

## Summary

The aim of this research was to determine whether the immunological and oxidative–reductive response of the organism to copper nanoparticle (CuNPs) supplementation depends on the physiological properties of dietary fiber. It was hypothesized that the biological effects of CuNPs are dose-dependent and modulated by the type of dietary fiber, which, through its impact on the intestinal environment and microbiota, may regulate their bioavailability and metabolic effects.

The study was conducted on Wistar rats using a two-factor experimental design, including two levels of copper (6.5 and 13 mg/kg), two forms of copper (CuCO<sub>3</sub> and CuNPs), and four types of dietary fiber (cellulose, inulin, pectin, and psyllium). The effects of these factors on gastrointestinal function, oxidative–reductive status, copper bioavailability and distribution, liver metabolism, and immune response were evaluated.

The results demonstrated that CuNPs exhibit higher bioavailability compared to conventional inorganic forms, leading to altered tissue distribution and affecting the homeostasis of other minerals. At the same time, CuNPs were shown to induce oxidative stress and modulate immune responses in a dose-dependent manner.

It was found that the intestine plays a key role in regulating the organism's response to CuNPs. Interactions between nanoparticles and gut microbiota influence the production of short-chain fatty acids, the integrity of the intestinal barrier, and inflammatory processes, thereby determining systemic effects.

Dietary fiber was identified as a significant modulator of CuNPs' biological effects. Inulin exhibited protective effects at the recommended dose, whereas pectin and psyllium reduced oxidative stress and inflammatory responses under higher CuNPs intake. These differences result from the distinct physicochemical properties of dietary fiber.

In conclusion, the biological effects of CuNPs depend on the interaction between nanoparticle dose and dietary composition. Appropriately selected dietary fiber may mitigate the adverse effects of CuNPs, indicating its potential role in improving the safety of copper nanoparticle application in nutrition.

**Keywords:** rats, copper, nanoparticles, immunology, redox status