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# INFLUENCE OF THE ACTIVE SUBSTANCE OF PRP®FIX ON THE CONVERSION OF NITROGEN IN COMPOSTS FROM THE MUNICIPAL SEWAGE SLUDGE

## WPŁYW SUBSTANCJI CZYNNEJ PRP®FIX NA PRZEMIANY AZOTU W KOMPOSTACH Z KOMUNALNEGO OSADU ŚCIEKOWEGO

**Abstract:** Aim of the conducted research was to estimate influence of mineral granulate PRP®FIX on conversions of total, ammonium and nitrate nitrogen in composts prepared from municipal sewage sludge with addition of straw and urban green waste. Composts were prepared in three repetitions in November of 2007 and were composted in 70 $dm^3$ plastic containers kept in building of Hall of Vegetation of the former University of Agriculture.

The first compost consisted of municipal sewage sludge (70 %) and wheaten straw (30 %), the second consisted of sewage sludge (70 %) and urban green waste (30 %). In the first series of experiment decomposition was conducted without addition of PRP®FIX substance and in the second series PRP®FIX substance was added in amount of 3 kg per 1 $m^3$ of composted mass. Decomposition of composts was conducted through 180 days and total content of nitrogen as well as its ammonium and nitrate forms were determined each 30 days.

Conducted research show that during the time of decomposition of composts prepared from sewage sludge with 30-percentage addition of structure-making materials content of total nitrogen decreased in their mass. Course of changes of ammonium and nitrate nitrogen content in composts was different. In both of the composts content of $N\text{-}NH_4$ was increasing until $90^{th}$ day of composting and after that period was decreasing. However, considerable increase of content of nitrate nitrogen was found after 120 days and lasted till $180^{th}$ day of composting.

Addition of PRP®FIX substance caused increase of content of ammonium nitrogen on average by 17.2 % and had no distinct influence on shaping on total content of nitrogen and its nitrate form.

**Keywords:** municipal sewage sludge, composts from sewage sludge, chemical composition, fertilizing value, active substance PRP®FIX

Civilization development is causing more and more waste including among others municipal sewage sludge. Methods of utilization are being searched limiting their harmful influence on environment.

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One of the cheapest method of recycling is process of composting with addition of different organic waste. As a result of that process pathogenic threat is being eliminated and the fertilizing value is being preserved or increased in received product [1].

In order to accelerate the decomposition process and increase the availability of macro- and micronutrients to composting mass are added different preparations. One of them can be active substance PRP®FIX containing complex of mineral ingredients which regulate the development of microorganisms in waste mass.

With this end in view in 2007 researches were conducted which aim was estimation of influence of active substance PRP®FIX on conversions of total, ammonium and nitrate nitrogen in composts prepared from sewage sludge.

## Material and methods

In November of 2007 in hall of vegetation of the former University of Agriculture in Szczecin composts were prepared, which in 70 % (in conversion on dry matter) consisted of municipal sewage sludge and in 30 % of wheaten straw or urban green waste. In the first series of experiment decomposition of composts were conducted without PRP®FIX and in the second series with addition of 3 kg of PRP®FIX in conversion on 1 $m^3$ of composts.

Experiment was set up in three repetitions. Decomposition of composts was conducted through 180 days and total content of nitrogen and its mineral forms ($N\text{-}NH_4$ and $N\text{-}NO_3$) were determined each 30 days.

Content of the first row elements (N, P, K) and of the second (Ca, Mg, S) decides on the fertilizing value of composts. In sewage sludge, used for preparation of composts, content of nitrogen was one and a half higher than in manure (30.2 g · $kg^{-1}$ d.m.). Content of phosphorus (13.02 g · $kg^{-1}$ d.m.) was also higher than mean content in manure, while content of potassium and magnesium was lower (Table 1). Data in Table 2 showed that wheaten straw, in comparison with urban green waste (two structure-making materials), contained more nitrogen, potassium, calcium and sulphur.

Table 1

Physical and chemical properties of sewage sludge

| pH in $H_2O$ | Dry matter [g · $kg^{-1}$] | Organic carbon | $N\text{-}NH_4$ | $N\text{-}NO_3$ | Total content | | | | | C:N (N=1) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | N | P | K | Mg | S | |
| | | [g · $kg^{-1}$ d.m.] | | | | | | | | |
| 10.1 | 225.0 | 251.0 | 1.24 | 0.030 | 30.2 | 13.02 | 3.98 | 3.05 | 4.98 | 8.31 |

Table 2

Total content of macronutrients in components of composts [g · $kg^{-1}$ d.m.]

| Components | N | P | K | Mg | Ca | S |
|---|---|---|---|---|---|---|
| Wheaten straw | 10.1 | 1.26 | 14.1 | 0.90 | 2.31 | 2.1 |
| Urban green waste | 8.25 | 2.19 | 2.94 | 0.98 | 2.04 | 1.07 |

Content of heavy metals in sewage sludge did not exceed norms given in Decree of Minister of Environment [2].

Chemical analyzes of composts were conducted in accordance with the current norms: ammonium nitrogen – PN 75/C-04576-15, nitrate nitrogen in the presence of phenyldisulphide acid, total nitrogen was determined on Coestech CNS elemental analyzer. Significance of differences between individual determined values was assessed with Tukey's test on significance level $p < 0.05$.

## Results and discussion

In the day of setting up the experiment total content of nitrogen in compost prepared from sewage sludge and wheaten straw with and without PRP®FIX was almost equal (37.8 and 37.9 g · kg$^{-1}$ d.m.) – Table 3. However, in compost with 30-percent addition of urban green waste – with and without PRP®FIX total content of nitrogen was lower 31.2 and 32.1 g · kg$^{-1}$ d.m.), but somewhat higher content of that element was noted in compost with PRP®FIX. During the time of decomposition of both composts with and without PRP®FIX total content of nitrogen was decreasing. Significant decrease of total content of nitrogen, in comparison with the day the experiment was set up, was found after 180 days of decomposition of composts. Mean loss of total content of nitrogen in that time amounted to 38.3 %. There was no significant difference noted in total content of nitrogen in composts prepared from sewage sludge with straw or urban green waste with and without addition of PRP®FIX. But similar as after preparation of composts more nitrogen was contained in composts prepared from sewage sludge and straw than in composts with addition of urban green waste.

Table 3

Changes of total content of nitrogen in composts prepared from municipal sewage sludge with and without participation of PRP®FIX during the time of their decomposition [g · kg$^{-1}$ d.m.]

| Type of compost* | Time of research | | | | | | | | $LSD_{0.05}$ |
|---|---|---|---|---|---|---|---|---|---|
| | on the day of setting up the experiment | after 30 days | after 60 days | after 90 days | after 120 days | after 150 days | after 180 days | $\bar{x}$ | |
| Compost I | 37.8 | 34.8 | 32.4 | 26.4 | 24.4 | 23.8 | 22.9 | 28.9 | n.s. |
| Compost I + PRP®FIX | 37.9 | 35.0 | 32.5 | 27.0 | 25.5 | 23.6 | 22.4 | 29.1 | |
| Compost II | 31.2 | 30.2 | 28.5 | 25.5 | 21.8 | 21.8 | 20.1 | 25.6 | |
| Compost II + PRP®FIX | 32.1 | 30.4 | 28.1 | 25.6 | 21.8 | 21.8 | 20.3 | 25.7 | |
| Mean | 34.7 | 32.6 | 30.4 | 26.1 | 23.4 | 22.7 | 21.4 | 27.3 | |
| $LSD_{0.05}$ | 12.30 | | | | | | | | |

* Explanations of composition of composts in conversion to dry matter: Compost I – municipal sewage sludge (70 %) + wheaten straw (30 %), Compost I + PRP®FIX – municipal sewage sludge (70 %) + wheaten straw (30 %) + PRP®FIX, Compost II – municipal sewage sludge (70 %) + urban green waste (30 %), Compost II + PRP®FIX – municipal sewage sludge (70 %) + urban green waste (30 %) + PRP®FIX.

Decomposition of organic compounds had influence on changes of total content of nitrogen. Under the influence of their decomposition nitrogen converts to form of ammonium. In the research of Krzywy et al [3] there was the decrease of total nitrogen content in composts prepared from sewage sludge. Ciećko et al [4] also proved that during the composting of sewage sludge with and without addition of organic materials losses of nitrogen followed. Huge influence on their tempo had properties and origin of sewage sludge as well as type of added structure components.

After the preparation of composts higher content of ammonium nitrogen was in compost prepared from sewage sludge and urban green waste. Addition of PRP®FIX did not become significantly diverse of that form of nitrogen in both composts (Table 4). On 90$^{th}$ day of decomposition of composts significant increase of N-$NH_4$ content was found, in relation to content determined in the day of setting up the experiment. Mean content of N-$NH_4$ in composts increased almost six times and was always higher in composts with addition of PRP®FIX. After 90 days of decomposition content of ammonium nitrogen in composts decreased reaching after 180 days in compost prepared from sewage sludge+straw content of 4.87 g · kg$^{-1}$ d.m. and in compost prepared from sewage sludge+urban green waste – 4.92 g · kg$^{-1}$ d.m. However, in composts with addition of PRP®FIX there was 13 % above of that form of nitrogen.

Table 4

Changes of content of ammonium nitrogen in composts prepared from municipal sewage sludge with and without participation of PRP®FIX during the time of their decomposition [g · kg$^{-1}$ d.m.]

| Type of compost* | Time of research | | | | | | | | $LSD_{0.05}$ |
|---|---|---|---|---|---|---|---|---|---|
| | on the day of setting up the experiment | after 30 days | after 60 days | after 90 days | after 120 days | after 150 days | after 180 days | $\bar{x}$ | |
| Compost I | 1.00 | 1.44 | 3.15 | 6.37 | 5.33 | 5.03 | 4.87 | 3.88 | n.s. |
| Compost I + PRP®FIX | 1.05 | 1.66 | 4.23 | 7.21 | 6.81 | 6.24 | 5.52 | 4.67 | |
| Compost II | 1.21 | 1.41 | 3.45 | 6.86 | 6.03 | 5.35 | 4.92 | 4.17 | |
| Compost II + PRP®FIX | 1.22 | 1.47 | 4.37 | 7.45 | 6.95 | 6.29 | 5.58 | 4.76 | |
| Mean | 1.12 | 1.49 | 3.80 | 6.97 | 6.28 | 5.72 | 5.22 | 4.37 | |
| $LSD_{0.05}$ | 5.281 | | | | | | | | |

* Explanations of composition of composts are given in Table 3.

On the day of the setting up the experiment mean content of nitrate(V) nitrogen in composts amounted to 0.056 g · kg$^{-1}$ d.m. which presented merely 0.16 percentage participation in total content of nitrogen. Till 90$^{th}$ day of decomposition changes of content of N-$NO_3$ in composts were not large. After that period significant increase of content of N-$NO_3$ in composts, which on 180$^{th}$ day of research, in relation to initial value, amounted on average 69.9 %. Differences in content of N-$NO_3$ in individual composts were not statistically proved, but somewhat higher content of that form was in composts with addition of PRP®FIX.

Table 5

Changes of content of nitrate(V) nitrogen in composts prepared from municipal sewage sludge with and without participation of PRP®FIX during the time of their decomposition [g · kg$^{-1}$ d.m.]

| Type of compost* | Time of research | | | | | | | | $LSD_{0.05}$ |
|---|---|---|---|---|---|---|---|---|---|
| | on the day of setting up the experiment | after 30 days | after 60 days | after 90 days | after 120 days | after 150 days | after 180 days | $\bar{x}$ | |
| Compost I | 0.052 | 0.052 | 0.055 | 0.057 | 0.074 | 0.083 | 0.097 | 0.067 | n.s. |
| Compost I + PRP®FIX | 0.063 | 0.063 | 0.063 | 0.048 | 0.075 | 0.084 | 0.103 | 0.071 | |
| Compost II | 0.054 | 0.043 | 0.054 | 0.049 | 0.065 | 0.073 | 0.084 | 0.060 | |
| Compost II + PRP®FIX | 0.053 | 0.044 | 0.055 | 0.054 | 0.076 | 0.082 | 0.097 | 0.066 | |
| Mean | 0.056 | 0.050 | 0.057 | 0.052 | 0.072 | 0.080 | 0.095 | 0.066 | |
| $LSD_{0.05}$ | 0.037 | | | | | | | | |

* Explanations of composition of composts are given in Table 3.

In opinion of Struczyński [5] appearance of nitrate nitrogen in compost mass shows its maturity.

## Conclusions

1. During the decomposition of composts prepared from municipal sewage sludge with 30 % addition of structure-making materiale total content of nitrogen in their mass decreased.

2. Course of changes of ammonium and nitrate(V) nitrogen content in composts was different. In both of the composts content of N-$NH_4$ was increasing until 90$^{th}$ day of composting and after that period was decreasing. However, considerable increase of content of nitrate nitrogen was determined after 120 days and lasted till 180$^{th}$ day of composting.

3. Addition of PRP®FIX substance caused increase of content of ammonium nitrogen on average by 17.2 % and had no larger influence on shaping on total content of nitrogen and its nitrate form.

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## WPŁYW SUBSTANCJI CZYNNEJ PRP®FIX NA PRZEMIANY AZOTU W KOMPOSTACH Z KOMUNALNEGO OSADU ŚCIEKOWEGO

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**Abstrakt:** Przeprowadzone badania miały na celu określenie wpływu granulatu mineralnego PRP®FIX na przemiany azotu ogólnego, amonowego i azotanowego(V) w kompostach z komunalnego osadu ściekowego z dodatkiem słomy i odpadów zieleni miejskiej. Komposty sporządzono w trzech powtórzeniach w listopadzie 2007 roku i kompostowano w 70-litrowych pojemnikach plastikowych, przechowywanych w budynku Hali Wegetacyjnej byłej Akademii Rolniczej w Szczecinie.

Pierwszy kompost składał się (w przeliczeniu na suchą masę) z komunalnego osadu ściekowego (70 %) oraz słomy pszennej (30 %), a drugi z osadu ściekowego (70 %) i odpadów zieleni miejskiej (30 %). W I serii doświadczenia rozkład prowadzono bez dodatku, a w serii II do masy kompostowej dodano substancję PRP®FIX w ilości 3 kg na 1 $m^3$ masy kompostowej. Rozkład kompostów prowadzono przez 180 dni, oznaczając co 30 dni ogólną zawartość azotu oraz jego formy amonową i azotanową(V).

Przeprowadzone badania wskazują, że w czasie rozkładu kompostów z komunalnego osadu ściekowego z 30-procentowym dodatkiem materiałów strukturotwórczych nastąpiło zmniejszenie w ich masie ogólnej zawartości azotu. Przebieg zmian zawartości azotu amonowego i azotanowego(V) w kompostach był różny. W obu kompostach zawartość $N\text{-}NH_4$ zwiększała się do 90. dnia kompostowania, a po tym okresie zmniejszała się. Natomiast znaczniejsze zwiększenie zawartości azotu azotanowego(V) stwierdzono po 120 dniach i trwało ono do 180 dnia kompostowania. Natomiast dodatek substancji PRP®FIX spowodował wzrost zawartości azotu amonowego średnio o 17,2 %, i nie miał większego wpływu na kształtowanie ogólnej zawartości azotu i jego formy azotanowej(V).

**Słowa kluczowe:** komunalny osad ściekowy, komposty z osadów ściekowych, skład chemiczny, wartość nawozowa, substancja czynna PRP®FIX