Nitrogen transformation during co-fermentation in agricultural biogas plants

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Introduction

According to a report by Bioenergy Europe, up to 71% of all biogas plants in Europe are powered by agricultural substrates (silage, slurry agricultural waste, etc.). The growing number of biogas plants means an increase in the load of waste products in the form of digestate. In some European countries (such as Germany, France and Italy) attention has been paid to environmental problems associated with its overproduction. This is connected with the problem of its improper management, which is most often limited to fertilizing agricultural crops in fields located near the biogas plant. The solution of this problem may be found in dewatering of digestates, followed by separate management of the solid and liquid fraction. Due to low hydration, the solid fraction can be dried and burned (as a biofuel) or used directly as an organic fertilizer or after composting. But liquid fraction of digestates (reject water) contains high concentrations of nitrogen and phosphorus, and improper management (e.g. excessive infiltration leading to soil over-fertilization) can lead to leaching of nutrients from soil or their infiltration into groundwater, contaminating this way nearby rivers and negatively affecting the development of aquatic flora and fauna.

The aim of the work

determine the transformations of nitrogen compounds contained in the biogas plant feed during the co-cementation of selected products from the agri-food industry;

Material & Methods

Fermentation:

- Volume : 44 L
- Time : 28 days
- Temperature : 37°C

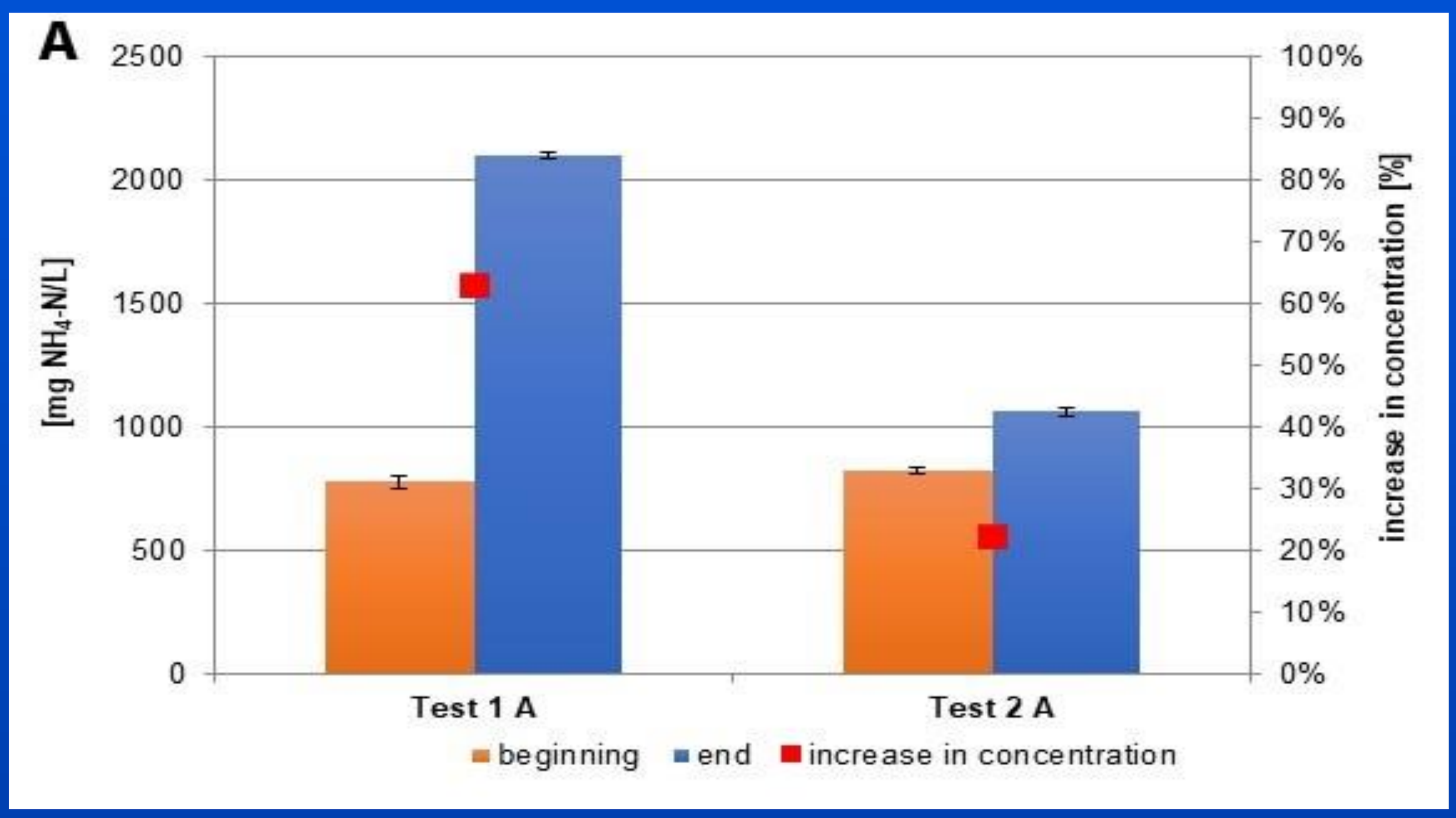
Mechanical separation into solid and liquid fraction (4000 rpm, 30 min)

Two tests (1A and 2A) were conducted, differing in the feedstock and inoculum proportion of 20%. Then, two more tests (1B and 2B) were conducted with the same feedstock but with an inoculum proportion of 80%.

Table 1 shows the individual tests with the feedstock.

Test:	Feedstock:
Test 1A	10 kg=341.7 g corn silage + 3738.7 g slurry + 5918,6 g water; (20% inoculum)
Test 2A	10 kg=5247 g distillery residue+ 433 g corn silage + 4319 g water; (20% inoculum)
Test 1B	10 kg=341.7 g corn silage + 3738.7 g slurry + 5918.6 g water (80% inoculum)
Test 2B	10 kg=381.6 g corn silage + 5131 g distillery residue+ 4470.9 g water (80% inoculum)

Results & Discussion



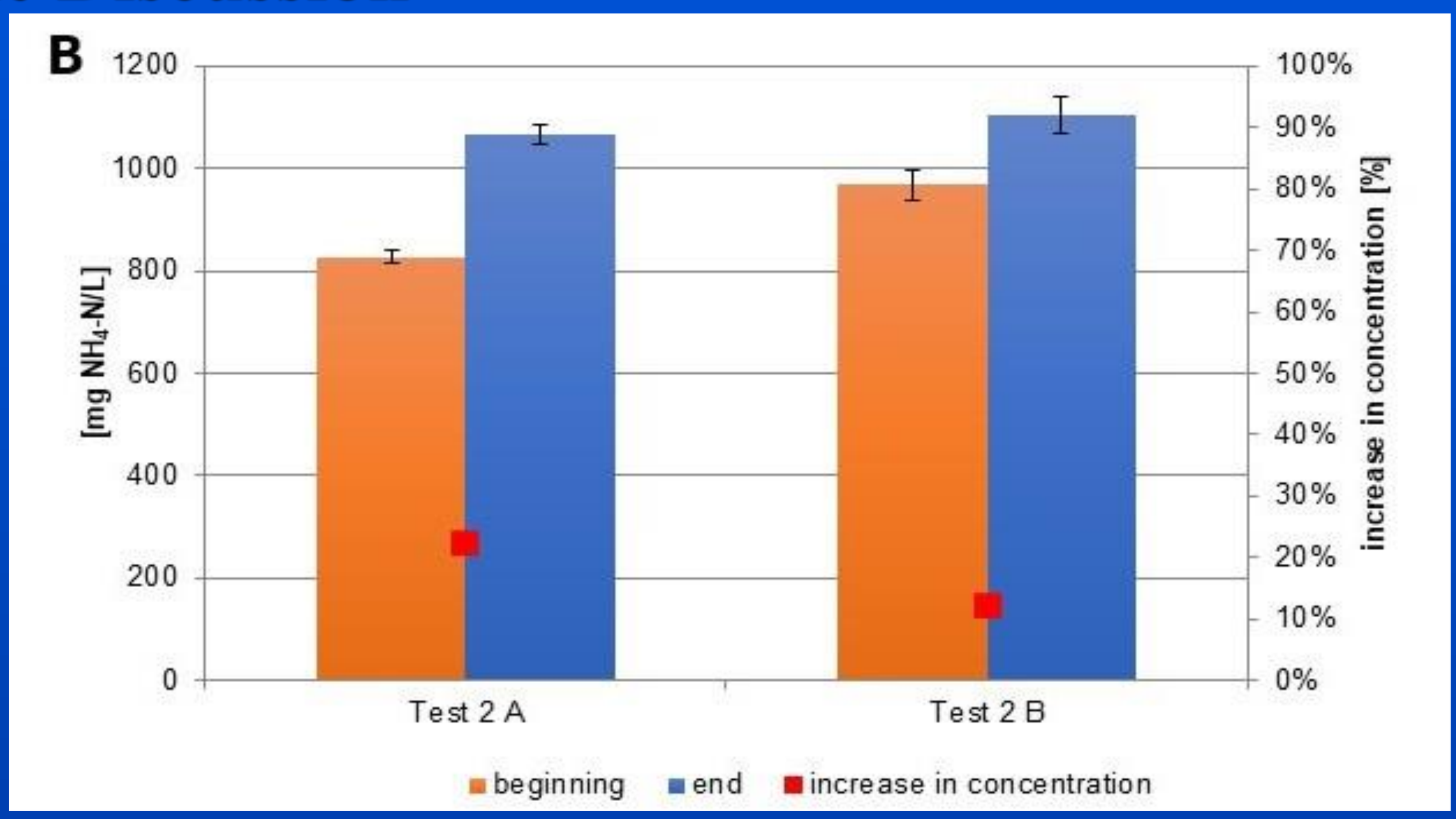
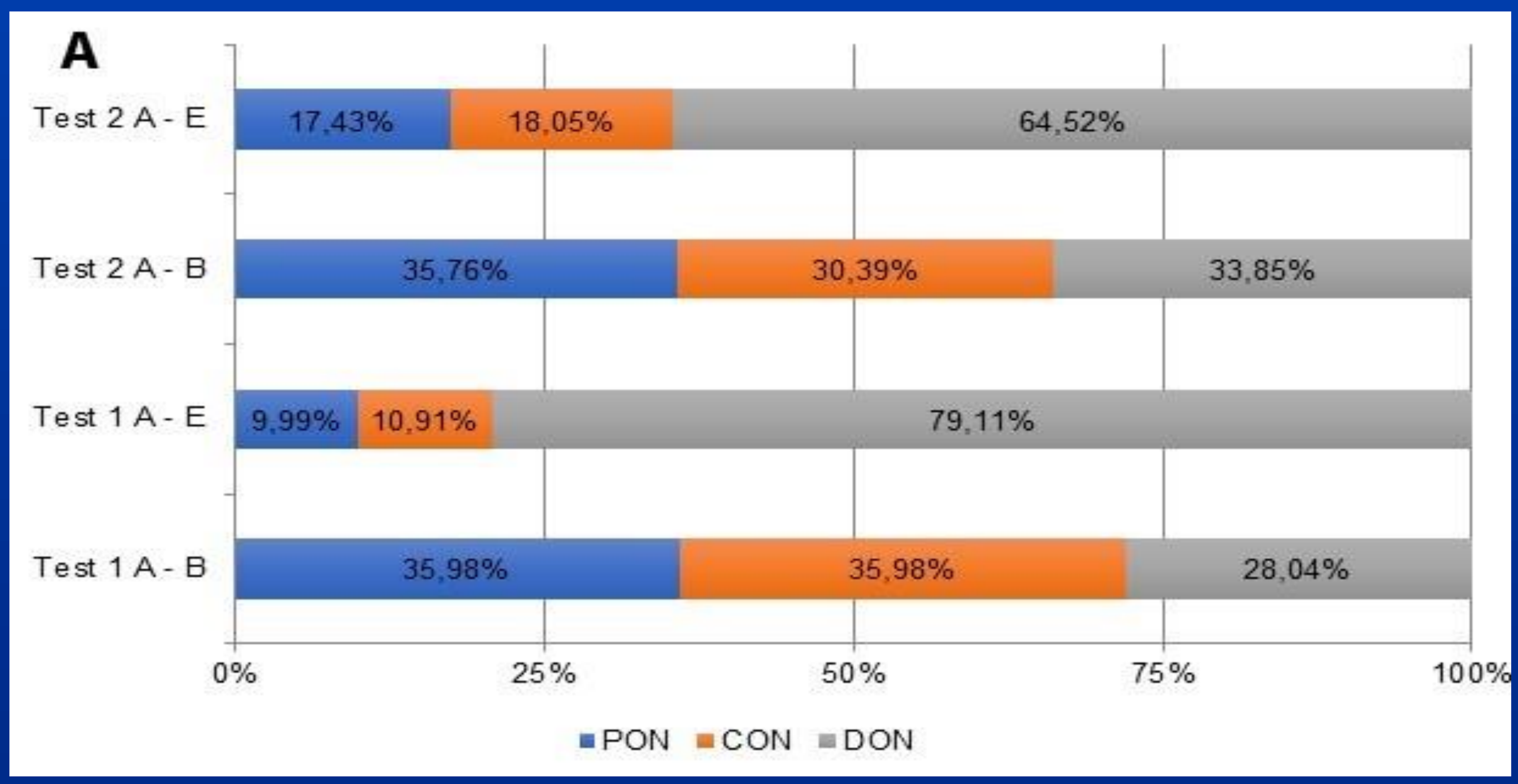
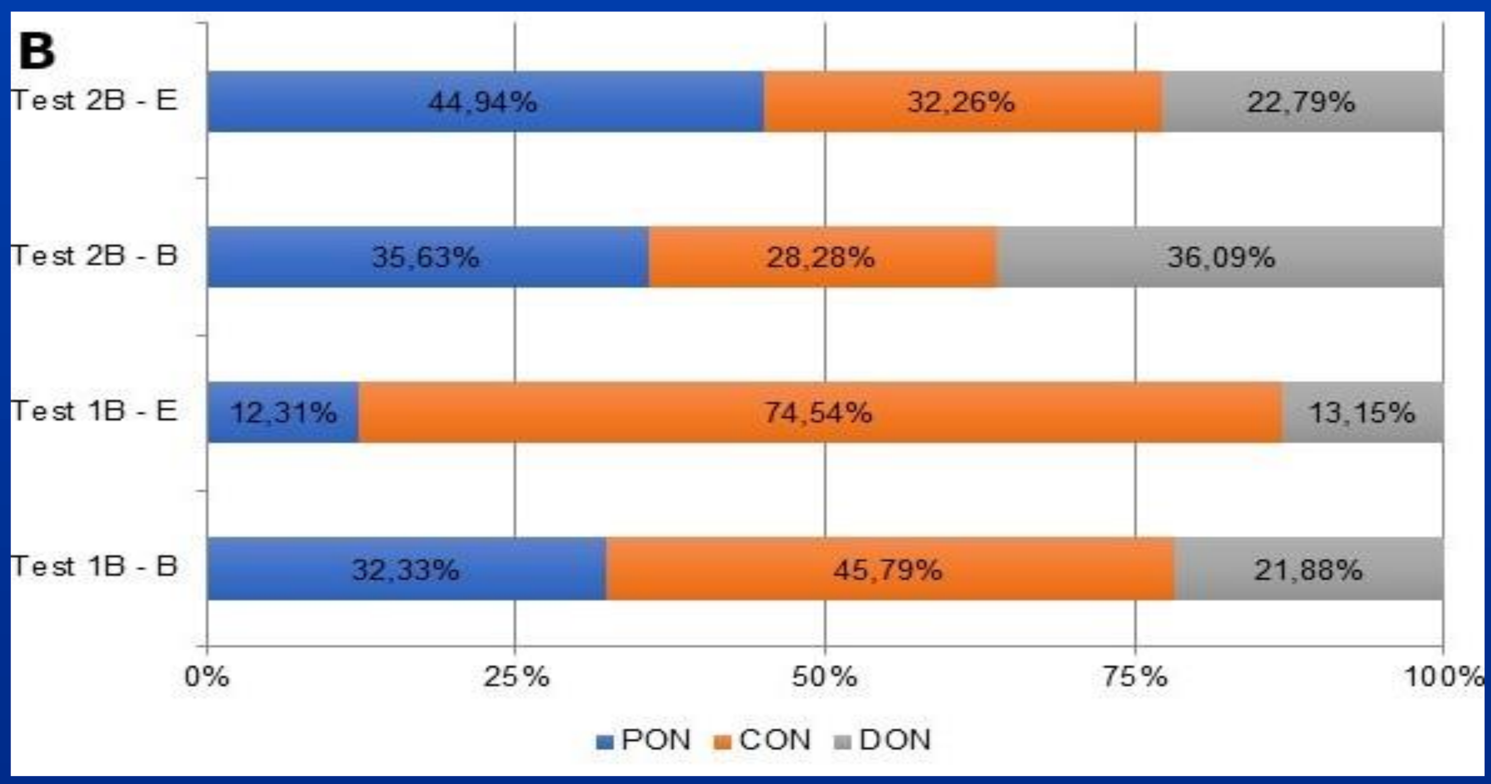


Figure 1 A and B shows the changes in ammonia nitrogen concentrations for selected parameters in the liquid fraction as a result of the fermentation process.





Figures 2 A and B show the proportion of organic nitrogen fractions in leachate before and after fermentation. One graph shows samples with the same feedstock but with different inoculums.

Conclusions

1. Ammonium nitrogen formed during the hydrolysis of proteins and urea (components of feedstock substrates) was the dominant form of nitrogen in post-fermentation leachates, and its concentration was related to the original nitrogen content in the raw material.

2. An increase in ammonium nitrogen concentration was observed as a result of fermentation, with the level of increase depending on the initial concentration in the feedstock. The highest increase was found for distillery residue and maize silage (over 60%)

3. At the beginning of the fermentation, the samples showed a predominance of different fractions of ON: PON, DON to a greater or lesser extent. However, after the fermentation process, the proportion of ON fractions evened out and one of the fractions was dominant. In the case of fermentations with distillery stillage and maize silage, the colloidal fraction was dominant, while in the case of samples with slurry and maize silage, the dissolved fraction was dominant. A lower proportion of inoculum (test 1 A and 1B) resulted in a higher concentration of the dominant fraction than in samples with 80% inoculum (test 2A and 2B).

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