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The Use of Additives to Control Malodour Generations in Animal Production, Particularly Swine

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Abstract. The menace of malodour generations is currently a major concern to livestock producers, principally because of the interface between animal production and residential areas often leading to law suits against producers. Land being a fixed asset, the levels of conflicts between animal producers and residents within or living near animal production areas are projected to be on the increase as projections support increased livestock production in the future due to continuous increase in the demand for animal protein. These challenges had resulted in the search for means of deciphering some of the challenges being presented. To this end, current researches have focused on the assessment of the efficacy of additives in reducing malodour related to barn air, fresh faecal samples and short-term storage of animal manures, such as pig manure consisting of faeces and urine, respectively. Different compounds have been identified in the swine manure as potential odour-generating agents. Some of these compounds are: sulphides, phenols, indoles and skatole. These compounds are produced during microbial fermentation within the caecum and large intestine, especially in the pig. Thus, the manipulation of the microbial ecosystem and nutrient supply would have the potentials of effecting changes in the production of most of these agents of odour-triggering compounds. The feed additive approaches employed in achieving this are: the use of enzyme-resistant but fermentable carbohydrates in diets to stimulate the production of less putrefactive bacteria (prebiotic approach), the use of antibiotic or antimicrobial agents and the use of direct-fed microbial (probiotic approach) to manipulate intestinal microflora. This paper lays out in a broad-spectrum fashion in the practical applications of these techniques in controlling malodours.

Key words: Animal Production, Feed additives, Malodour Control and Swine

Introduction

The next level of studies on reducing malodour from animal production activities have focused on reducing the causative agents of malodour generators. To this point, one of the major management approaches being explored to reduce or minimize malodour generations from animal production activities, particularly swine is the impact of dietary additives on animal production-related odours. The major nutritional concept upon which feed additives are employed in combating malodour is mostly based on the manipulation of the types of products found in the caecum and large intestine of the animal, particularly swine (Farnworth, Modler & Mackie, 1995). To this point therefore, the manipulation of the microbial ecosystem and the kind of nutrient supply significantly have the potentials of effecting changes in the production of most of the agents of odour-triggering compounds (Gebbink et al., 2001). The different feed additive approaches employed in minimizing the menace of malodour generations in livestock production activities, especially in swine include the use of enzyme-resistant but fermentable carbohydrates in diets of pigs to stimulate the production of less putrefactive bacteria (prebiotic approach) as demonstrated by the studies of Farnworth, Modler and Mackie (1995) and Colina et al. (2001), the use of antibiotic or antimicrobial agents as also shown in the studies of Hansen et al. (1997) and Armstrong et al. (2000), and the use of direct-fed microbial (probiotic approach) according to the data of Shu, Qu and Gill (2001) to manipulate intestinal microflora. Therefore, the objectives of this paper are to clearly lay out how different methods based on the above stated additive approaches involving different additives can be used to mitigate against malodour generations in animal production activities, especially in areas where there are intensive animal production activities, including those of swine.

Prebiotic Approach

The use of this approach involves the inclusion of an enzyme-resistant but fermentable carbohydrates by microbes presents dietary feed components that are resistant to enzymatic hydrolysis within the small intestine of the animal and therefore pass more readily into the caecum and large intestine, the known primary sites for bacterial fermentation in non-ruminants, particularly the pig. By this, high amounts of resistant carbohydrates are presented to the hindgut with the potential to altering the fermentation patterns and microbial populations in the large intestine. This invariably results in the reduction of the productions of most malodour causing agents. This is supported by the findings of the data of Farnworth, Modler and Mackie, (1995), where the addition of 3 or 6% of *Jerusalem artichoke* (*JA*) in weanling pigs' diets showed a highly significant reduction in the intensity of sharp and pungent odour due to skatole from manure and also significantly produced 'sweeter' manure smell as assessed by a sensory evaluation panel. These findings in the studies were based on the fact that *JA* contains fructans that have been implicated in the manipulation of intestinal microflora by favouring the growth of *bifidobacteria* species. An enrichment of *bifidobacteria* species is a means of out-competing pathogenic bacteria species such as *E. coli* and *clostridia* (Gebbink et al., 2001). Additionally, the addition of *yucca* extract (De-Odorase) to feed significantly aid in minimizing odour. This is principally due to the ability of the extract to bind ammonia and thus reduce its concentrations in animal barns. Amon et al. (1995) observed a 26% reduction in ammonia emissions when *yucca* extracts were added to the diet of fattening pigs. Colina et al. (2001) reported similar trend in the reduction of ammonia in swine barns when *yucca* extracts were added to growing pigs' diets. Again, the addition of dietary acidifiers reduces odour generations. This is because the rate of ammonia volatilization from manure sources is dependent on many factors, including pH. Low or acidic pH maintains ammonia in the non-volatile form as ammonium ions ($NH4^+$). This implies that the air pollution potential related to airborne ammonia levels can be reduced significantly by maintaining low or acidic pH conditions. This is where acidifiers come handy as demonstrated by the data of van Kempen (2001). In that study, 1% adipic acid (a product known to be very safe and also serves as a flavour enhancer) inclusion level in grower-finisher pigs' diets showed reduction of ammonia by 25%. Acidifiers can also be used to store manure to mitigate pungent odours emanating from manure. It is important to note that the greatest increase in ammonia release takes place between a pH of 7 to 10 (Ndegwa et al., 2008) such that ammonia volatilization decreases below pH 7, but around a pH of 4.5 there is almost no measurable free ammonia (Hartung & Philips, 1994). Furthermore, Jensen (2002) demonstrated that sulphuric acid maintained manure pH at 5.5. In that study, 75 - 90% reduction of ambient concentrations of ammonia was observed while the weight of the pigs increased by 1074 g day^{-1} during the study period compared to the pigs in the control buildings. The findings of this study therefore lay credence to the concerns of the well-being and health of animals in an odorous environment as well as those living within such vicinities. This area needs to be explored further, including the suitability of acidifiers for on-farm use due to the associated safety concerns of their hazardous properties. Another category of additives are the antimicrobials.

Antimicrobial Approach

As earlier alluded to manipulating the hindgut microflora of the pig can lead to changes in the production of odour-causing metabolites resulting in the reduction of malodour. Antimicrobials though banned in Europe, North America still uses some selected antimicrobials as a result of increases in performance that are attributable to their uses.

Therefore, despite international pressure for antimicrobial removal as additives in animal diets, the potential exists for their uses to causing changes to odour profiles. For example, addition of 50 mg zinc *bacitracin* per kg of diet significantly reduced skatole concentrations in blood and back fat of boars (Hansen et al., 1997). This is a clear indication that antimicrobials are anti-malodour agents. Furthermore, the use of 225 ppm copper from copper sulphate or 100 ppm copper from copper citrate demonstrated a significant reduction using static olfactometry in malodour generations emanating from fresh fecal samples of pigs (Armstrong et al., 2000). To this extent therefore, the looming prohibition of their uses as additives would no doubt have a huge impact on production and their improved effect on malodour reductions. This therefore, necessitates further research in the light of rapid changes in regulations and requirements pertaining to the uses of antimicrobials and their alternatives.

Probiotic Approach

This approach involves the delivery of selected beneficial organisms to the hindgut of the animal, such as the pig. Some key factors required in order to have a suitable probiotic are that the organism must survive low pH and proteolytic activity within the gastric region and the proteases and bile salts within the small intestine; there must be evidence of enrichment or establishment of a significant microbial population and the probiotic must be effective in manipulating hindgut fermentation for the desired effect. It is the latter factor that is linked to having effect on odour reduction as most studies on probiotic focused on their potentials for health-promoting effects with the sole aim of reducing reliance on antibiotics in animal feeds. Nevertheless, there are documentations in the literature demonstrating the effects of probiotics on odour reductions. This is mainly linked with the shifting of microbial species that may be less putrefactive and thereby lead to reduction of emissions of malodorous compounds. In this regard, Shu, Qu and Gill (2001) provided a live culture of *bifidobacteria lactis* in the diets of weanling pigs and observed significant reductions in *E. coli* populations in fecal samples of the pigs, suggesting shifts in microflora in the hindgut. This further suggests that *bifidobacteria lactis* may be a potential probiotic based on the findings in that study. However, the major drawback in that study was that the authors did not enumerate *bifidobacteria lactis*. Nevertheless, *bifidobacteria* are known to be less putrefactive than *E. coli*. Although, probiotics had been demonstrated as anti-odour agents (Shu, Qu & Gill, 2001), more data generations are warranted to better characterize their potentials and a more robust guide on their uses as anti-agents of malodour generations.

Conclusions

This paper exploited how some feed additives as well as their modus operandi in the control of malodour in intensive animal productions, particularly in swine. The additives as highlighted include enzyme-resistant but fermentable carbohydrates in diets to stimulate the production of less putrefactive bacteria, antibiotic or antimicrobial agents and the use of direct-fed microbial to manipulate intestinal microflora. Evaluation of novel additives are also suggested because malodour generations from animal productions is currently becoming a major nuisance in our environments resulting in conflicts between animal farmers and neighbors.

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