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# SUCCESSIVE INFLUENCE OF FLUIDAL ASHES ON GENERAL NUMBER OF BACTERIA, ACTINOMYCETES AND FUNGI IN POT EXPERIMENTS

## NASTĘPCZY WPŁYW POPIOŁÓW FLUIDALNYCH NA OGÓLNĄ LICZBĘ BAKTERII, PROMIENIOWCÓW I GRZYBÓW W BADANIACH WAZONOWYCH

**Abstract:** The aim of conducted studies was to determine the impact of fluidal ashes obtained from coal combined with fermented sewage sludge and straw and using effective microorganisms, on the overall abundance of bacteria, fungi, actinomycetes and *coli* bacteria. The experiments were conducted in a pot environment. An increase in the number of bacteria and actinomycetes in the samples containing fluidal ashes and various organic components was observed in comparison with the first year of studies. However, the number of *coli* bacteria, compared with the first two years of the experiment, was significantly reduced.

**Keywords:** fluidal ash, bacteria, fungi, actinomycetes, *coli* bacteria

Because of physicochemical properties such as very high pH and low organic matter content, slag waste is not a suitable environment for the development of microorganisms. Therefore, when it is used in agriculture, it becomes necessary to enrich it with various types of organic materials, such as composted sewage sludge, straw or effective microorganisms (ceramic EM-X and EM-1), which would also be a source of microflora [1, 2]. The aim of this study was to compare the successive effect of fluidal ashes from CHP Zeran combined with fermented sewage sludge and straw, using effective microorganisms, on the number of bacteria, fungi, actinomycetes and *coli* bacteria.

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## Material and methods

In the pot experiment the granulometric composition of loamy and slightly acidic soil ($pH_{KCl}$ 5.13) was used. The experiment was set up by the method of complete randomization in four replications. The scheme of the experiment included eight variants of fertilizing: 1 – control (soil), 2 – control II (fluidal ash), 3 – soil + sewage sludge + straw (4:2:1), 4 – fluidal ash + sludge + straw (4:2:1), 5 – soil + sewage sludge + straw (4:2:1) + microbiological formulation EM-1 (15 $dm^3 \cdot ha^{-1}$), 6 – fluidal ash + sludge + straw (4:2:1) + microbiological formulation EM-1 (15 $dm^3 \cdot ha^{-1}$), 7 – soil + sewage sludge + straw (4:2:1) + microbiological formulation EM-1 (15 $dm^3 \cdot ha^{-1}$) + EM ceramic powder-X (40 $dm^3 \cdot ha^{-1}$), 8 – fluidal ash + sludge + straw (4:2:1) + microbial formulation EM-1 (15 $dm^3 \cdot ha^{-1}$) + EM ceramic powder-X (40 $dm^3 \cdot ha^{-1}$). Soil samples for microbiological analysis were taken after harvesting the crop (test plant *Festulolium*, variation *Felopa*). In the collected samples of ash and soil, the following parameters were determined: the number of bacteria on Bunte-Roviry's base [3], the number of actinomycetes on Cyganow's base [4] and the number of fungi on Martin's base [5]. Because of the fact that digested sludge was used, the number of *coli* bacteria of faecal form was determined according to PN-77, C – 04615, Sheet 07, on Endo nourishment [6].

Cultures incubated at room temperature (20 °C) for 3 to 7 days. The number of *coli* bacteria was determined after 24 h of incubation at 37 °C. The results were subjected to univariate analysis of variance and then on the basis of Tukey's test $LSD_{0.05}$ values were calculated and homogenous groups were distinguished at significance level of $P = 0.05$.

## Results and discussion

The obtained results are presented in Figs. 1, 2, 3 and 4, homogeneous groups are given. Analyzing the obtained results it should be noted that in comparison with the first year of studies a gradual increase in the number of bacteria in subsequent years was observed. The increase was from 2 to 10 times higher in comparison to the number of bacteria in 2007. Most of these microorganisms were found in samples containing fluidal ash, sewage sludge, straw and microbiological formulations.

The number of actinomycetes also increased in comparison with the first year of study in all examined soil and ash samples. The largest, statistically significant, increase in the number of these bacteria was observed in samples with the addition of sewage sludge, straw and microbiological formulations: EM-1 and EM-X. The significant increase in the number of these microorganisms could be related to the antiacidic influence of the added ashes. The reaction is, in fact, one of the factors influencing the dynamics of the development of soil actinomycetes [7, 8].

The number of microscopic fungi in comparison to the year 2007 increased significantly in the control soil, in the soil with sewage sludge and straw and in the sample with fluidal ash, sediment, straw and microbiological formulations. In other trials the number of fungi, in most cases, was lower in comparison to the amount measured in the second year of the experiment.

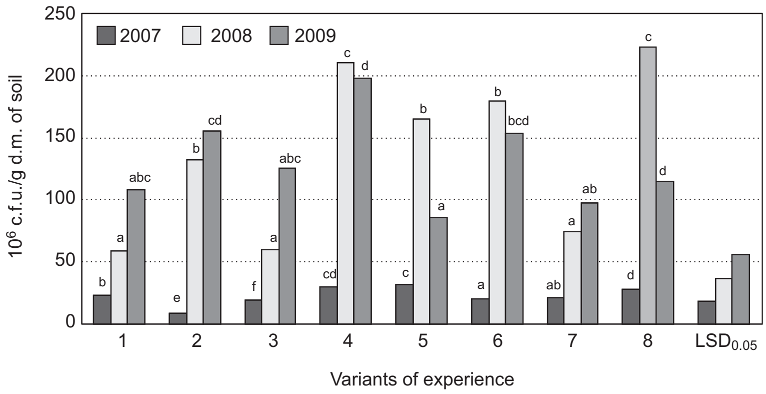


Fig. 1. The number of bacteria in examined samples of soil and fluidal ash
Variants of experiments: 1 – control (soil), 2 – control (fluidal ash), 3 – soil + sewage sludge + straw (4:2:1), 4 – fluidal ash + sewage sludge + straw (4:2:1), 5 – soil + sewage sludge + straw (4:2:1) + microbial formulation EM-1 (15 $dm^3 \cdot ha^{-1}$), 6 – fluidal ash + sewage sludge + straw (4:2:1) + microbial formulation EM-1 (15 $dm^3 \cdot ha^{-1}$), 7 – soil + sewage sludge + straw (4:2:1) + microbial formulation EM-1 (15 $dm^3 \cdot ha^{-1}$) + EM-X Ceramic Powder (40 $dm^3 \cdot ha^{-1}$), 8 – fluidal ash + sewage sludge + straw (4:2:1) + microbial formulation EM-1 (15 $dm^3 \cdot ha^{-1}$) + EM-X Ceramic Powder (40 $dm^3 \cdot ha^{-1}$)

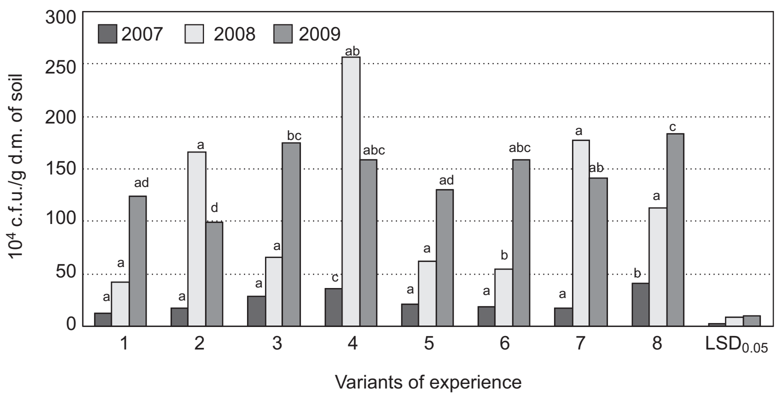


Fig. 2. The number of actinomycetes in examined samples of soil and fluidal ash
Explanations: see Fig. 1.

The number of *coli* bacteria, as an indicator of sanitary contamination, ranged from about 250 to 1200 in the first year of studies, up to about 2–20 cells in 1 g d.m. of soil and fluidal ash sample in the third year of research (Fig. 4). Compared with the control soil, statistically most of these bacteria were observed in the soil with sewage sludge and straw and in the combination of soil, sewage sludge, straw and microbiological formulation EM-X. The statistically lowest content of *coli* occurred in the control soil and fluidal ash.

Summarizing the results of three-year studies on the fitness of fluidal ashes for agricultural purposes and soil recultivation, it should be noted that the addition of

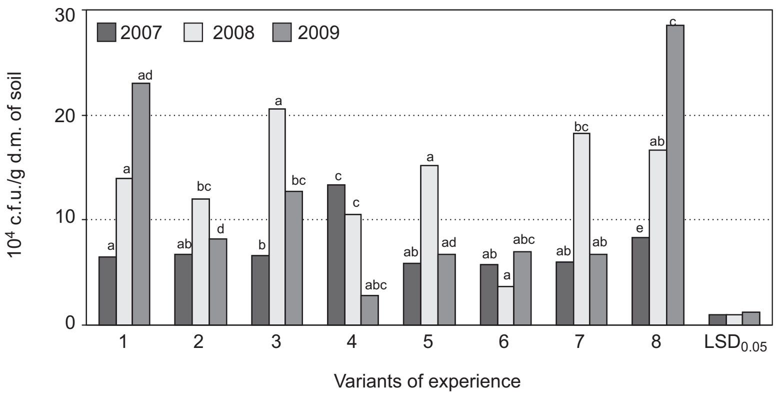


Fig. 3. The number of fungi in examined samples of soil and fluidal ash
Explanations: see Fig. 1.

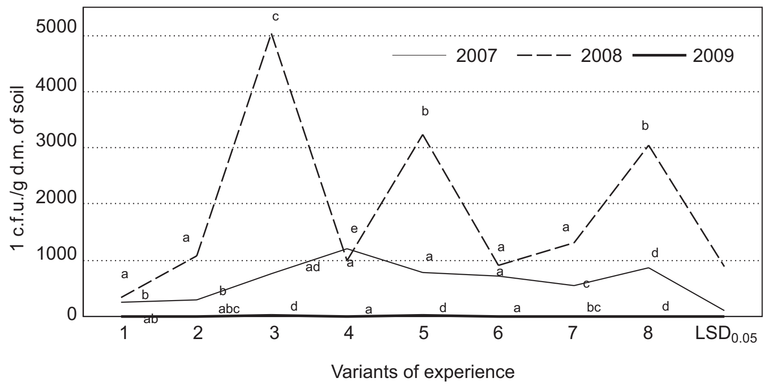


Fig. 4. The number of *coli* bacteria in examined samples of soil and fluidal ash
Explanations: see Fig. 1.

organic materials, such as composted sewage sludge, which is rich in microorganisms or microbial preparations EM-1 or EM-X to ashes or soils with ashes, caused an statistically significant increase in the number bacteria and actinomycetes. Studies by other authors [9–11] confirm the stimulative effect of fermented sewage sludge on the number and activity of many groups of microorganisms. Also the addition of microbiological formulations EM-1 or EM-X, caused in particular the increase in the number of bacteria and actinomycetes. As indicated in a few studies, the EM formulations, containing several strains of microorganisms isolated from soil, classified in different taxons, and having different physiological and biochemical features [12] have demonstrated the beneficial influence both on the functioning of a soil ecosystem and the intensity of growth and development of plants. The results of conducted studies indicate that the addition of effective microorganisms to soil or fluidal ash increased the number of microorganisms, and hence, caused the intensification of metabolic and biochemical processes in soil, and, indirectly, affected pedogenetic abilities of microorganisms. Enrichment of ash in the microbiological formulation (effective microorganisms) accelerated the mineralization of soil organic compounds and thereby increased the biological activity of soil [13, 14]. The obtained results indicate that coal ashes can be used for fertilizing purposes.

## Conclusion

1. Compared with the first year of the experiment an increase in the overall number of bacteria and actinomycetes in soil and ash samples was found.
2. There was a significant decrease in the number of *coli* bacteria in comparison to the first year of studies.

### References

[1] Barabasz W., Szmigiel A., Albińska D. and Barabasz J.: *Wpływ nawożenia osadami ściekowymi na mikroflorę ryzosfery pod uprawą wierzby energetycznej*. Gospodarka odpadami, K. Szymański (ed.), Monografia, t. 3, Komitet Chemii Analitycznej PAN, Koszalin 2007, 141–148.
[2] Higa T.: *Effective microorganisms, concept and recent advances in technology*. Proc. Conference on Effective Microorganisms for a Sustainable Agriculture and Environment. 4th Int. Conf. on Kyusei Nature Farming, Bellingham – Washington, USA 1998, 247–248.
[3] Bunt J.S. and Rovira A.D.: J. Soil. Sci. 1955, **6**, 119–128.
[4] Cyganov V.A., Žukov R.A. and Timofeleva K.A.: Mikrobiologija 1964, **33**(5), 863–869.
[5] Martin J.P.: Soil Sci. 1950, **6**, 215–217.
[6] Burbianka M. and Pliszka A.: Mikrobiologia żywności. PWN, Warszawa 1971.
[7] Kurek E.: Zesz. Probl. Post. Nauk Roln. 2002, **482**, 307–316.
[8] Wolna-Maruwka A. and Pilarski K.: Ochr. Środ. Zasob. Natural. 2010, **42,** 212–224.
[9] Furczak J. and Joniec J.: Polish J. Soil Sci. 2002, **35**, 59–67.
[10] Nowak A. and Błaszak M.: Zesz. Nauk. UP we Wrocławiu 2006, **546**, 271–278.
[11] Wolna-Maruwka A., Sawicka A. and Styła K.: *Zmiany liczebności wybranych grup drobnoustrojów w glebie o zróżnicowanym nawożeniu organicznym*, VIII Ogólnopolskie Symp. Nauk.-Techn. "Biotechnologia Środowiskowa", Wisła-Jarzębata 2005, 41–50.
[12] Mau P.: Fantastische Erfarungen mit EM, Publ. EMIKO, Germany 2003.
[13] Bielińska E. and Baran S.: Inż. Roln. 2009, **6**(115), 7–15.
[14] Bielińska E., Stankowski S. and Węgorek T.: *Zastosowanie testów automatycznych do oceny możliwości przyrodniczego wykorzystania popiołów fluidalnych z węgla kamiennego.* Mat. Międzynarod. Konf. Nauk.-Techn., Sławsko 16–18 IV 2008.

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**Abstrakt:** Celem przeprowadzonych badań było określenie następczego wpływu popiołów fluidalnych z węgla kamiennego w połączeniu z przefermentowanym osadem ściekowym i słomą, przy użyciu efektywnych mikroorganizmów, na ogólną liczebność bakterii, grzybów, promieniowców oraz bakterii z grupy *coli*. Badania prowadzono w warunkach wazonowych. Stwierdzono wzrost liczebności bakterii i promieniowców w próbkach zawierających popiół fluidalny oraz różne komponenty organiczne w porównaniu z pierwszym rokiem badań. Natomiast liczebność bakterii z grupy *coli* w porównaniu z dwoma pierwszymi latami doświadczenia uległa istotnemu zmniejszeniu.

**Słowa kluczowe**: popiół fluidalny, bakterie, grzyby, promieniowce, bakterie z grupy *coli*