INFLUENCE OF THE PARTICLE SIZE AND ANIMAL SLURRY TYPE ON THE POTENTIAL OF NITROGEN MINERALIZATION AFTER SOIL INCORPORATION

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1 INTRODUCTION

Animal manures are rich in organic matter and nutrients, namely nitrogen (N) and, consequently, widely applied to soil as organic fertilizers. However, a large part of the nitrogen contained in animal manures is in the organic form and so not directly available for plants. Indeed, organic N has to be mineralized prior to plant uptake (Rees and Castle, 2002). Several manure characteristics as the C:N ratio (Chadwick et al., 2000), the lignin content (Kristensen, 1996) and the NH_4^+/organic N ratio (Beauchamp and Paul, 1989) have been suggested as indicators of the plant-available N. More recently, Fangueiro et al. (2008) showed that the potential of N mineralization (PNM) of cattle slurry is inversely correlated with slurry particle size: finest fractions are the particle-size fractions from which N mineralization occurs in slurries whereas coarser fractions are associated with immobilization. Furthermore, Moller et al. (2002) reported that animal diet and anaerobic decomposition during storage in slurry channels and stores affect the slurry particle size distribution. Such information is of great interest since the finest slurry particle size should infiltrate the soil more easily and quickly relative to the coarser slurry particle size that should remain close to soil surface. Furthermore, mechanical slurry separation is now performed in many pig and dairy farms in order to improve slurry management in terms of nutrients utilization and reducing costs related to slurry storage. Slurry separation by screw press leads to a nutrient rich organic solid fraction (0.7– 3.2 mm particles) that may be composted and a liquid fraction that can be used for fertigation.

In the present study, three types of slurry (pig, duck and cattle) were separated into 4 slurry particle size fractions (>2000 µm, 2000-500 µm, 500-100 µm, <100 µm) in order to assess the influence of the type of slurry and slurry particle size on the PNM after soil incorporation.

2 MATERIALS AND METHODS

The three slurries (pig, cow and duck) studied were obtained in commercial farms and slurry separation was performed by sieving. All the particle size fractions and whole slurries were characterized in terms of total N, ammonium (NH_4^+-N), dry matter (DM) and total organic carbon (TOC) using standard methods. More details about the methods used can be found in Fangueiro et al. (2010). The PNM of the fresh slurry fractions and non-separated slurries was determined using an anaerobic incubation method described by Fangueiro et al. (2008). Briefly, an amount of a specific slurry fraction corresponding to 0.02 g of N was added to 10 g of field-moist soil in a 60mL syringe and the amount of water was adjusted to have a total water amount of 25mL in the mixture soil + slurry. The soil used was a sandy-loam soil. Ten replicates of each slurry fraction were used to allow one half to be incubated for 7 d at 40°C, whilst the other half was extracted immediately after the injection of 25mL of 4 M KCl into each syringe to give a 1:5 ratio of (soil + slurry) to 2 M KCl. After 1 hour shaking, the suspensions were filtered and the filtrates analyzed for NH_4^+-N content. Soil-only treatments acted as controls. The same extraction method was used at day 7 of the incubation period. The PNM (% of organic N applied) was calculated using the following equation:

$$PM = \{([NH_4^+]_{t=7} - [NH_4^+]_{t=0})_{sample} - ([NH_4^+]_{t=7} - [NH_4^+]_{t=0})_{control}\} / \text{organic } N_{applied} \times 100$$

3 RESULTS AND DISCUSSION

The composition of the three slurries in terms of total N, organic C and DM content varied significantly ($P<0.05$) (Figure 1). Furthermore, the relative proportion of the slurry fractions obtained depended on the slurry type considered. In the pig and duck slurries that showed lower DM contents relative to the cow slurry, the < 100 µm fraction represented more than 98% of the whole slurry whereas the cow slurry contained a higher amount of coarser slurry particles. The largest fractions of slurry presented higher total N, organic N, DM and TOC contents relative to the finest one in accordance with the results reported by previous authors (Moller et al., 2002; Fangueiro et al., 2007). Nevertheless, differences in terms of total and organic N were not so evident in the cow slurry. It is still to note that the NH_4^+-N: total N ratio was significantly (P<0.05) higher in the pig and duck slurries relative to the cow slurry. More details about the slurry fractions characteristics are described in Fangueiro et al. (2010).

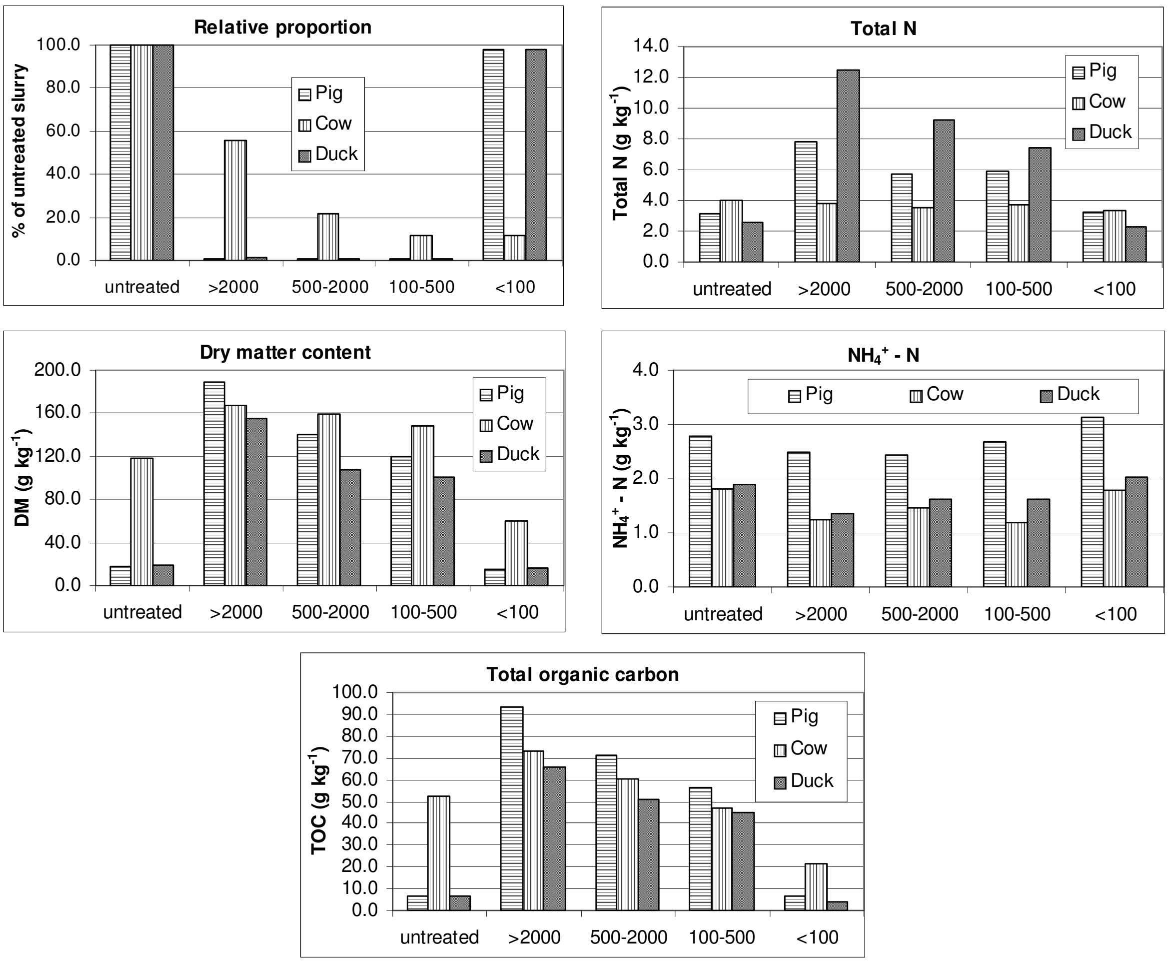

FIGURE 1 **Characteristics of the non-separated slurries and slurry fractions used; X axis unit: µm; DM: dry matter; NH_4^+-N: ammonium nitrogen; TOC: total organic carbon (Fangueiro et al., 2010)**

Higher values of PNM were obtained for the pig whole slurry relative to the non-separated duck and cow slurry (Figure 2). The highest values of PNM were detected for the finest particle size fraction (<100 µm) in duck and pig slurries and in the 100-500µm and 500-2000 µm fractions of cow slurry. Hence, a large part of the organic N from the finest slurry fractions is expected to be quickly and easily mineralized being available for plants whereas this amount of potentially available organic N is smaller in larger slurry particle sizes. The values of PNM obtained were significantly higher than those reported by Fangueiro et al.(2008) for cattle slurry fractions using the same methodology. Despite the high variations observed between non-separated slurries and slurry fractions in terms of C:N ratio, N mineralization was observed in all slurries and slurry fractions. This result is in contradiction to previous results reported by Chadwick et al (2000) who concluded that materials with lower C:N ratio led to N mineralization whereas higher C:N ratios led to N immobilization. Nevertheless, the C:N ratio and the PNM were negatively correlated in the case of the duck (R^2= 0.981) and pig (R^2=0.636) slurry fractions but no significant relation was observed in the case of cow slurry.

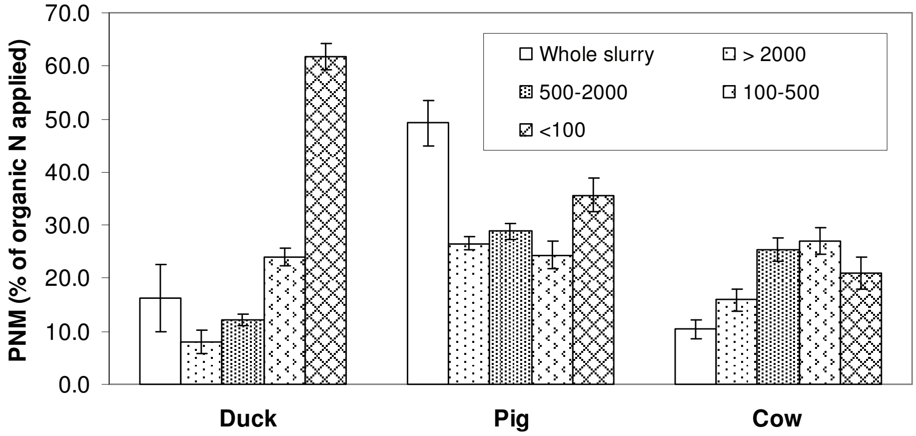

FIGURE 2 **Potential N mineralization (PNM) of the non-separated slurries and slurry fractions considered – average and standard deviation of 5 replicates (Fangueiro et al., 2010)**

4 CONCLUSIONS

Our results showed that the slurry type as well as the slurry particle size strongly influence the potential of N mineralization. Such information is of relevant importance since slurry separation is used by farmers as pre-treatment and, according to the particle size fraction obtained, it may be of interest to apply different slurry fractions at different stages of plant growth depending on the plant nitrogen requirements. Furthermore, combined application of different types of slurry may also be helpful to better match plants' nitrogen demand.

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