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Summary of the doctoral dissertation prepared by Patryk Kosowski, Master of Science

Title: Usefulness of municipal sewage sludge stabilized with ozone for fertilization of selected species of crops

In Poland, sewage paths formed by sewage sludge, it is conditioned by the development of infrastructure in the discharge of municipal sewage. Therefore, it encourages to establish their rational disposal and final disposal. The target national goals of the Waste Management Plan 2022 are to maximize the use of biogenic capacity for admission in sewage sludge, while meeting the requirements for sanitary, chemical and environmental safety.

One of the methods of stabilizing sewage sludge in Poland is its liming with the use of calcium oxide. Liming sewage sludge may cause the loss of some nutrients, as this process results in a decrease in the content of organic matter and loss of nitrogen contained in the sludge through the emission of ammonia to the atmosphere. This method is also costly for sewage treatment plants. An alternative method could be the use of ozone gas. It is under the influence of this gas that not only the physicochemical properties of the sludge change, but also the microbiological ones. Ozone also destroys a number of compounds considered carcinogenic, such as polycyclic aromatic hydrocarbons (PAHs), and is also used to remove odors and refractive compounds.

The work involved the ozonation process in a countercurrent flow reactor, sludge from the treatment plant in Ropczyce. Optimization of the process was carried out for 15, 30, 45 and 60 minutes at an ozone concentration of 90-110 ppm. As a result of ozone action on the sewage sludge, the number of colony forming units was reduced by at least one order of magnitude in relation to the non-ozonized sample and better sludge dewaterability was obtained, with the sludge pH unchanged. The value of COD and BOD₅ increased with the time of the process, thanks to the increased availability of organic matter. Also, the ozonation process did not increase the content of heavy metals (Cd, Cr, Cu, Ni, Pb, Zn). Moreover, no pathogenic microorganisms (Coli bacteria of faecal type, live eggs of intestinal parasites *Ascaris* sp., *Trichuris* sp., *Toxocara* sp.)

Were present in the examined sediments. Thus conditioning the possibility of their natural use in accordance with applicable law.

Pot experiments were established to assess the influence of sewage sludge on the initial growth and development of selected crop species. The soil with the granular composition of loose sand was used and mixed with ozonized and non-ozonated sludge, respectively. The dose of each sludge was 0, 3, 6 and 9 Mg · ha⁻¹ d.m. The soil material mixed with the sewage sludge was placed in plastic vases in which the seeds of: maize (MAS 29.T), spring wheat (Ostka) were sown. After sowing the seeds, the vases were placed in a phytotron chamber (type G, 1000 LTH) with set daily cycles for a period of 4 weeks.

Corn and wheat growing on loose sand were characterized by a faster growth and development rate and a better general condition, compared to the object with the non-ozonised sludge and the control object. Sewage sludge provides the plant with valuable nutrients and organic matter. Present, among others easily digestible compounds of phosphorus and nitrogen in the sludge are better accumulated by the plant, which increased their yield. The content of micronutrients and macronutrients in the above-ground parts of the studied plants depended on the method of sludge stabilization, the time of uptake and its dose. On the other hand, the toxic heavy metals present in the sewage sludge were accumulated by these plants in various ways. Corn accumulated more Cu and Fe than wheat.

After completion of the pot experiments, it was found that fertilization with various doses of sludge in loose sand did not change its pH. The content of biogenic compounds and heavy metals changed depending on the date of sludge collection and its dose.