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Effect of bio-acidification and leonardite addition to slurry on ammonia and GHG emissions in soil-plant systems

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Agricultural ecosystems are significant sources of reactive trace gases, such as ammonia and nitric oxide, as well as greenhouse gases (GHGs), including carbon dioxide, methane, and nitrous oxide. These emissions contribute to global warming, air pollution, and ecosystem eutrophication. Traditional mitigation strategies, such as sulfuric acid slurry acidification in slurry storage, reduce ammonia and methane emissions effectively but face high costs, safety concerns, and restrictions in organic farming. This study explores alternative amendments for slurry, including organic acids waste i.e. cheese whey (a dairy byproduct), sauerkraut juice (a fermentation byproduct), and leonardite (a humic-rich natural material), to assess their potential for emission mitigation.

Using a controlled soil-plant mesocosm system to simulate field-like conditions under a laboratory setting, emissions of ammonia, methane, nitrous oxide, nitric oxide, and carbon dioxide were continuously monitored over nine days. Flux rates were determined using the dynamic chamber method at a temperature of 18°C and a water-filled pore space of 50%. The mesocosms were treated with either untreated slurry, slurry amended with cheese whey, sauerkraut juice, or leonardite, or left unfertilized as a control.

Results highlighted the potential of cheese whey and sauerkraut juice to substantially lower ammonia emissions by as much as 91%, with cheese whey also reducing combined GHG emissions significantly. While sauerkraut juice showed promise in reducing methane emissions, nitrous oxide emissions were elevated due to a higher ammonium content in the slurry-amendment mixture. Leonardite, though not effective in mitigating ammonia emissions, demonstrated its utility in lowering GHG emissions overall.

The findings suggest cheese whey and sauerkraut juice as promising amendments for ammonia reduction, with leonardite offering potential for GHG mitigation. However, the trade-offs observed with nitrous oxide emissions emphasize the need for further optimization to achieve a balanced mitigation strategy. These results contribute to the understanding of gas exchanges in agricultural

ecosystems and promote sustainable practices by repurposing agricultural byproducts in a circular economy.