Feed and manure additives to reduce NH_3 emissions from slurry – a meta-analysis

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Abstract

Managing animal manure, from housing to field application, plays a key role in NH_3 emissions control. Strategies include diet optimization, prompt manure removal, additives in storage, and innovative field application methods. Yet, the effectiveness of feed and manure additives in curbing NH_3 emissions remains unclear. To fill this knowledge gap, we conducted a meta-analysis examining NH_3 reduction strategies across the feed-to-slurry process chain. We analyzed data from 69 studies published until February 2019. Our findings revealed that additive application led to a substantial 77% reduction in NH_3 emissions. Notably, acidification emerged as the most effective strategy, achieving a 78% reduction, followed by sorption (55%) and urease inhibition (43%). In contrast, the utilization of feed supplements yielded a comparatively lower NH_3 reduction of 16%. This study offers valuable insights into several potential methods for achieving a 50% reduction in ammonia emissions from farm manure.

Introduction

The integration of livestock with crop production in intensified mixed farming has led to the accumulation of nitrogen in specialized agricultural systems (Oomen et al., 1998). Managing animal manure in barn, during storage and field application contributes significantly to NH_3 and N_2O emissions, posing environmental, health, and economic concerns. To mitigate NH_3, strategies involve optimizing animal diets, timely manure removal, using additives during storage, and specialized field application techniques (Bittman et al., 2014). However, the efficiency of feed and manure additives in reducing NH_3 emissions from slurry remains inadequately understood. We conducted a meta-analysis to identify NH_3 reduction approaches across the feed-to-slurry process chain, offering potential alternatives to established low-emission techniques. The objective of this study was to assess the efficiency of various feed and slurry supplements to mitigate NH_3 emissions in animal slurry along the process chain i) feedstuff, ii) animal housing, iii) slurry storage and iv) field application.

Method

The data was collected from peer-reviewed literatures published until February 2019. The keywords used in the search engine of the Web of Science were "slurry," "manure," "livestock waste," "ammonia," "feed additive," "additive," and "treatment". In the initial phase 383 studies were selected that were relevant to our objectives. We excluded studies that did not meet our selection criteria for the meta-analysis i.e.1) the presence of the effect variable "NH_3 emissions", " 2) the requirement for at least one pairwise comparison with a control variant, and 3) minimum of three independent replicates in the

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selected studies. This screening process ultimately led to the inclusion of 69 studies, which were deemed suitable for our analysis (Table 1).

Table 1: Number of studies and pairwise comparisons according to the farm manure investigated in the studies

Farm manure	No. of studies	No. pairwise comparison
Cattle slurry	27	114
Pig manure	28	67
Poultry manure	12	61
Other	2	10
Total	**69**	**252**

Results and Discussion

The results show that numerous additives and treatment methods have the potential to significantly reduce NH_3 emissions from farm manure (Fig. 1). Additive application in the form of acids, alums, chlorides and humic substances within animal housing showed highest efficacy, resulting in a substantial 77% reduction in NH_3 emissions. Among the assessed modes of action, acidification stood out as the most effective strategy with 78% reduction of NH_3, followed by sorption (55%) and urease inhibition (43%). Conversely, the utilization of feed supplements yielded a comparatively lower NH_3 reduction of 16%. Notably, NH_3-reducing additives exhibited no significant impact on N_2O emissions. These findings underscore the effectiveness of acidification and highlight the limited potential of feed supplements in mitigating NH_3 emissions within agricultural systems.

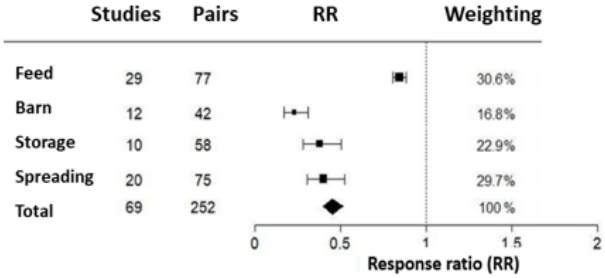

Fig 1. Effects of additives on NH_3 emissions in the farm manure chain. All RR values lower than 1 indicate a decrease in NH_3 emissions from the treatment.

Conclusion

Our study highlights several potential methods for achieving 50% reduction in ammonia emissions from farm manure.

Acknowledgment

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