engineering proceedings

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Proceeding Paper

The effect of homogenized biosolution allocation in the digestate on reducing ammonia emissions

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Abstract: Digestate (anaerobic ferment) is an organic substance remaining after anaerobic processing (fermentation, fermentation) of organic matter or biodegradable waste - biogas extraction or anaerobic alcoholic fermentation - bioethanol extraction. Biogas production waste digestate is a valuable fertilizer in agriculture, but there are issues with odor emissions. Therefore, in order to reduce environmental air pollution, the efficiency of integrating a homogenized biosolution - an activator of rotting residues into the digestate for ammonia emission was evaluated by scientific studies of ammonia gas emission. The purpose of the study is to evaluate the effect of homogenized biosolution - rotting residue activator (carrier molasses without GMO) in the digestate on reducing ammonia emissions. The assessment of ammonia gas emission was performed by measuring the average ammonia concentration values fixed in time intervals every 15 min by automatic switching of the analyzer channels, in order to first assess the sudden immediate effect of the biosolution and the regular gradual long-term effect. After evaluating the average concentration and emission of ammonia gas from the control and digestate with biosolutions depending on the duration of digestate storage, the correlation of the values compared with each other was established and the effect of the allocation of the biosolution - rotting residue activator in the digestate on the reduction of ammonia concentration and emission was recorded. The highest efficiency of the biosolution in reducing ammonia emissions ranged from 3 to 43% in the period from 1 to 100 h, which reached up to 450,000 mg $m^{-2}h^{-1}$. After evaluating the overall average reduction of ammonia emissions from digestate with biosolution over the entire period, the essential effect of the use of biosolutions was proven and the highest effect was recorded in the first 24 hours. after the allocation of the biosolution - the activator of rotting residues in the digestate. Thus, supplementing the digestate with various nutrients and specialized biosolutions provides an even better fertilizing value and prospects for reducing odor emissions.

Keywords: barley yield; bacteria; potassium; phosphorus; soil

Citation: Naujokienė, V.; Stankevičius, E.; Šarauskis, E. The effect of homogenized biosolution allocation in the digestate on reducing ammonia emissions. **2023**, *5*, x. https://doi.org/10.3390/xxxxx

Published: 31 May

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1. Introduction

Digestate (anaerobic ferment) is an organic substance remaining after anaerobic processing (fermentation, fermentation) of organic matter or biodegradable waste - biogas extraction or anaerobic alcoholic fermentation - bioethanol extraction. Biogas production waste digestate is a valuable fertilizer in agriculture, but there are issues with odour emissions and contribute to pollution without comprehensive management strategies. Raw material, processing technology and process operating conditions greatly influence the characteristics of the digestate product (Lamolinara et al., 2022). To date, no data are available on digestate production, but according to EU-28 estimates, around 180 million tonnes of digestate are produced annually, of which 68% is of agricultural origin (Catenacci et al., 2022). Cascade pre-treatment with ozonation and ammonia removal is applied for

sustainable liquid digestate treatment, nutrient recovery and value-added biomass production (Zhu et al., 2022).

1. Method

In order to reduce environmental air pollution, the efficiency of integrating a homogenized biosolution - an activator of rotting residues into the digestate for ammonia emission was evaluated by scientific studies of ammonia gas emission. The purpose of the study is to evaluate the effect of homogenized biosolution in the digestate on reducing ammonia emissions. Biosolution is rotting residue activator (carrier molasses without GMO, calcium carbonate, dolomite, sodium hydrogen carbonate, magnesium sulphate) complies with EC Eco-BasisVO 834/2007 and 889/2008, has ECOCERT approval, is listed in FiBL Switzerland, manufactured by Roland with Plocher integral technology, the physical and chemical structure of molasses does not change after processing. It is recommended to add 1.5 - 2 l/100 m^3 of biosolution to the liquid part of the digestate. The assessment of ammonia gas emission was performed by measuring the average ammonia concentration values fixed in time intervals every 15 min by automatic switching of the analyzer channels, in order to first assess the sudden immediate effect of the biosolution and the regular gradual long-term effect.

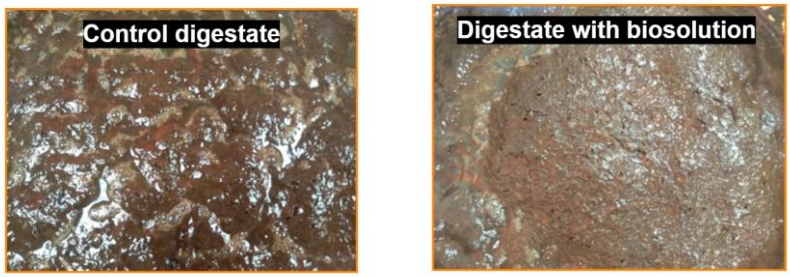

Figure 1. Visual difference between control and digestate with biosolutions.

The consistency structure of the digestate in the surface visualization shows an increased density and percentage composition of dry matter in the digestate with biosolutions. The differences in ammonia emissions from the control and digestate with additives after certain test periods confirm the previously obtained results and show the effect and target efficiency of biosolutions to influence the processes taking place in the manure (Figure 1).

1. Results and Discussion

After evaluating the average emission of ammonia gas from the control and digestate with biosolutions depending on the duration of digestate storage, the correlation of the values compared with each other was established and the effect of the allocation of the biosolution - rotting residue activator in the digestate on the reduction of ammonia concentration and emission was recorded (Figure 2, 3, 4).

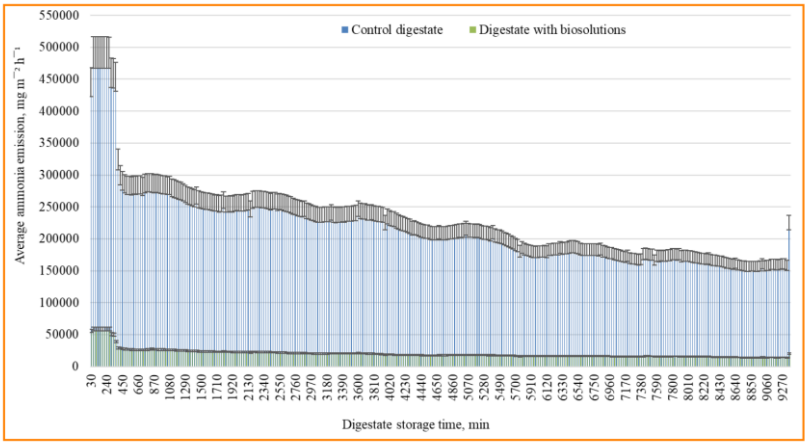

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Figure 2. Ammonia emission from digestate with biosolutions and control digestate.

The highest efficiency of the biosolution in reducing ammonia emissions ranged from 3 to 43% in the period from 1 to 100 h, which reached up to 450,000 mg $m^{-2}h^{-1}$. After evaluating the overall average reduction of ammonia emissions from digestate with biosolution over the entire period, the essential effect of the use of biosolutions was proven and the highest effect was recorded in the first 24 h after the allocation of the biosolution - the activator of rotting residues in the digestate (Figure 2).

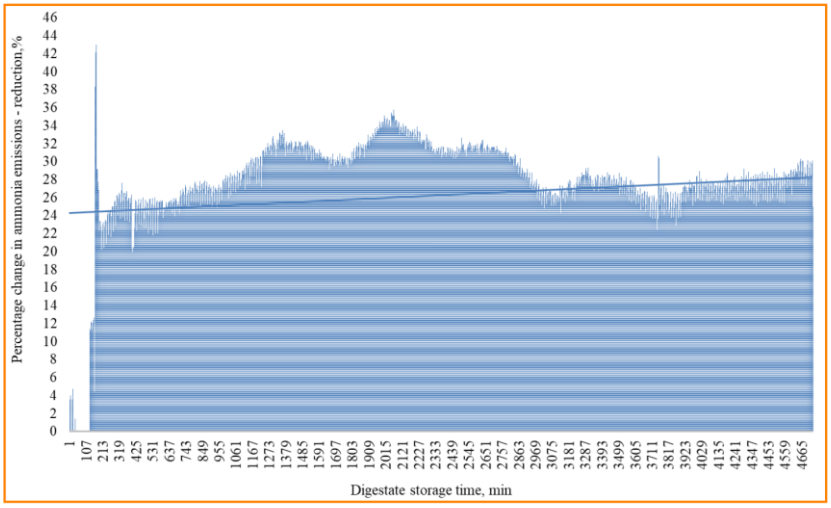

Figure 3. Efficiency of biosolutions in reducing ammonia emissions from digestate depending on digestate storage time (min).

After evaluating the average concentration and emission of ammonia gas from the control and digestate with biosolutions depending on the duration of digestate storage, the correlation of the values compared with each other was established and the effect of the allocation of the biosolution - rotting residue activator in the digestate on reducing ammonia concentration and emission was recorded (Figure 3).

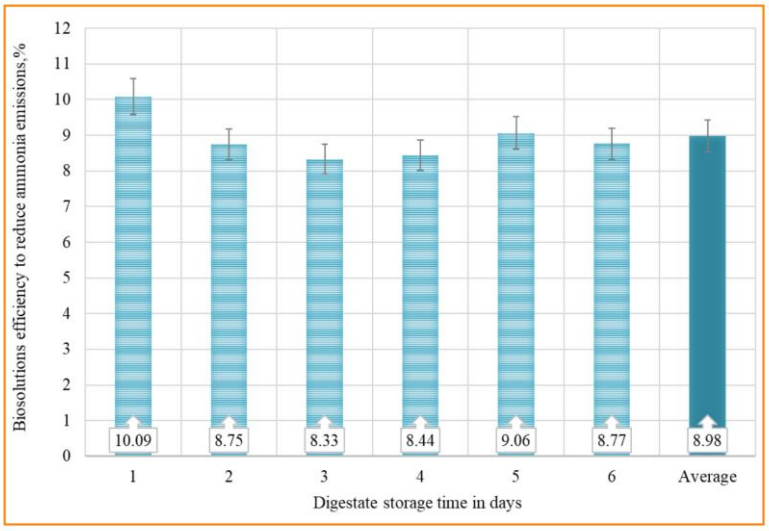

Figure 4. Efficiency of biosolutions in reducing ammonia emissions from digestate depending on digestate storage time (days).

After identifying the variation of the change in ammonia emission after affecting the digestate with a biosolution, the essential efficiency of the biosolution in reducing ammonia emission in the first days of storage was found to be 8.98% on average. The greatest reduction of ammonia emission up to 10.09% using biosolutions was determined on the first day - justifying the immediate effect and maximum efficiency of the biosolution at the beginning of experimental studies. When evaluating the regular long-term effect of the biosolution on reducing ammonia emissions from digestate, it varied on average from 8.33 to 10.09% (Figure 4).

Other scientific analyzes have found that as the size of anaerobic digesters (AD) continues to increase, the handling and disposal of digestate has become a challenging task for AD operators. Anaerobic digestate contains many nutrients and pollutants; thus, appropriate treatment is required to comply with environmental legislation and protect the host environment. The use of digestate helps to recycle already extracted resources. Efforts have been made to use digestate as a raw material for energy and value-added products, which can certainly help create a circular economy in modern society. This could help decision-makers to pre-determine environmentally sound and sustainable solutions (Malhotra et.al., 2022). Scientists describing trials of different digestates with different plants demonstrate high efficiency determined by an increase in yield (up to 28%), nitrogen uptake (20%) or phosphorus recovery rate (43%) or an increase in biometric parameters (such as leaf area) (Samoraj et.al., 2022).

The use of digestate in agriculture is an effective way to recycle materials and reduce the use of mineral fertilizers. Agronomic properties of digestates can improve plant growth and soil properties after digestate fertilization. In one study, all urban digestates tested produced 5-30% higher ryegrass yields compared to control mineral fertilizers with similar inorganic nitrogen concentrations, and the source of the feedstock affected the agronomic value (Angouria-Tsorochidou et.al., 2022).

Thus, supplementing the digestate with various nutrients and specialized biosolutions provides an even better fertilizing value and prospects for reducing odour emissions.

4. Conclusion

After identifying the variation of the change in ammonia emission after affecting the digestate with the biosolution, the significant efficiency of the biosolution in reducing the

ammonia emission in the first days of storage was determined, on average from 8.33 to 10.09%.

The highest effectiveness of the bio additive in the first 24 hours. justified the desired immediate effect and maximum efficiency immediately after the allocation of the rotting residue activator in the digestate.

Author Contributions: Conceptualization, V.N and E.S.; methodology, V.N.; software, E.S.; validation, V.N and E.Š.; formal analysis, E.Š.; investigation, V.N., E.S.; data curation, V.N.; writing—original draft preparation, V.N.; writing—review and editing, E.Š.; visualization, V.N.; supervision, V.N. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data will be provided individually by contacting the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

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