PRODUCTION OF SLOW-RELEASED NITROGEN FERTILIZER FROM URINE

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Abstract

To recover the nitrogen nutrients from real urine as slow-release fertilizer, Methylene urea, which is polymer of urea and formaldehyde, was prepared from synthetic and real urine. Low pH condition leads high reaction rate and low concentration of residual urea. The synthetic urine with doubled concentration showed same trend of normal concentration. Elemental analysis and C13-NMR represents that the production was methylene urea. The methylene urea could be prepared from real urine on equality with synthetic urine case.

KEYWORDS: Urea derivative, aldehyde, molecular weight distribution, C13-NMR, elementary analysis

Introduction

The human urine contains 90 % of nitrogen in domestic wastewater (Almeida et. al., 1999). Most of the nitrogen exists as urea formation, but urea easily decomposes into ammonium formation by biological activity result of contamination of feces (Hotta et al., 2008). In current situation, the ammonia nitrogen in wastewater is converted into nitrogen gas with nitrification-denitrification process without any recycle process. On the other hand, 100M ton-N of nitrogen fertilizer is consumed in the world par year (FTOSTAT, 2010), while some part of nitrogen fertilizer makes pollution of grand water and surface water with unsuitable utilization. To overcome this problem, slow- or controlled-released fertilizer is better way. Here, methylene urea which is polymer of urea and formaldehyde is widely used as slow release fertilizer in the world. The objectives of this paper are to prepare the slow-released fertilizer from synthetic urine and real urine and to analyze the production with C13-NMR and elementary analysis.

Methods

The composition of the synthetic urine referred to J.A. Wilsenach et al (2007). The doubled concentration of synthetic urine was also prepared. The real urine was taken from 4 volunteers then stored at 2 °C refrigerator. The real urine was applied to experiment in 1 day.

20 ml of formaldehyde was added into 200 ml of the urea solution, synthetic and real urine, and then kept at 20 °C. To control the pH of synthetic urine, the 2M sulfuric acid was dropped into the solution before addition of formaldehyde. The precipitation was filtered with 0.45 μm membrane paper and washed with distilled water. This precipitation was analyzed by C13-NMR (ECX-400, JEOL) and elemental analyzer (CHN corderMT-6, YANACO). The concentration of urea residue in the solution was measured with diacetylmonoxime method. The molecular size distribution of urea derivative was obtained by dialysis with UF membrane of several cut off. The nitrogen concentration was measured by Kjeldahl method.

Results and discussion

Precipitation from synthetic urine

The effect of pH on the reaction rate is illustrated in Figure 1 and 2. The low pH solution showed high reaction rate and reached low concentration of residual urea. The synthetic urine with doubled concentration also showed same trend and reached same concentration of residual urea at low pH solution. Figure 3 shows time course of molecular distribution at pH 2 and pH 5. There are molecular form of urea and other

Figure 1. Urea concentration of normal synthetic urine

Figure 2. Urea concentration of double concentrated synthetic urine

Figure 3-a. Molecular weight distribution at pH2

Figure 3-a. Molecular weight distribution at pH5

components of low molecular weight in both conditions at initial. After reaction had occurred, the concentration of molecular form decreased to produce intermediate. Then, the concentration of intermediate also decreased to polymerize into precipitation. The pH 2 solution had higher polymerization rate into intermediate and precipitation comparing with pH 5. This shows same trend with figure 1 and 2.

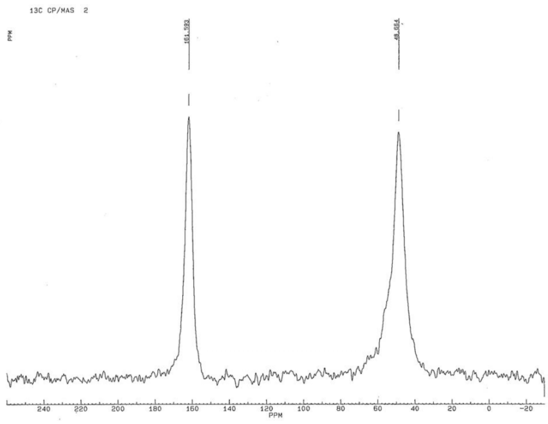
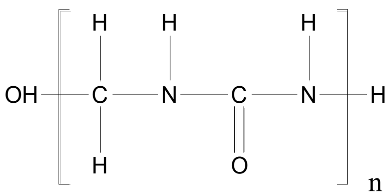


Figure 4. NMR spectrum of production

The result of elemental analysis shows C : H : N = 28.52 : 5.57 : 35.33. This is similar to theoretical ratio of methylene urea which structural formula is shown as follows:



C : H : N = 33.3 : 5.56 : 38.9

Figure 5. Urea concentration of real urine

The C13-NMR spectrum is shown in Figure 4. Two peaks were observed and represented methylene and ketone. Therefore, the production should be methylene urea.

Precipitation from real urine

The real urine was tested to produce methylene urea. Figure 5 illustrates the urea concentration decline in real urine under pH 2 condition. It was same curve of synthetic urine. The elemental analysis displayed C : H : N = 26.9 : 5.85 : 30.5 and 2 peaks were observed in C13-NMR spectrum. Therefore, methylene urea could be prepared from real urine.

Conclusions

Methylene urea, which is a kind of slow-release fertilizer, was prepared from synthetic and real urine. Low pH condition leads high reaction rate and low concentration of residual urea. The synthetic urine with doubled concentration showed same trend of normal concentration. Elemental analysis and C13-NMR represents that the production was methylene urea. The methylene urea could be prepared from real urine on equality with synthetic urine case.

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