FARMING PRACTICE
LIVESTOCK FEEDING TECHNIQUES

IMPACT: AIR POLLUTANTS EMISSIONS

Reference 10

Wang, HL; Long, WT; Chadwick, D; Velthof, GL; Oenema, O; Ma, WQ; Wang, JJ; Qin, W; Hou, Y; Zhang, FS 2020 Can dietary manipulations improve the productivity of pigs with lower environmental and economic cost? A global meta-analysis AGRICULTURE ECOSYSTEMS AND ENVIRONMENT, 289, 106748. 10.1016/j.agee.2019.106748

Background and objective

Inappropriate management of pig manure contributes considerably to pollution of waterbodies by nitrogen (N) and phosphorus (P), and to air pollution by ammonia (NH_3) and hydrogen sulfide (H_2S) emissions. Dietary manipulation is recognized as a possible pollution mitigation measure, but it may affect pig growth and thereby production costs. The objectives of this study are therefore to i) determine the effects of four specific dietary manipulation strategies on N and P excretion, emissions of NH_3 and H_2S and the growth performance of pigs, using a meta-analysis of published data, and ii) to evaluate the cost-effectiveness of these dietary manipulation strategies through marginal abatement cost curves analysis.

Search strategy and selection criteria

Studies related to the effects of pig dietary manipulations on growth performance, nutrient excretion and emissions were searched using the bibliographical databases: Web of Science and China National Knowledge Infrastructure. The peer-review studies published in the period between January of 1990 and July of 2018 in both English and Chinese were searched. 1) Only data from studies with control treatments were included in ourdatabase, so as to allow side-by-side comparisons.; 2) Studies to be included had to include at least one of the following indicators: (i) growth performance; (ii) N and/or P digestibility; (iii) total N and/or P excretion; (iv) NH_3 and/or H_2S emissionfrom manure; 3) When an experiment in a study had more than one treatment (e.g. various levels of crude protein reduction, various doses of adding enzymes, various fermented feed ingredients and additives), each treatment had a control for comparison. In addition, data quality was further checked by considering the following criteria on treatment design: 4) the effects of dietary manipulations have to be tested as the main objectives of the treatments; 5) the experiments must be conducted in randomized and controlled trials; 6) feed additives have to be administrated through the feed; 7) animals must be free of diseases.

Data and analysis

A mixed-effects model was used to calculate themean effect size and the 95% confidence intervals (CIs) of each groupand performed in the nlme (linear and nonlinear mixed effects models) package of R statistical software Version 3.1. Experimental sites were considered as a random effect factor, to allow accounting for variances among studies. The lnR ofindividual pairwise comparison was the dependent variable. The significance of the effects on emissions was statistically assessed at 0.05 level.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
245	Swine	1) Low crude protein diet; 2) Enzymes suppementation; 3) Fermented feed; 4) Other diet additives supplementation	1) No reduction of dietary CP; 2-4) No feed additives	Metric: 1) Ammonia (NH_3) emissions; 2) Hydrogen sulfide emissions; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	68.75

Results

- Mean emissions of NH_3 decreased by 34.4% and 21.5% following reductions in dietary CP content and the usage of other additives, respectively ($P < 0.01$).
- Diets supplemented with exogenous enzymes and fermented feed ingredients did not affect NH_3 emissions ($P > 0.05$).
- Emissions of H_2S from manure were reduced by the usage of other additives (23.2%; $P < 0.01$) but not by the use of fermented feed ingredients (9.6%; $P > 0.05$).
- Effects of dietary CP reduction and addition of enzymes on emissions of H_2S were inconsistent, based in part on the limited number of observations ($P > 0.05$).
- Lowering dietary CP content and supplementation of other additives significantly decreased the ratio of NH_3 emission to average daily gain.

Factors influencing effect sizes

- Dietary crude protein (CP) reduction : Ammonia emissions decreased with decreasing dietary CP reduction, with mean reduction values ranging from 18.2% to 65.5% ($P < 0.05$).

Conclusion

Non specified feed additives reduced ammonia and hydrogen sulfide emissions while reduction in dietary crude protein reduced only ammonia emissions. Enzymes and fermented feed have non-significant effect both on ammonia and hydrogen sulphide emissions.