Utilization of anaerobic digestate for fertilization purposes - a new technology proposal

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A large proportion of farms uses mineral fertilizers, the production of which has a negative impact on the environment. An additional problem is the low content of organic matter in arable soils. Enriching the soil with organic carbon, or at least keeping it at a constant level, is recognized as one of the main goals of European agriculture (Costantini et al., 2020). Agricultural and livestock production waste is mainly collected and stored, which causes ammonia and methane emissions. Agriculture is responsible for around 20% of greenhouse gas emissions and generates large amounts of waste biomass (Muscolo et al., 2021). This negative impact can be minimized by valorization of the waste to produce new liquid and solid fertilizers for local use.

For the management of waste from the agri-food industry, the anaerobic digestion (AD) process is increasingly used, which makes it possible to transform biodegradable organic matter into biogas. The process also produces leachate and digestate, which may contain macro and micronutrients (Zhang et al., 2021). The liquid digestate from AD organic waste discharged into the environment may result in its contamination with nutrients. Another way is the use as the base for organic-mineral fertilizer formulations (Orner et al., 2021).

The possibility of managing leachate and digestate from anaerobic fermentation of sewage from biological chambers from biogas plants of municipal waterworks in Wrocław (MPWiK, Wrocław, Poland) have been examined. The composition of the sewage after the biological treatment process, which can potentially be used for irrigation of arable lands, was tested, as well. The compositions of leachate, digestate from the biogas plant and treated sewage are presented in Table 1.

Table 1. Elemental composition of leachate, digestate from anaerobic fermentation and treated sewage

Element	**Treated sewage**	**Leachate**	**Digestate**
		Macronutrients, mg/kg	
Ca	73 ± 11	55 ± 8	17915 ± 2687
K	95 ± 14	258 ± 39	2430 ± 365
Mg	14 ± 2	26 ± 4	4092 ± 614
Na	114 ± 17	126 ± 19	701 ± 105
P	17 ± 3	78 ± 12	15700 ± 2355
S	67 ± 10	35 ± 5	3301 ± 495
		Micronutrients, mg/kg	
B	< LOD ± < LOD	< LOD ± < LOD	9.6 ± 1.4
Co	0.11 ± 0.02	0.051 ± 0.008	5.3 ± 0.8
Cu	0.91 ± 0.14	0.39 ± 0.06	126 ± 19
Fe	3.0 ± 0.4	6.0 ± 0.9	17840 ± 2676
Mn	0.45 ± 0.07	0.34 ± 0.05	211 ± 32
Mo	0.24 ± 0.04	0.041 ± 0.006	5.4 ± 0.8
Se	0.31 ± 0.05	0.23 ± 0.03	< LOD ± < LOD
Si	2.5 ± 0.4	19 ± 3	72 ± 11
Zn	2.3 ± 0.3	1.6 ± 0.2	1416 ± 212
		Toxic elements, mg/kg	
Al	0.66 ± 0.10	1.5 ± 0.2	12365 ± 1855
As	0.39 ± 0.06	0.16 ± 0.02	8.7 ± 1.3
Cd	0.042 ± 0.006	0.012 ± 0.002	1.4 ± 0.2
Cr	0.049 ± 0.007	0.088 ± 0.013	63 ± 10
Ni	0.13 ± 0.02	0.15 ± 0.02	20 ± 3
Pb	0.080 ± 0.01	0.54 ± 0.08	43 ± 6
Sb	0.09 ± 0.01	0.073 ± 0.011	4.3 ± 0.6

The tested samples were characterized by the content of fertilizer nutrients at a level predisposing them to agricultural use and a low content of toxic elements. The possibility of biofortification of plants was assessed in the pot tests. Integrating the anaerobic digestion approach will increase the circulation of waste and reduce greenhouse gas emissions by converting biomass to fertilizers.

Application batches of fertilizers were produced. which were subjected to phytotoxicity tests and preliminary tests of agricultural suitability.

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Costantini. E. A. C.. Antichi. D.. Almagro. M.. Hedlund. K.. Sarno. G.. & Virto. I. (2020). Local adaptation strategies to increase or maintain soil organic carbon content under arable farming in Europe: Inspirational ideas for setting operational groups within the European innovation partnership. *Journal of Rural Studies*. *79*. 102–115. https://doi.org/10.1016/J.JRURSTUD.2020.08.005

Muscolo. A.. Romeo. F.. Marra. F.. & Mallamaci. C. (2021). Recycling agricultural. municipal and industrial pollutant wastes into fertilizers for a sustainable healthy food production. *Journal of Environmental Management*. *300*. 113771. https://doi.org/10.1016/J.JENVMAN.2021.113771

Orner. K. D.. Smith. S. J.. Breunig. H. M.. Scown. C. D.. & Nelson. K. L. (2021). Fertilizer demand and potential supply through nutrient recovery from organic waste digestate in California. *Water Research*. *206*. 117717. https://doi.org/10.1016/J.WATRES.2021.117717

Zhang. X.. Lopes. I. M.. Ni. J. Q.. Yuan. Y.. Huang. C. H.. Smith. D. R.. Chaubey. I.. & Wu. S. (2021). Long-term performance of three mesophilic anaerobic digesters to convert animal and agro-industrial wastes into organic fertilizer. *Journal of Cleaner Production*. *307*. 127271. https://doi.org/10.1016/J.JCLEPRO.2021.127271