Searching for the power of hormesis - Effects of silver nanoparticles, graphene oxide (GO), and GO-Ag composite on the functions of digestive enzymes in *Acheta domesticus*

Due to their unique physicochemical properties, nanoparticles arouse great interest and hope for their use in many areas of human life. The very small size of nanoparticles and their high reactivity are the main features that make them attractive and useful in producing electronic and optical devices, clothing, fuels, paints, packaging, drugs and dressings, cosmetics, and many other products. Undoubtedly, nanoparticles are now the driving force behind the development of civilization and improve the comfort of our lives. However, when deciding to use them, we must remember that they are not neutral to humans and other organisms. We now know that nanoparticles can cause an imbalance in the body under certain conditions (i.e., a disturbance of homeostasis), leading to impaired vital functions. Even in some circumstances, they can cause serious diseases.

Nanoparticles can enter food as a result of intentional human actions. For example, they are used as food additives, preservatives, supplements, or packaging components. Not infrequently, however, they can contaminate food in an accidental manner, such as during food production (e.g., the use of nanopesticides), cleaning, and disinfection of devices and equipment. It is also possible to accidentally consume personal care products and cosmetics containing these structures. As we might guess, the consumption of nanoparticles may affect the functions of the digestive system, including the activity of digestive enzymes responsible for food decomposition. Disorders at this stage of the body's functioning will shift into the amount of available matter and energy necessary for the proper functioning of an organism. In a situation of energy/matter deficiency, the organism is forced to get a certain compromise, which means a shift of energy towards the critical processes for survival. When exposed to an additional stress factor (e.g., a toxin), usually part of the energy obtained from food is used to detoxify and repair the resulting damage instead of keeping growth and reproduction.

Few studies by other authors show that some nanoparticles can inhibit the activity of digestive enzymes, contributing to digestive impairment. However, in our preliminary research on an insect model - *Acheta domesticus*, we showed that low concentrations of silver nanoparticles (AgNPs), graphene oxide (GO), and a composite of silver nanoparticles and graphene oxide (GO-Ag) increased the activity of digestive enzymes in the early stage of exposure. Furthermore, these changes were accompanied by a temporary increase in food consumption. We conducted our research using a semi-quantitative screening test and low concentrations of nanoparticles. Therefore, in this project, we want to explain in detail the relationship between the type of nanoparticles - their concentration in food - exposure time - the activity of selected digestive enzymes - the amount of food consumption. We will measure the activity of proteases, amylases, α-glucosidase, β-glucosidase, β-galactosidase, and lipases after exposure of insects to various concentrations of AgNPs, GO and GO-Ag composite. In addition, we will determine the amount of food consumption depending on the dose and exposure time to the nanoparticles. We will also check whether the nanoparticles affect the condition of the epithelial cells. The results obtained during the project will be discussed in light of the theories of stress, energy allocation, and hormesis.

It seems that the penetration of various nanoparticles in various concentrations into the gastrointestinal tract is inevitable. Their consumption is also related to the development of pharmacology, where nanoparticles can be used as drug carriers. They are also increasingly used in the production of plant protection products. Therefore, knowing how these structures affect all organisms is crucial. The results of this project will provide an opportunity to understand the impact of selected nanoparticles on the functions of the gastrointestinal tract and provide arguments for discussion and draw the attention of producers and users of products containing nanoparticles to the safety of their use.