Improvement of environmental quality in intensive pig farming through an integrated bioactivation program for the control and prevention of swine mycoplasmal pneumonia

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ABSTRACT

The decline of pig health status is the effect of a bad air quality inside breeding facilities related to the concentration of biogases derived from the action of faecal microbial flora on urine nitrogen. Bioactivation of the environment with bacterial-enzymatic mixtures is able to reduce this chemical emanation.

An experimental trial has been performed to evaluate the efficacy of the bioactivation treatment to prevent mycoplasmal pneumonia in finishing pigs. Treated and untreated groups, different treatment schemes and different floors have been compared. The ammonia concentration was checked by a chemical method. *M. hyopneumoniae* infection was evaluated through seroprevalence and by a quantitative lung-scoring system. For all slaughter-lots average carcass weight was recorded.

The decrease of the environmental ammonia concentration resulted in lower lung-scores and higher carcass weight.

KEYWORDS: environment, mycoplasma, bioactivation, pig, ammonia

INTRODUCTION

The improved productivity of intensive pig farming has increased the environmental impact of ammonia emissions that are responsible for acidification of rainfalls and surface water, but also for social and territorial problems due to odours dispersion [10].

Smell emissions from sewage degrading processes include simple gases, such as methane (CH_4), ammonia (NH_3), hydrogen sulphide (H_2S) and other volatile organic compounds (VOCs) frequently related to dust respirable fraction [7]. Microbial flora of faecal origin hydrolyzes the urea present in urine to CO_2 and NH_3, releasing free ammonium in gaseous form when faeces and urine are mixed in the manure [12, 14].

Inside farm facilities, air quality affects the welfare state of animals [1, 5] because biogases may cause behaviour modification and reduce organic resistance of pigs [2, 11]. In addition, gas concentration in the facilities depends on floor type and the method of manure collection.

An improvement of air quality in pig facilities can be obtained through bioactivation with enzymatic bacterial compounds, which control the development of harmful substances and reduce noxious emissions of biogas from manure [9]. These compounds were initially settled up for the control of odour emissions from animal farm, but our group has indicated and developed their use also for improvement of environmental quality in pig facilities.

In normal condition, manure is a bacterial ecosystem in which all microorganisms have a specific and integrated role, but macro and micro-climatic variations can modify the microflora balance in manure pits and some bacterial strains may predominate over others [18]. The system balance and utility can be maintained or modified by adding substances that adjust the micro-nutrients availability, such as organic acids, vitamins and microelements or enzymes of bacterial origin [8]. This is exactly the final function of bioactivating compounds [19] that improve digestive processes, reduce the bioavailability of organic substance for pathogens and reduce polluting residues in the environment [15].

Moreover, a regular use of biological promoters increases slurry fluency, reducing the pits washing necessity and decreases the volume, maturation times and bad smelling emissions [16]; furthermore, the easier movement of manure enhances machinery efficiency and duration inside the farm, while an improved environment guarantees better conditions for workers and animals [17].

Bioactivators can be dispensed in powder form on the surfaces trampled by animals or directly mixed with slurry or even nebulised in the air under a liquid form. The continuous association of the two kinds of treatment and the contemporary use of vegetable mixture can improve enteric biochemistry [15].

A direct correlation between the concentration of ammonia in the air and the seriousness of mycoplasmal lung lesions has already been demonstrated [6, 13]. This paper reports the results obtained through the controlled application of an integrated bioactivation programme in the prevention of productive damage due to mycoplasmal pneumonia.

MATERIALS AND METHODS

During experimental tests the Micropan® biological activation system manufactured by Eurovix Srl (Cazzago San Martino – Italy) was applied. The system consists of two different products (Micropan® Powder and Micropan® Liquid) and of a natural vegetable mixture (Biolife®).

Bioactivators contain enzymes (cellulases, lipase, pancreatic, proteases, α-Amylolytic enzymes, β-Amylolytic enzymes, Hemicellulase, pectinase and beta-glucanase), micro-organisms selected in a process of controlled fermentation with prevalence of Bacillus spp., active substances of *Fucus laminariae*, mineral salts of calcium and magnesium, algae of the species *Lithothamnium calcareum*, mineral salts of mordenite and dolomia, vegetable extracts and agar medium.

Biolife® is a compound of vegetable origin, obtained by controlled fermentation processes containing polysaccharides, essential amino acids, natural enzymatic and vitamin factors. It improves the biochemical and organic balance of the enteric microflora, preventing enteropathogenic bacteria replication and toxin production.

Micropan® powder has been distributed manually on the floors (0.5 Kg per 100 m^2 every 15 days) while liquid has been sprayed after 3-5% (v/v) dilution in water into the facilities air under control of a computerized system (1 litre per 100 m^2 per month, in 3 x 20 seconds applications/day). Biolife has instead been added to the feed (500 g/ton) on a daily basis.

Moreover, the correct use of this food additive reduces the pollution of ammonia compounds, having environmental and olfactory benefits.

For our evaluation trial, two intensive pig farms have been selected on structural, managerial and sanitary basis among those already applying the bioactivation programme in the Po valley area. Their features are schematically reported hereinafter.

A 300 sow farrow-to-finish farm (farm 1) has applied the protocol in three facilities, each of 600 fatteners. Two of them (group 1 and 2) have used Biolife® and Micropan® (powder and liquid) while the third (group 3) has not applied liquid bioactivator. The facilities of group 2 and 3 have concrete partially slatted floor, while that of group 1 is fully slatted. All are ventilated naturally.

Farm 2 is a fattening unit, with 15 facilities (fully slatted floor and natural ventilation) and 13.500 places. Finishing pigs came from eight suppliers, but fattening batches are separately managed. Two equivalent weight groups of pigs, of 1000 animals each, coming from the same supplier and placed in the same facility have been used for trial investigation. In the first cycle (fattening group 3) the house has not been treated, while in the second (fattening group 4), Biolife® and Micropan® powder have been used.

Ammonia concentration in the air has been detected by a chemical method (Drager Accuro – D). NH_3 specific vials have been located at established times, in the same position and always at the same height from the floor. Finally, 20 pigs of each cycle have been blood-sampled just before slaughtering and seropositivity for *Mycoplasma hyopneumoniae* has been checked by ELISA (Hyoptest II Bommeli – CH).

Treatment efficacy has been evaluated both considering the reduction of the average lung score in treated pigs and the improvement of productive parameters. Kolmogorov - Smirnov test has been preliminarily performed to assess the normality of sampling distribution and U test of Mann-Whitney has been used to compare qualitative data (presence/absence of lesions)

The correlation between lesion presence and mycopalsmal infection according to the kind of treatment used has been performed by the Chi-square test.

RESULTS AND DISCUSSION

The treatment results are presented in table 1. Data refer to bioactivation scheme and are related to *Mycoplasma hyopneumoniae* seroprevalence before slaughter. Air concentration of NH_3, lung scores and average slaughter weight have been considered for each experimental batch.

A quantitative lung-scoring method already validated on the traditional Italian swine [6, 13] has been applied to all trial slaughter-lots.

Lung-scores together with seroprevalence and productive parameters have been already shown to be good indicators of mycoplasmal infection incidence [13] .

Table 1. Serological and pathological results at slaughtering, productive and environmental data

Farm	Group	Floor	Treatment	Sero-prevalence Mycoplasma (%)	NH3	Lung score	Average weight
Farrow to finish	1	slatted	powder + liquid	93	8 ppm	1.94	165.70
	2	concrete-slatted	powder + liquid	87	12 ppm	2.90	159.86
	3	concrete-slatted	powder	79	20 ppm	3.20	158.16
Fattening	3	slatted	none	57	30 ppm	4.76	162.30
	4	slatted	powder	83	5 ppm	2.32	166.30

Average lung scores related to standard deviation and analysed according to the type of treatment have been reported in Table 2. The percentage increase of pigs without lesions or with very low scores is evident in treated groups.

Table 2. Lung scores according to the type of treatment

Treatment	n° of pigs	Average	Standard deviation
None	100	4.76	4.94
Powder	200	2.76	4.00
Powder + liquid	200	2.42	2.85
Total	500	3.02	3.90

In the following Table 3 the results of the study are reported. The significance of the lesion presence/absence has been evaluated in the different groups of animals. The five groups have different prevalence and the differences are statistically significant (Chi-square test = 10.045; p = 0.040).

Table 3. Presence/absence of lung lesions in the 5 groups.

		Lung lesions		Total
Type of farm	Group	Absent	Present	
farrow to finish	1	23	77	100
farrow to finish	2	19	81	100
farrow to finish	3	31	69	100
fattening	3 (control)	14	86	100
Fattening	4	27	73	100
Total		114 (22.8%)	386 (77.2)%	500

In table 4 presence / absence of lung lesions has been evaluated depending on the application of the bioactivation protocol. The lesion prevalence (75% versus 86%) is significantly lower in the treated groups (chi-square test = 5.500, p = 0.019). Even the average lung score difference (4.76 in control and 2.59 in treated groups) has been significantly lower (U = 14197.5; p = 0.000).

Table 4. Presence / absence of lung lesions (treated vs control).

treatment	lung lesions absent	present	Total
No	14	86	100
yes	100	300	400
Total	114 (22,8%)	386 (77,2%)	500

Finally, in table 5 lung lesions prevalence has been related to the treatment protocol. Even in this case the differences are significant (chi-square = 9.136, p = 0.010).

Table 5. Presence / absence of lung injuries according to the type of treatment

Treatment	lung injuries absent	present	Total
None	14	86	100
Powder	58	142	200
Powder+liquid	42	158	200
total	114 (22.8%)	386 (77.2%)	500
			100,0%

In previous studies the acceptability threshold of average score compatible with good carcass quality was stated at 1.87 [6] . Moreover, the average lung score increase was statistically related to the decrease of average weight of each lot [13].

The recurring and statistically significant differences between control, treated groups and type of treatment have confirmed these remarks even in both farms of this trial. Based on these results, bioactivation could be considered a reliable tool for environmental improvement. In fact, average lung scores have always been lower in treated groups than in control ones. Furthermore, the complete programme with liquid and powder bioactivators allowed better and more homogeneous results. Even when high seroprevalence has confirmed circulation of *M. hyopneumoniae*, the treatment of manure with powder only has been sufficient to decrease the environmental concentration of ammonia, with evident effects on the average lung score.

The acceptability threshold of ammonia in the air is between 20 and 25 ppm [4] , but our data clearly have shown production improvement to be directly in proportion with air quality. The most relevant difference has been detected in the only fattening farm, where one cycle has not been treated.

In the same farm, treated pigs of the same origin and average initial weight of control pigs, have shown an important average weight increase at the end of the fattening period (166.3 kg vs. 162.3 kg).

In the farrow to finish farm, where treatments have been applied in same size houses and animals on two types of floor, the best results have been achieved by the combined use of powder and liquid on the slatted floor.

Such results have been related to reduced ammonia (8 ppm), lower lung score (1.94) and better average weight of the batch (165.7 kg). The use of powder only on concrete floor has been less effective, even with low infection levels. This could be due to atmospheric oxygen as bioactivation is more effective in anaerobic conditions.

Nevertheless, better results have been accomplished when liquid bioactivator has been nebulised in facilities previously treated with powder on completely slatted floor.

CONCLUSIONS

According to the above mentioned results, the right balance between animal welfare and environmental quality achieved by bioactivation is a feasible solution for an adequate sanitary management.

The control of the infections through the welfare improvement is possible also in growing and finishing continuous cycles and bioactivation can be a useful tool in minimising the productive impact of diseases.

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