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Mechanism of the insecticidal effect of lambda-cyhalothrin loaded mesoporous silica nanoparticles with different sizes and surface modifications on *Ostrinia furnacalis* (Guenée) larvae

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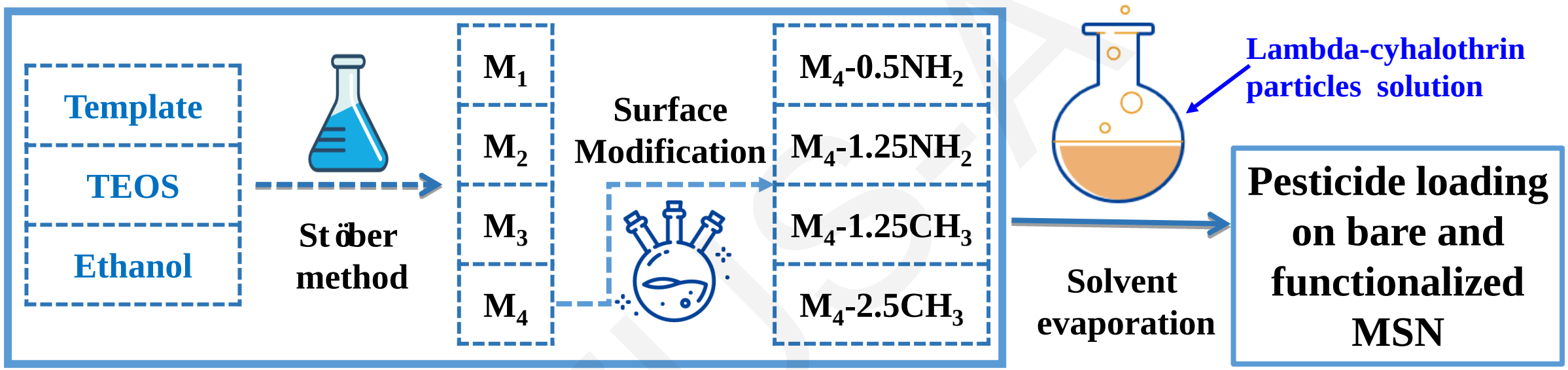
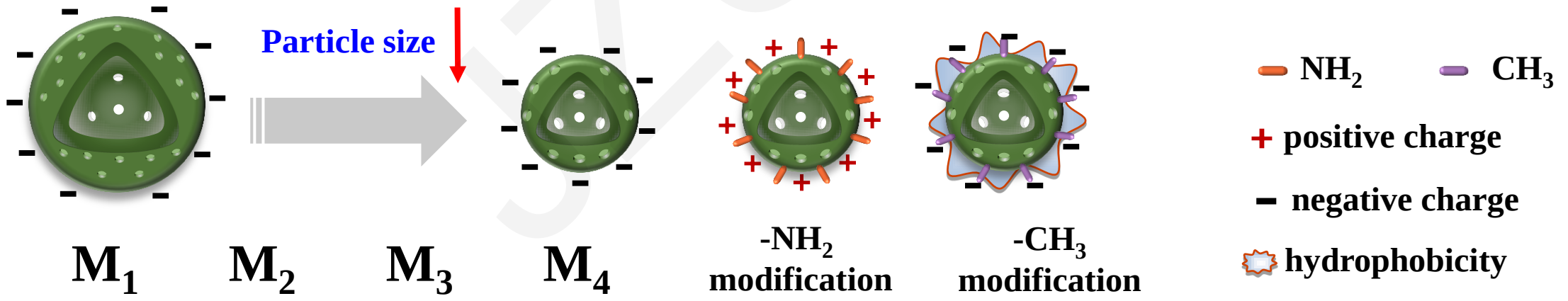
Pesticide loading on bare and functionalized MSN

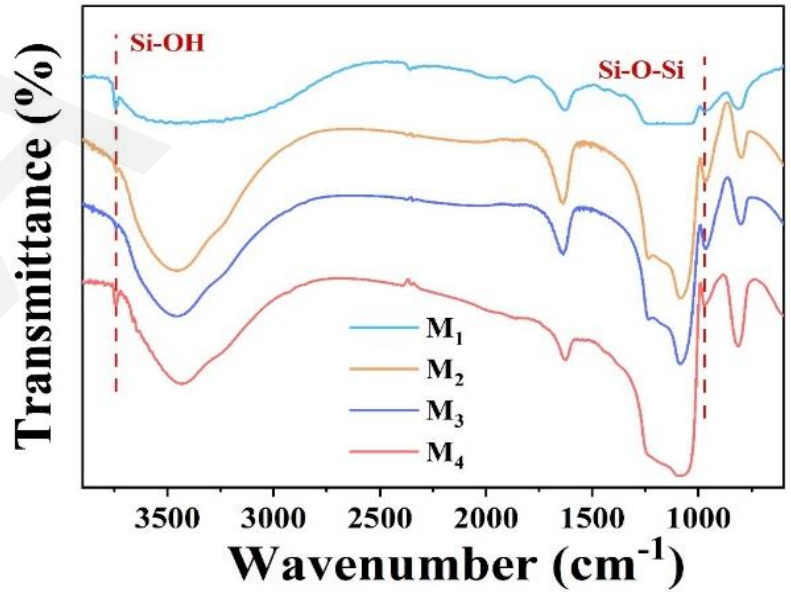


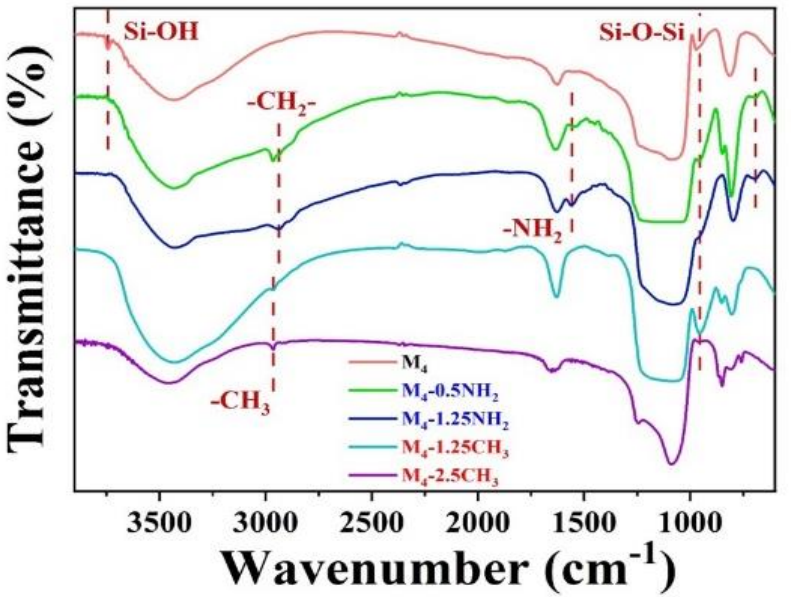


Xiao et al., *Science of the Total Environment*, 831:154914

Material characteristics

Materials	Surface area (m^2/g)	Total pore volume (cm^3/g)	Pore size (nm)
M_1	1586	0.89	2.23
M_2	1858	0.98	2.11
M_3	1441	1.03	2.86
M_4	1634	1.46	3.56
M_4-0.5NH_2	653	0.59	2.42
M_4-1.25NH_2	389	0.40	1.48
M_4-1.25CH_3	1323	1.00	2.31
M_4-2.5CH_3	1184	0.90	2.31





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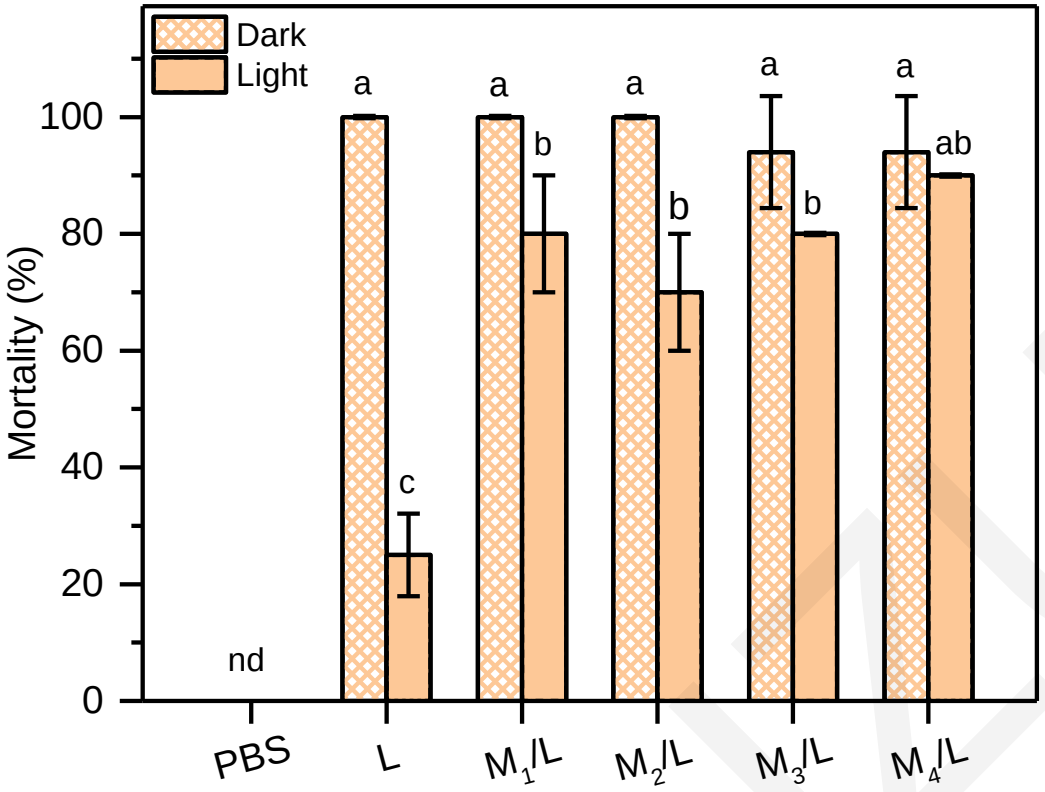
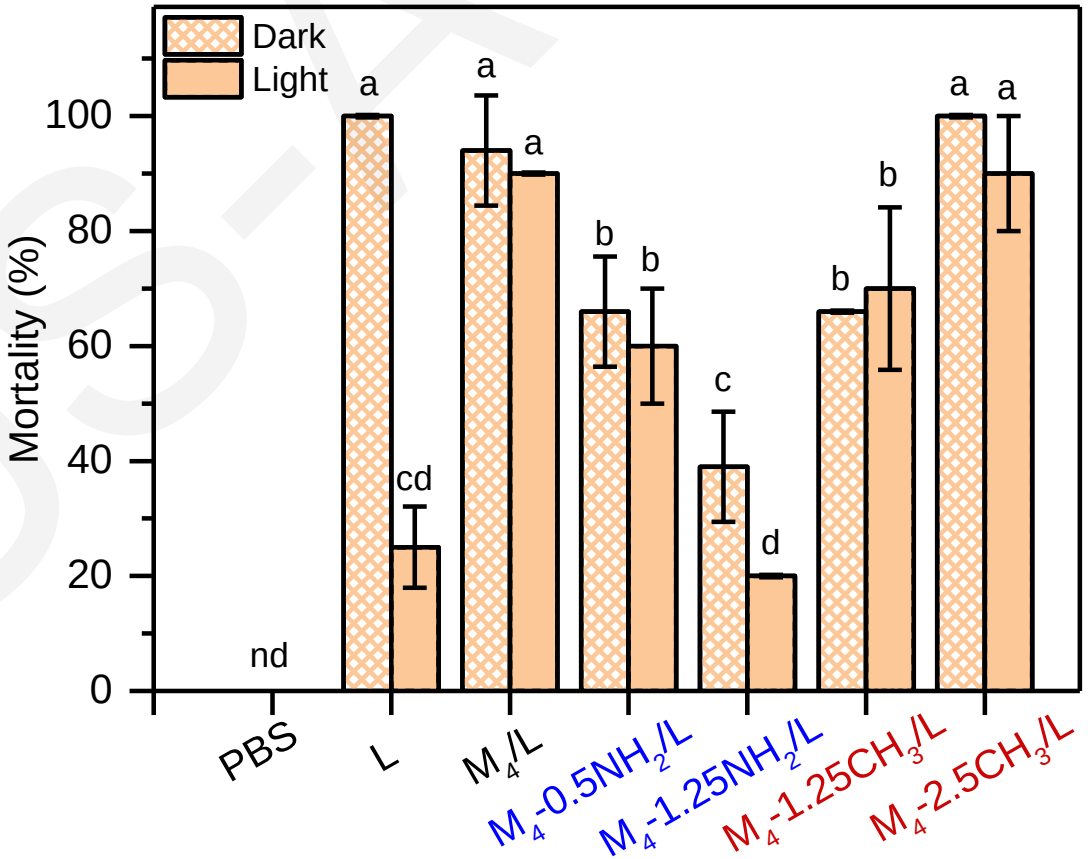
Insecticidal assessment of different LCNS-loaded MSNs under light and dark conditions

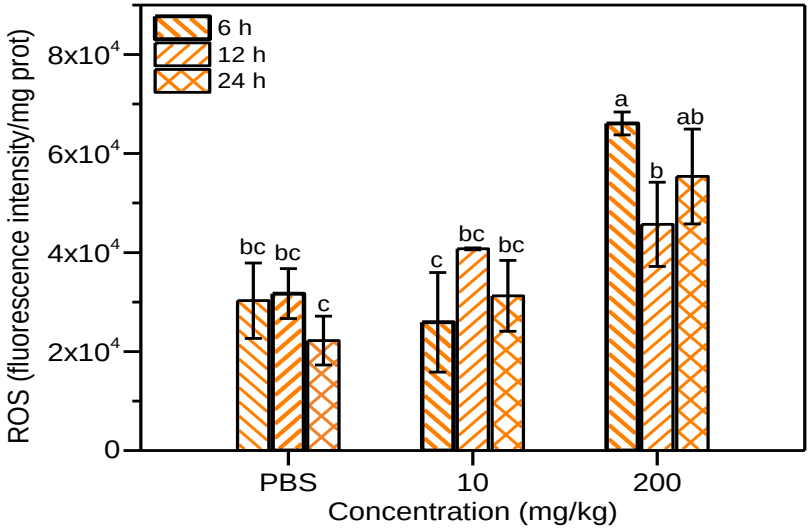


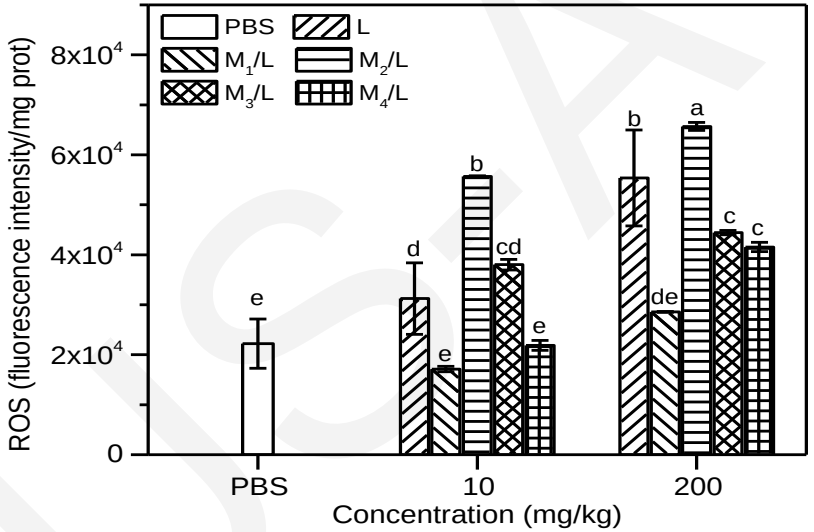
A negligible effect of MSN size was observed on the mortality of O. furnacalis larvae caused by M/L treatments (M_1/L, M_2/L, M_3/L, and M_4/L) under light or dark conditions

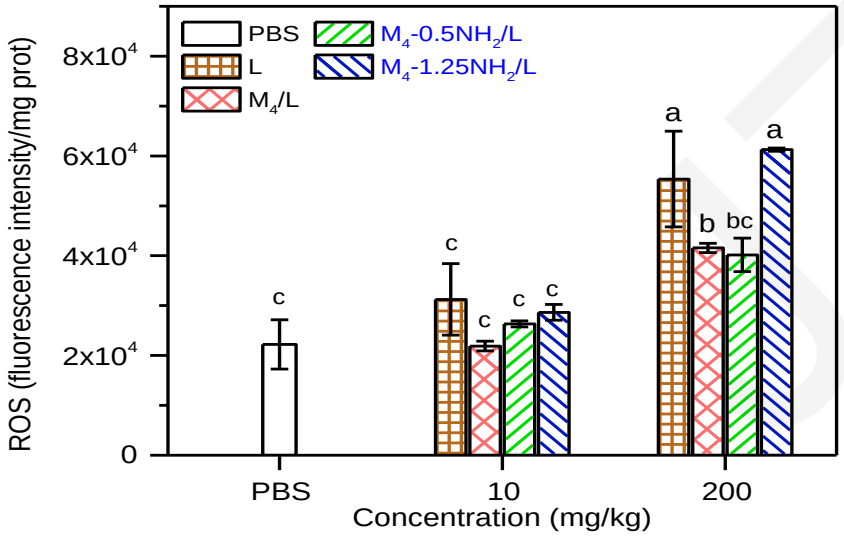


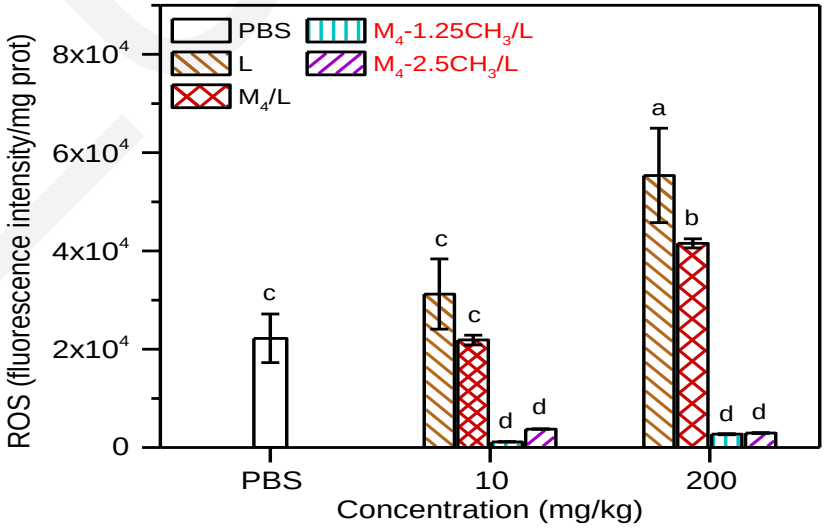
Surface modification of MSN could decrease the biological toxicity of LCNS loaded MSNs

Effects of different LCNS-loaded MSNs on reactive oxygen species accumulation





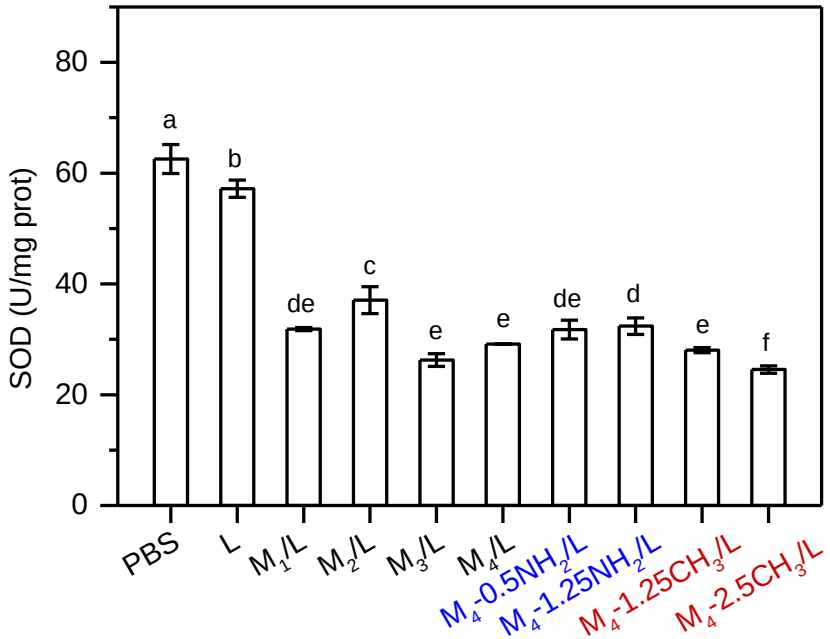


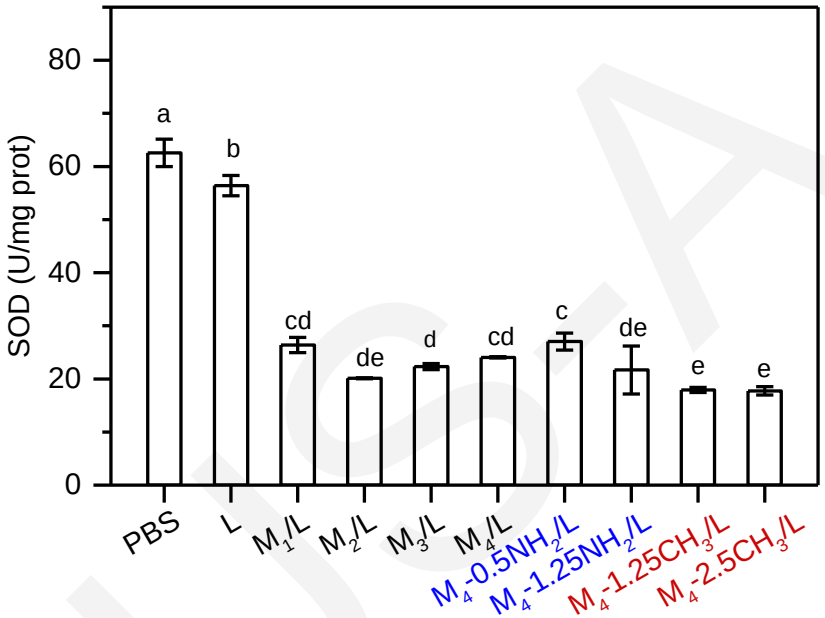


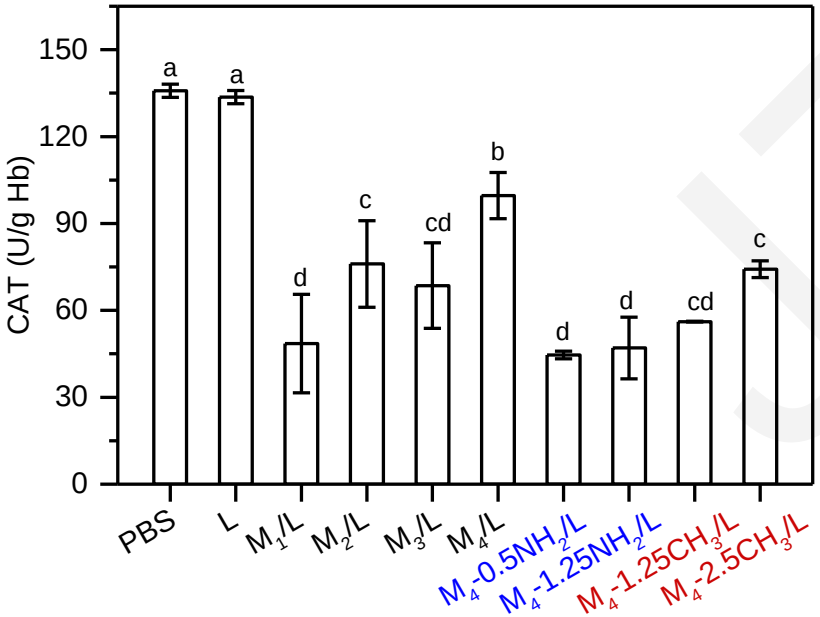
The comparable or lower ROS levels in the LCNS-loaded MSN treatments were observed in comparison with the LCNS treatment

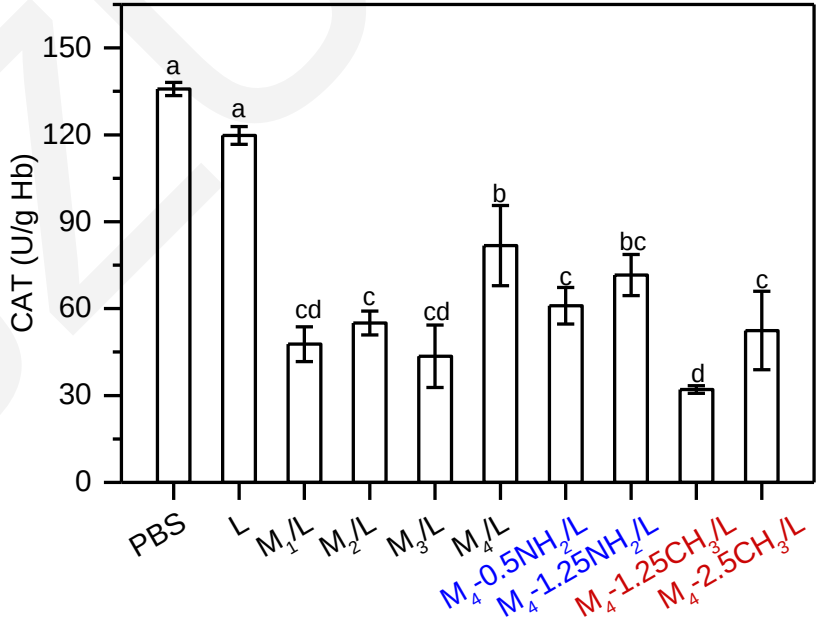
Oxidative damage in *O. furnacalis* larvae was not the main reason for the high insecticidal activity of LCNS-loaded MSN.

Effects of different LCNS-loaded MSNs on antioxidase activity



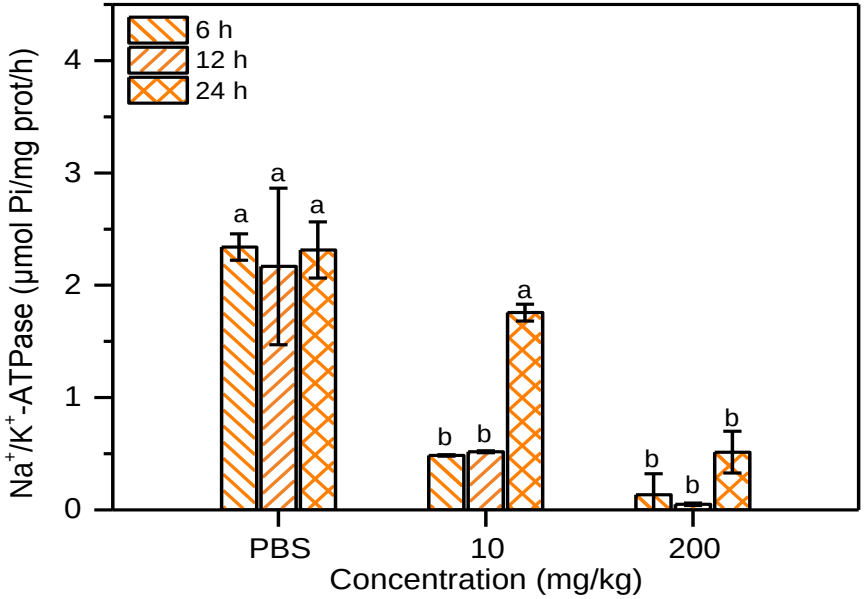


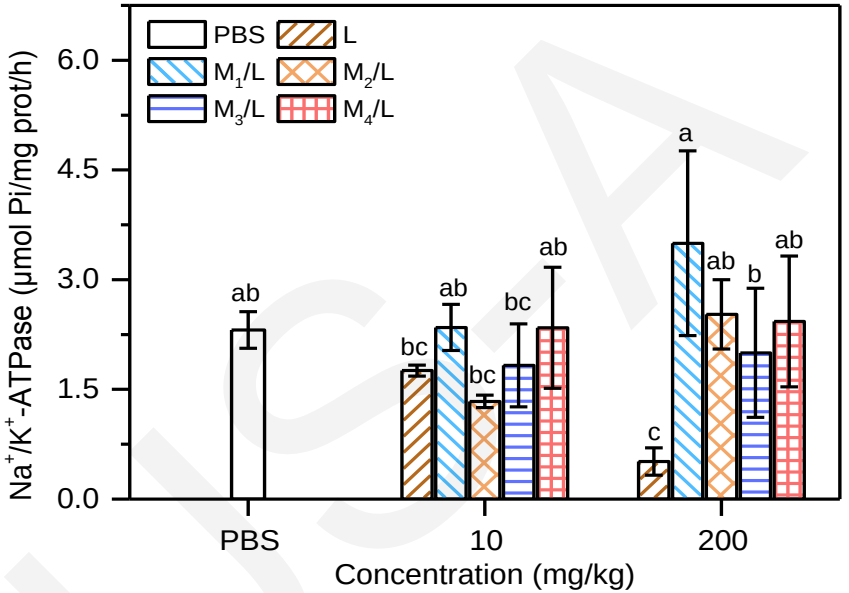


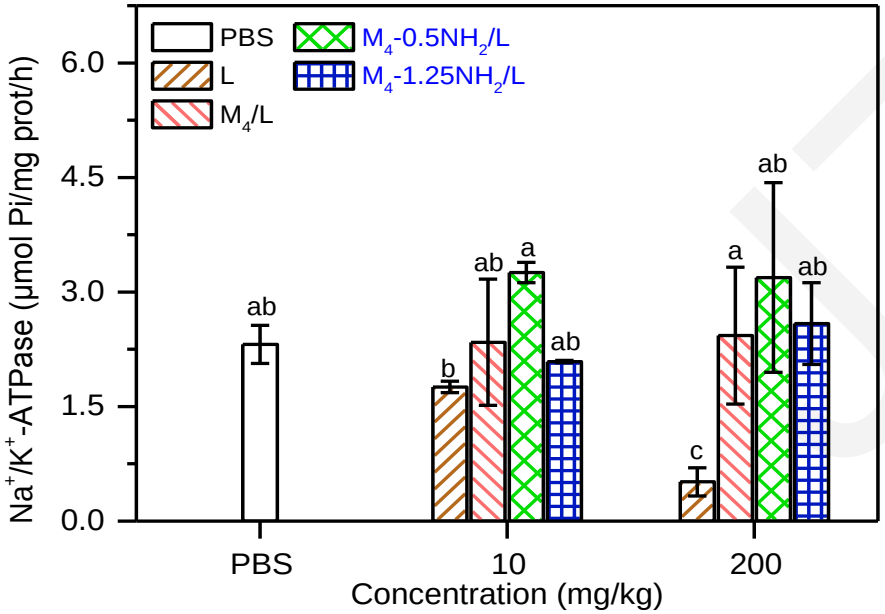


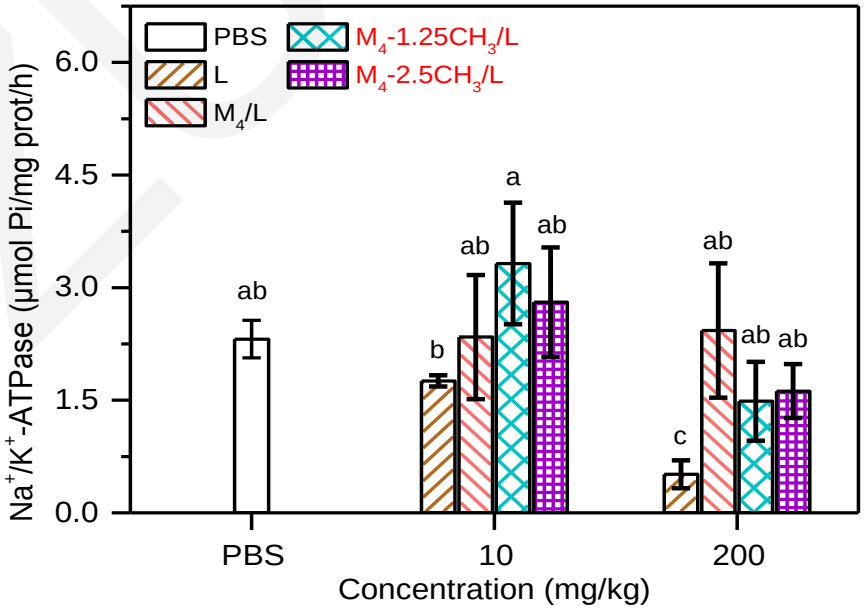
The alteration of antioxidase activities by treatments of LCNS-loaded MSNs was size-, dose-, and surface modification-dependent.

Effects of different LCNS-loaded MSNs on Na^+/K^+-ATPase activity









Comparable Na^+/K^+-ATPase activity was observed between the M/L and PBS treatments.

Compared to the PBS treatment, the M_4–NH_2/L and M_4–CH_3/L treatments showed no significant inhibition of Na^+/K^+-ATPase activity.

Conclusions

- **Loading LCNS onto bare or modified MSNs could reduce the negative impacts of light due to the improved photochemical stability of the loaded LCNS on MSN.**
- **The effect of MSN size on the insecticidal effect of LCNS-loaded MSN was negligible, while the surface modifications of $-NH_2$ and $-CH_3$ on MSN decreased the insecticidal effect under both the light and dark conditions.**
- **The ROS content in *O. furnacalis* larvae increased following treatment with LCNS-loaded MSNs of medium size (about 95 nm) and a surface modification of $-NH_2$.**
- **LCNS-loaded MSNs with different sizes and surface modifications inhibited SOD and CAT activities, but LCNS-loaded MSN treatment had a negligible effect on Na^+/K^+-ATPase activity in the *O. furnacalis* larvae.**
- **The high insecticidal activity of LCNS-loaded MSNs was probably caused by the increased exposure of LCNS from the sorbed LCNS-loaded MSNs rather than oxidative damage to *O. furnacalis* larvae.**