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THE INFLUENCE OF USE ADDITIVES ON NITROUS OXIDE EMISSION DURING SWINE SLURRY COMPOSTING

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Abstract
This work evaluated the use of additives (Mg/P and nitrification inhibitor dicyandiamide - DCD), on nitrous oxide emission during swine slurry composting. The experiment was run in duplicate; the gas was monitored for 30 days in different treatments (control, DCD, Mg/P and DCD + Mg/P). Nitrous oxide emissions rate (mg of N_2O-N.day^{-1}) and the accumulated emissions were calculated to compare the treatments. Results has shown that emissions of N-N_2O were reduced by approximately 70, 46 and 96% through the additions of DCD, $MgCl_2.6H_2O$ + H_3PO_4 and both additives, respectively, compared to the control.

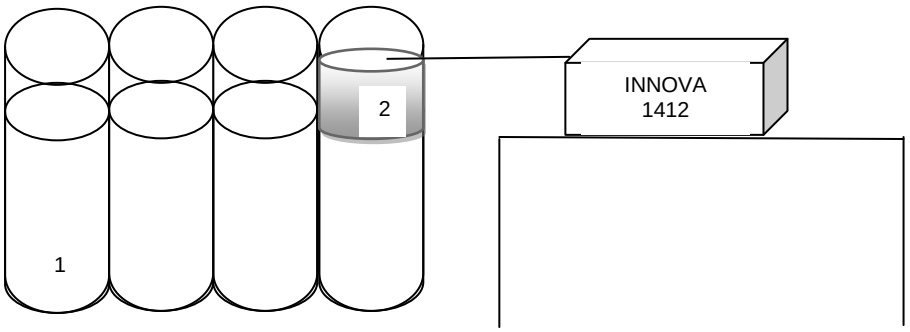
Keywords
Composting; swine slurry; additives; nitrous oxide.

INTRODUCTION
Swine slurry composting with sawdust is an emerging technology in Brazil and an important strategy for the sustainability of intensive swine production systems. Nevertheless, previous study showed relevant N losses (up to 54%) during the composting process as NH_3 (15%), N_2O (5%) and N_2 (79%). This N loss during swine slurry composting decrease nutrient content of the compostand also can cause environmental risks, such as global warming, and odours problems (Angnes et al., 2013; Zhong et al, 2013).
Therefore same studies employ different methods to reduce N losses, as use of additives. The nitrification inhibitor, dicyandiamide (DCD) is used to inhibit the first-stage of nitrification: the ammonia (NH_4) oxidation to nitrite (NO_2). According to O'Cornnor et al (2012) the DCD acts specifically on ammonium oxidase bacteria, maintaining the nitrogen as NH_4^+ and reducing its loss as NO_3^-.
The Mg and P can form the struvite ($Mg.NH_4PO_4.6H_2O$).The crystallization of struvite has been considered an effective method to decrease N loss by volatilization of NH_3 and struvite is a valuable fertilizer of slow release. Previous studies showed that the precipitation of struvite affects the microorganisms that participate in the nitration process, the conversion of nitrite (NO_2) to nitrate (NO_3) by nitrobacter (Lee et al, 2009; Fukumoto, 2012).
The aim of this work was to evaluate two additives that promote the inhibition of nitrification (dicyandiamide - DCD) and the crystallization of struvite ($MgNH_4PO_4.6H_2O$) to control gaseous N losses from swine slurry composting piles. This may be a useful tool to improve compost quality and to mitigate pollutant and greenhouse gases emissions.

MATERIAL AND METHOD

Reactor Composting

Experiment was run during 30 days in 8 tubular PVC reactors V= 25 L (ϕ=200 mm; h= 800 mm). Reactors (Figure 1) were filled with a mixture of swine slurry and sawdust (50:50 v/v) and the following treatments were carried out in duplicate: (1) Control, (2) DCD - 1.07% in Dry Matter- DM, (3) $MgCl_2.6H_2O + H_3PO_4$ – 1.01% Mg: 5.32% P in DM and (4) Both additives in the same loads as (2) and (3). The biomass from each reactor was revolved twice a week and samples of composts were collected and analysed dry DM and $N\text{-}NH_4$ according to official methods (APHA, 2005).



1.Composting reactor; 2. Static chamber.
Figure 1. Experimental system of the conposting reactor.

Nitrogen Gases Emissions

Emission of $N\text{-}N_2O$ from each reactor was daily measured using static chambers and the increase of gas concentration was measured by infrared photoacoustic gas monitor (INNOVA 1412, Denmark). The fluxes were calculated based on a standard protocol (Robin et al, 2006).

RESULTS AND DISCUSSION

The $N\text{-}N_2O$ losses were reduced by 70; 46 and 96,56% through the additions of DCD, $MgCl_2.6H_2O + H_3PO_4$ and both additives, respectively, compared to the control treatment.

Figure 2 shows that in terms of efficiency on reducing $N\text{-}N_2O$ emission, DCD+Mg/P reached the best result (18,73 mg of $N\text{-}N_2O$ in 30 days), followed by DCD and Mg/P an
.

Fukomoto (2012) showed that the addiction of Mg and PO_4 can reduce 25-43% NH_3 emission compared to control, according to these authors this happened by struvite formation, reducing the amount of nitrogen dissolved, which doesn't have a direct influence on nitrification/denitrification process ($N\text{-}N_2O$ emission). Otherwise Luo et al (2013) observed that the treatment with DCD shows significant reduction emission of N_2O because it inhibit the metabolic turnover of Nitrosomonas bacteria. O'Callaghan et al (2010) states that DCD did have effect on the ammonium-oxidizing bacteria by reducing the population and altering their activity.

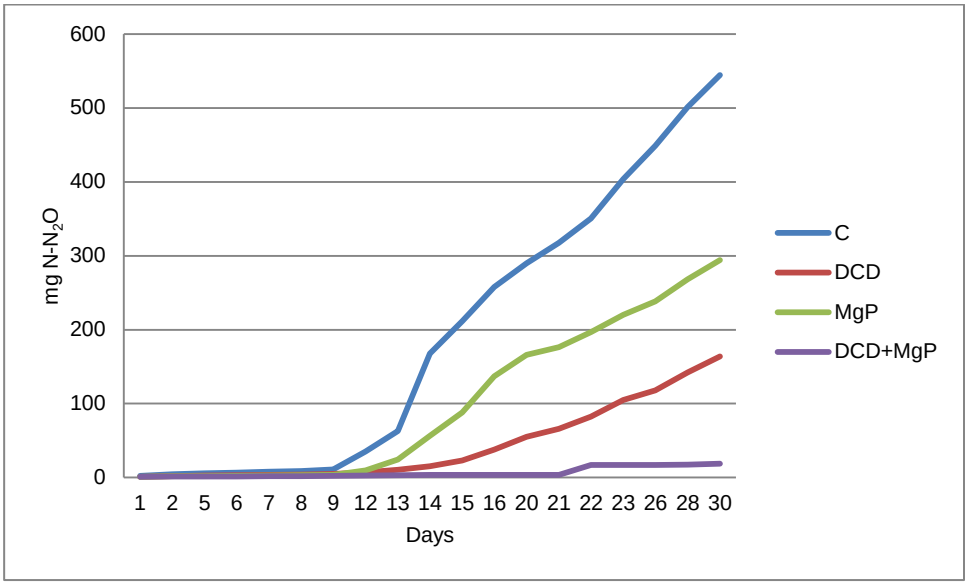


Figure 2. Accumulate emission of N-N2O during the experiment.

Figure 3 shows the concentration of N-NH_4 (%) in the resulting composts. It was observed that the treatment DCD+Mg/P has the higherN-NH_4 concentration when compared with control. The amount of N-NH_4 in this study were 0,7% (DCD), 0,5% (MgP) and 0,4% (DCD+Mg/P). These results confirms that Mg/P decreases N-NH_3 loss and keep it in the resulting compost increasing its' fertilizing a potential.

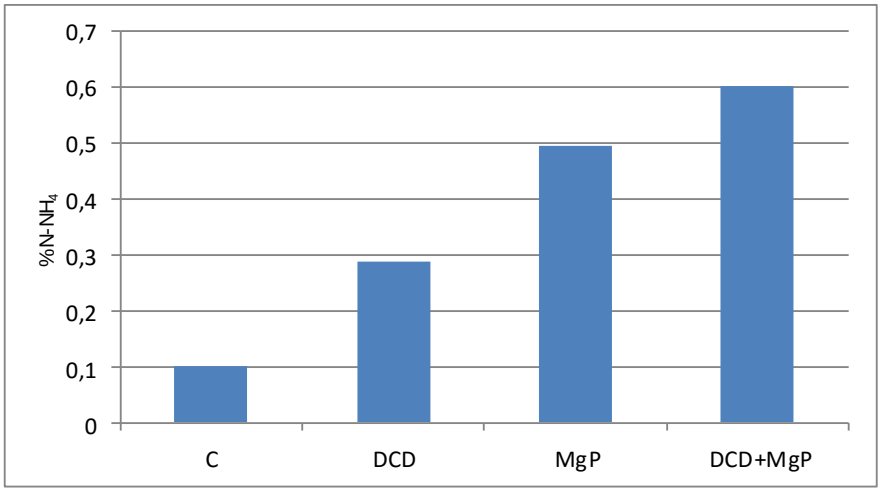


Figure 3. % of N-NH4 in % in the compost final (resulted in dry matter).

CONCLUSIONS

The additives DCD and $MgCl_2.6H_2O$ + H_3PO_4 mitigated N_2O emission from swine slurry composting piles through different processes. Also, the resulting compost had higher N-NH_4 contents which may have influence in the performance of the organic compost as a fertilizer for crop production. Further studies should address the mechanisms and interactions among additives controlling N losses from compost piles.

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