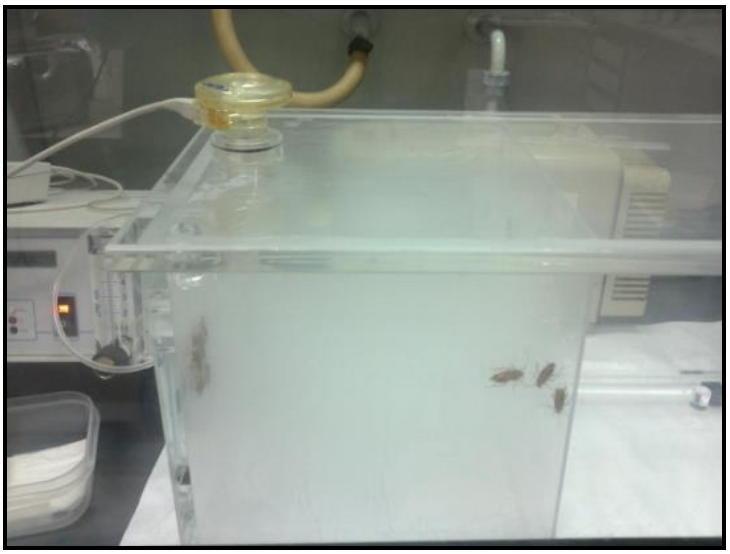

Figure 1. Adult cockroaches being exposed to nebulized AuNPs in the nebulization chamber