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ASSESTMENT OF ADDITIVES EFFICACY IN REDUCING AMMONIA LOSSES FROM PIG SLURRY

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ABSTRACT

During the last years the individuation of new techniques for odors and ammonia emissions control has assumed great importance in Italy due to the growing concentration of the breeding farms into narrow surfaces and their closeness to urban areas. During the last years several additives for the ammonia and odor control have appeared on the international market earning a fairly good success inside the breeding farms. Five different additives have been tested by the Mechanical Section of the D.E.I.A.F.A (Torino University). The products were evaluated at three different rates: the one recommended by the manufacturer, a lower and a higher one. For each dosage the trial was repeated three times. The ammonia emissions were evaluated every 24 hours with regular samplings, for a duration of each trial of 96 hours. The main climatic parameters and the slurry temperature were recorded during all the trial period. The test, repeated with slurries characterized by three different total solids contents, showed ammonia emission reduction as regards the control ones ranging between 1% and 18%.

INTRODUCTION

During the last years the individuation of new techniques for odors and ammonia emissions control has assumed great importance in Italy due to the growing interest of the public opinion as regards to environmental matters and the concentration of the breeding farms into narrow surfaces closed to urban areas. Ammonia, in detail, is an environmental issue since its concentration in the air in the vicinity of point sources as large animal husbandry can damage the vegetation, can contribute to water and air acidification and to eutrophication of terrestrial and aquatic ecosystems (ECETOC, 1994). Moreover, ammonia toxic effect - also at low concentrations (15mg/m^3) - makes the problem greater in relation to the hygienic conditions of the livestock exercise areas and to the animal wellness (Fabbri et al., 2000).

Owing to these reasons, the possibility to use efficient techniques for the ammonia emissions abatement permits to limit the livestock impact on the environment and on the urban areas as well. The traditional available techniques for the ammonia emission reduction (control and modification of cattle diet, frequent animal wastes removal, storage covering.) are often too difficult and expensive to apply (Valli and Bonazzi, 1996). During the last years several additives for the ammonia and odor control have appeared on the international market earning a fairly good success inside the breeding farms. In order to verify the efficacy of some of these commercial products, actually available on the Italian market, five different additives have been tested by the Mechanical Section of the D.E.I.A.F.A. (Torino University).

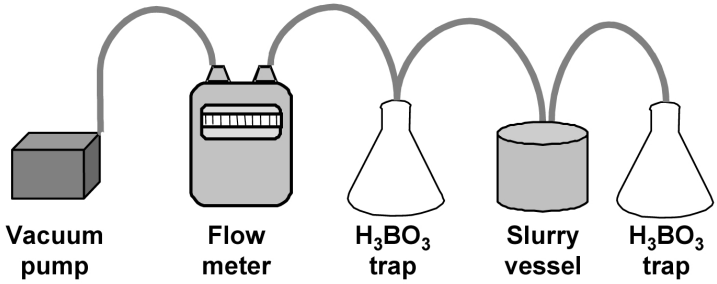
MATERIALS AND METHODS

The device for the ammonia losses determination

For the trial a specific device for the ammonia emissions determination has been developed by the DEIAFA. The instrument is constituted by a vacuum pump, a glass

vessel containing 500 g of slurry, two flasks containing 400 ml of a 1% boric acid solution, a volume-meter and a flow-meter for the air flow arrangement. The air - sucked by the pump - is purified by the ammonia through its gurgling in the first boric acid solution then, passing through the upper part of the vessel, carries the ammonia to the second boric acid solution where it is trapped as ammonium borate (fig. 1). The pump flow rate is arranged to allow about 8-10 complete changes per min. of the vessel's air.

Figure 1 - The system for the ammonia emission determination.



The amount of ammonia collected by the boric acid solution is then determined by titration with sulfuric acid.

The additives

Five different additives, chosen among the most common on the Italian market, have been tested. The main characteristics of the additives are shown in tab. 1.

Table 1 - Main characteristics of the tested additives

Additive	Mechanism of action	Suggested application rate	Price €/kg
1	Enzymatic	1 l/m^3	4.13
2	Biologic	0.02 kg/m^3	13.94
3	Biologic	0.5-5 kg/m^3	2.76
4	Enzymatic	1-3% su S.T.	9.55
5	Enzymatic	0.3 g/kg aliment	11.62

The products 2-4 are sold as soluble powder, while the product n° 1 is liquid. Each product, but the number 5, must be directly added to the slurry with an application rate determined on the basis of the amount of slurry to threat or its Total solids content. Since the product 5 must be directly added to the feeds, its application rate is referred to the feed amount instead of the slurry volume. For the trial this product has been added directly to the slurry and its application rate has been determined on the basis of the ratio between the amount of feeds given to the animal and its excreta production.

The trials

Six devices have been used simultaneously for the experimentation: one for the ammonia emission determination from the control and five for the ammonia determination from the slurries treated with the five different additives.

The products were evaluated at three different rates: the one recommended by the manufacturer (D), a lower one reduced of the 50% (D-), and a higher one increased of the 50% (D+). For each dosage the trial was repeated three times and with slurries

characterized by three different total solids content. Slurry samples have been collected at the beginning of each trial for the determination of their main chemical and physical characteristics. (tab. 1). The ammonia emissions were evaluated with regular samplings of the traps every 24 hours, for a duration of each trial of 96 hours. The results obtained with the trial have been subjected to factorial ANOVA.
Both the temperatures of the slurry and of the environment were recorded during the trials.

Table 1 - Main characteristics of the slurries used for the trials

Trial	dosage	Total solids (%)	ash (%)	$N_{tot.}$ (% tq)	$N\text{-}NH_3$. (%)	Organic matter (%)
1 (7-8% T. S.)	D-	8.1	3.1	0.40	0.22	4.9
	D	7.1	1.5	0.56	0.33	5.6
	D+	7.1	2.6	0.50	0.28	4.5
2 (9.7% T. S.)	D-	9.6	3.9	0.53	0.31	5.6
	D	9.8	3.8	0.52	0.28	5.9
	D+	9.6	3.8	0.88	0.31	5.7
3 (<2% T. S.)	D-	0.8	0.3	0.11	0.09	0.4
	D	1.5	0.6	0.128	0.1	0.9
	D+	1.5	0.6	0.15	0.09	0.9

RESULTS AND DISCUSSION

The temperatures recorded during the trial (tab. 2) ranged between 15 and 28 °C. There were no significant difference between the temperatures of the slurry and of the environment.

Table 2 - Slurry and environment temperatures recorded during the trial

	Slurry total solids					
	<2%		7-8%		9,7%	
	environment	slurry	environment	slurry	environment	slurry
dosage	°C		°C		°C	
D-	10	11	20	19	17	17
D	15	15	28	28	18	19
D+	15	15	21	22	18	20

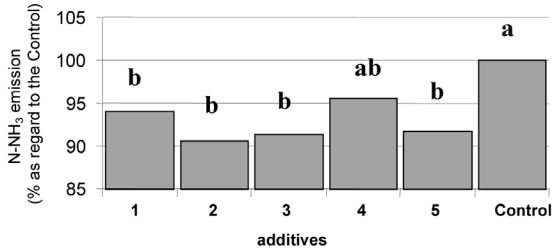
The ammonia emissions, determined during the trials ranged between the 2% and the 30% of the total nitrogen present in the slurry at the beginning of the determination.
The additives showed altogether a reducing capability of the ammonia emission - as regard to the test - ranging between the 1% and the 18,6% (tab. 3).

Table 3 - Reduction of the $N\text{-}NH_3$ emissions (as regard to the control ones) observed from the slurries treated with the additives

Slurry total solids content		<2%			7-8%			9,7%		
	dosage	**D -**	**D**	**D +**	**D -**	**D**	**D +**	**D -**	**D**	**D +**
Additive	**1**	9.1%	17.6%	5.7%	4.9%	5.0%	-4.9%	2.1%	5.0%	7.9%
	2	12.5%	18.6%	13.7%	4.4%	10.1%	6.4%	3.7%	10.1%	15.0%
	3	7.7%	8.8%	15.1%	11.5%	1.8%	3.7%	1.0%	1.8%	10.5%
	4	9.0%	3.7%	16.1%	-4.9%	4.4%	-1.9%	1.0%	4.4%	8.1%
	5	8.2%	13.4%	7.7%	3.1%	5.7%	8.8%	3.5%	5.7%	12.0%

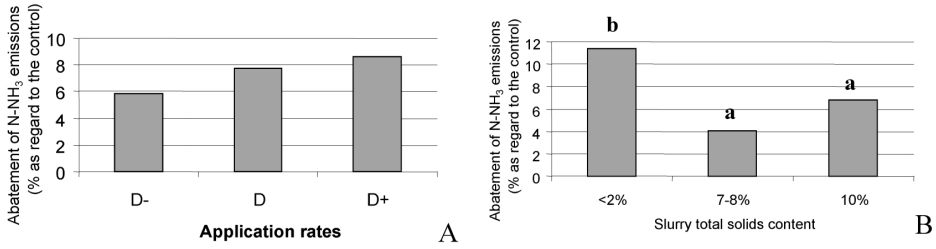
The ammonia nitrogen emissions, expressed as a percentage of the total nitrogen present in the slurry at the beginning of the trials, were lower from the slurries treated with the additives than from the control in the 97% of the examined cases.
The factorial ANOVA showed that the ammonia emissions recorded from every slurries treated with the additives were statistically lower than the ones from the control except for the slurry treated with the product number 4 (fig. 2).

Figure 2 - N-NH_3 emissions (% as regard to the Control). Values with the same letter are not statistically different (Duncan Test, α=0.01)



No significant effect of the application rate on the containment of the ammonia emissions was pointed out (fig. 3a). Significant greater abatements of the ammonia nitrogen emissions were observed from the slurry characterized by the lowest (<2%) total solids content (fig. 3b).

Figure 3 - Abatement of the ammonia emissions obtained with the three different additives dosages (A); and with different slurry total solids content(B). Values with the same letter are not statistically different (Duncan Test, α=0.01)



CONCLUSIONS

In our test conditions the additives showed a reduced effectiveness on the containment of the ammonia emissions.
The greatest benefits has been achieved with very diluted slurries (<2% T.S). Since the additives cost can weight upon the marketable gross production up to the 7%, their use is not to consider advantageous for the farmers. Alternative solutions have to be identified in order to limit the ammonia emissions from the slurry storage.

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