FOLIA VETERINARIA

www.uvm.sk

FOLIA VETERINARIA, 49, 3: — Supplementum, S23—S25, 2005

THE PERFORMANCE OF NATURAL ZEOLITE AS A FEED ADDITIVE IN REDUCING AERIAL AMMONIA AND SLURRY AMMONIUM ION CONCENTRATION IN THE PIG FARM NURSERY

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ABSTRACT

The investigations were carried out in a pig nursery on 985 piglets (554 experimental and 431 control piglets) for 50 days. The effect of natural zeolite (55 % clinoptilolite) used as a feed additive on the concentration of ammonia in the air was investigated as an important factor affecting the health and welfare of piglets. Our investigations included the determination of microclimatic parameters, aerial ammonia and physicochemical parameters in the slurry. Results of the study proved that the respective feed additive decreased ammonia emissions in the experimental unit. The addition of 2 % of zeolite to mixed feed resulted in a decrease in ammonia emission by about 33 % and a decrease in ammonium concentration in the slurry by 25 %.

Key words: aerial ammonia; ammonium ion; clinoptilolite; pig slurry; zeolite

INTRODUCTION

Intensive livestock production is increasingly regarded as an important source of gaseous and malodorous emissions due to the production of large quantities of animal excreta and their composition. One of the important air pollutants is ammonia. Other gases released from animal housings are methane, carbon dioxide, hydrogen sulphide, nitrous oxide, and additional more than 130 trace gases (7).

The presence of ammonia in animal housings affects the health of housed animals. Ammonia causes direct irritation of the retinal and respiratory mucosa resulting in conjunctivitis, coughing, and reduced lung capacity (9, 14). The possibility of intoxication increases with the duration of stay in an ammonia-rich atmosphere. The maximum allowed concentration of ammonia is 25 ppm.

Efforts aimed at reducing aerial ammonia in animal houses are based on various feed and manure additives, for example zeolites (10, 13), glycocomponents from the *Yucca shidigera* plant (1, 15), and a preparation containing sodium alginate obtained from brown seaweed *Ascophillum nodosum* (12).

Zeolites are naturally occurring three-dimensional, microporous, hydrated aluminosilicate minerals characterized by high internal surface area and high cation exchange capacities. Zeolites remove ammonia from slurry by trapping and exchanging it in its crystalline structure. There are more than 50 different types of natural zeolites differing in their selectivity towards various cations. The zeolite clinoptilolite has a specific affinity for ammonium ions and ammonia (11). Moreover, zeolites are non-toxic, non-hazardous and valuable soil conditioners when added to the soil with manure (2).

In the present study, the effect of a commercial preparation "Pigozen", added to piglet feed, was assessed in terms of aerial ammonia and physicochemical composition (ammonium ion) of the slurry.

MATERIALS AND METHODS

The study was conducted on Dubravica Pig-breeding farm in Hrvatsko Zagorje, Croatia. Measurements were taken in nursery units during the winter period. Piglets were housed in two equal nurseries, in boxes with 30 animals in each, on a partially slatted floor, and were supplied feed and water *ad libitum*.

There were 431 piglets in the control unit and 554 in the experimental. The experiment lasted 50 days.

The commercial preparation "Pigozen", a natural zeolite containing feed additive, was added to the mixed feed in the experimental group at an amount of 2 % by weight.

The microclimatic parameters (temperature, relative humidity and air velocity) were determined (n = 7) every week using a Testo 625 thermohygrometer and Testo 415 anemometer. CO_2 and NH_3 concentrations were determined by a Dräger-Acuro gas detector pump with respective detector tubes.

Untreated samples of pig slurry were used as a substrate in the study. Grab-bottle, dark green-brown, malodorous specimens were sampled from the channel under the slatted floor once a week (n = 7).

Standard physicochemical parameters in the slurry (dry matter — DM, inorganic matter — IM, pH, biochemical oxygen demand — BOD_5, and ammonium, nitrite and nitrate ions) were determined in accordance with standard methods (3, 4) using titration and photometric procedures and a HACH DREL/ 4000 chemistry/apparatus module.

RESULTS AND DISCUSION

The results obtained by the measurement of microclimate parameters in the control and experimental nursery units are presented as means in Table 1.

Table 1. Microclimate parameters in control and experimental nursery units

Parameter	Control unit	Experimental unit
Temperature (°C)	24.6	24.2
Relative humidity (%)	70.1	66.2
Air velocity ($m.s^{-1}$)	0.09	0.08

The piglets' health and productivity are greatly influenced by microclimate parameters. Their values measured met the criteria set for the respective animal species and category and were comparable between the control and experimental units. The mean temperature of about 24 °C corresponded to the requirements for this animal category (20—28 °C). Humidity is a factor closely related to air temperature. The relative humidity ranged from 50 % to 70 % in both control and experimental units. Air velocity ranging from 0.05 to 0.2 $m.s^{-1}$ corresponded to the requirements for this animal category (5, 8). Although natural zeolites have great affinity for small polar molecules like H_2O, SO_2 and NH_3, lower relative humidity in experimental unit could not be caused by 2 % addition of zeolites (6).

The effect of "Pigozen" was reflected in a considerable difference in the mean aerial gaseous contamination, especially ammonia, between the control and experimental nursery units (Table 2). According to the manufacturer's instructions, this feed additive greatly inhibits the emission of ammonia from animal excreta, thus improving the housing microclimate, which in turn results in reduced mortality and better health in piglets.

Table 2. Mean level of air pollutants in control and experimental nursery units

Parameter	Control unit	Experimental unit
Carbon dioxide CO_2 (% by vol.)	0.16	0.14
Ammonia NH_3 (ppm)	4.04	2.68
Reduction of NH_3 in comparison with control (%)		33.67

During the study period, the concentration of ammonia in the experimental unit was reduced by some 33 % on average, which could be attributed to the effect of clinoptilolite. The concentration of carbon dioxide as an indicator of ventilation showed a negligible decrease in the experimental unit.

The influence of zeolite on physicochemical parameters in the slurry differed according to individual parameters (Table 3 and 4). The pH of slurry showed a very small difference and DM content and IM was about 1 % higher in the experimental group, which is related to zeolite addition. On the other hand, the mean value of BOD_5 was lower in the experimental group.

Table 3. Physicochemical parameters in the slurry from control and experimental nursery unit

Parameter	Control unit	Experimental unit
pH	7.1	7.0
Dry matter (%)	7.1	8.1
Inorganic dry matter (%)	24.1	25.8
Biochemical oxygen demand ($mg.l^{-1}$)	6764	6280

The addition of zeolite-clinoptilolite to mixed feed reduced the concentration of nitrogen compounds — ammonium and nitrate ions by about 26 % and nitrite ions by 12 % (Table 4).

In conclusion, a positive effect of "Pigozen" was observed on the quality of air in terms of aerial ammonia,

Table 4. Level of nitrogen compounds determined in the slurry from control and experimental nursery unit

Parameter	Control unit	Experimental unit
Ammonium NH_4^+-N ($mg.l^{-1}$)	1880	1378
Reduction in NH_4^+-N in comparison with control (%)		26.7
Nitrite NO_2^--N ($mg.l^{-1}$)	6.4	5.6
Reduction of NO_2^--N in comparison with control (%)		12.2
Nitrate NO_3^--N ($mg.l^{-1}$)	2385	1771
Reduction of NO_3^--N in comparison with control (%)		25.8

which was decreased by 33 % in the experimental unit. The concentration of ammonium ions and other investigated nitrogen substances in the slurry was also decreased by between 12 and 26 %.

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