

INNOVATIVE ORGANIC NANOZYMES: A GAME-CHANGER FOR SUSTAINABLE FARMING AND SOIL HEALTH

Bohdan Todoruk

Faculty of Chemical Technology,

National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”

In the conditions of a growing population, a drastic increase in consumerism and the negative effects of climate change, the concept of sustainable agriculture is becoming particularly critical.

To solve the problem of soil degradation, it can be extremely important to use nanozymes, which are nanomaterials with enzymatic activity, but with greater strength and stability, compared to natural enzymes.

«...nanozyme is derived from nanomaterial and enzyme. Nanozymes were first developed about 15 years ago, when researchers found that iron oxide nanoparticles may perform catalytic activity similar to natural enzymes (peroxidase)» (Lee & Kamruzzaman, 2023, p. 12).

Nanozymes can completely replace peroxidase, a highly effective catalyst in the digestion processes of biologically active substances by plants, although it has many disadvantages, including excessively high cost, limited stability, and temperature and pH dependence.

Dong Hoon Lee mentions: the nanozymes that have been synthesized until now are created from inorganic metal materials (For example, Fe-based single-atom NZs), and therefore were not suitable for agricultural or food industry use, due to their high

toxicity and excessive production costs.

It is claimed that nanozymes synthesized on the basis of organic compounds, unlike traditional enzymes are easier and cheaper to produce, non-toxic and don't inflict any damage on the environment. Nanozymes can be created via a self-assembling one-pot particle synthesis procedure, showing good kinetic properties and pH stability.

It is promising to use them as an alternative to nitrate fertilizers, due to their significant positive effect on the growth of crops, a reduced rate of soil depletion, and low toxicity for humans.

Also, an attractive field for research is the development of a portable and applicable test kit for farmers and consumers, relying on a colorimetric sensor system: In order to identify specific molecules of interest, the scientists integrated an optical sensing method with the OC nanozyme, resulting in a colorimetric sensing device. This device uses variations in color intensity, with darker colors indicating lower concentrations of the target molecules. Colorimetric assays utilize this optical method to determine the presence and concentration of specific molecules in a given sample.

References:

Baily, S. (2023, October 17). Organic compound-based nanozymes for detecting agricultural herbicide. *AZONANO*. Retrieved October 31, 2023, from <https://www.azonano.com/news.aspx?newsID=40461>.

Cui, Z., Li, Y., Zhang, H., Qin, P., Hu, X., Wang, J., Wei, G., & Chen, C. (2022). Lighting up agricultural sustainability in the new era through Nanozymology: An overview of classifications and their agricultural applications. *Journal of Agricultural and Food Chemistry*, *70*(42), 13445–13463. <https://doi.org/10.1021/acs.jafc.2c04882>

Lee, D.H., & Kamruzzaman, M. (2023). Organic compound-based nanozymes for agricultural herbicide detection. *Nanoscale*, *15*(31), 12954–12960. <https://doi.org/10.1039/d3nr02025h>

Waris, Hasnat, A., Hasan, S., Bano, S., Sultana, S., Ibhaddon, A.O., & Khan,

M.Z. (2023). Development of nanozyme based sensors as diagnostic tools in Clinic Applications: A Review. *Journal of Materials Chemistry B*, 11(29), 6762–6781. <https://doi.org/10.1039/d3tb00451a>