

Streszczenie rozprawy doktorskiej w języku angielskim

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Doctoral thesis title: Valorization of poultry manure through anaerobic co-digestion with organic waste within the framework of a circular economy

This doctoral thesis presents a comprehensive study on the valorization of poultry manure through anaerobic co-digestion with locally available biowaste. Particular attention was devoted to improving process stability, increasing methane production efficiency, and evaluating the fertilizing value and safety of the resulting digestate. The research was driven by the need to develop sustainable strategies for managing poultry manure - one of the most abundant and nitrogen-rich agricultural residues, while simultaneously seeking technologies that enable energy and nutrient recovery in line with the principles of the circular economy.

The theoretical background, based on a series of review publications, identified anaerobic digestion as a promising technology for the stabilization of poultry manure and its conversion into renewable energy and nutrient-rich products. However, its practical application is constrained by the low carbon-to-nitrogen ratio and the risk of ammonia inhibition. To overcome these limitations, co-digestion with other locally available organic wastes, such as sewage sludge and grease trap residues was proposed. The management of these waste streams also poses significant environmental and technological challenges, while their complementary physicochemical properties make them suitable for joint processing. Combining these substrates helped balance feedstock composition, improve buffering capacity, and enhance process stability.

Experimental research confirmed that the co-digestion of poultry manure with sewage sludge is technically feasible and leads to a significant increase in methane yield compared with the digestion of sewage sludge alone. The optimal share of poultry manure in the feedstock mixture ranged from 20% to 40% of volatile solids, ensuring process balance, reducing ammonia accumulation, and creating a clear synergistic effect between substrates. The obtained digestate was characterized by a stable chemical composition, neutral to slightly alkaline pH, and a high content of nutrients,

particularly nitrogen, phosphorus, and calcium - indicating its fertilizing potential and suitability as a soil-improving material.

Further research focused on the possible reuse of digestate and the intensification of biogas production from poultry manure-based mixtures. The studies demonstrated that digestate can be successfully used in the cultivation of *Agaricus bisporus* as an additive to the casing layer, provided that its proportion does not exceed a few percent of the casing mass. Moreover, chemical and thermo-alkaline pretreatments, particularly saponification with sodium hydroxide - significantly improved substrate solubilization, accelerated hydrolysis, and increased methane yield by up to 63% compared with untreated mixtures.

The results confirmed the validity of the research hypotheses. It was shown that co-digestion of poultry manure with selected organic wastes enhances process efficiency and stability; that the resulting digestate exhibits valuable fertilizing potential but requires further assessment regarding its safe environmental application; and that pretreatment constitutes an effective tool for the intensification of methane production.

The dissertation demonstrates that integrating poultry manure co-digestion with appropriately selected biowastes, supported by targeted pretreatment methods and sustainable digestate management, provides an efficient and environmentally sound strategy for converting agricultural and municipal residues into renewable energy and value-added products. These outcomes align with the goals of the circular economy and support the development of energy self-sufficient wastewater treatment systems and waste-to-energy installations.