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GASEOUS EMISSION DURING BROILERS RAISING ACCORDING TO FLOOR MATERIAL AND LITTER BUDGET

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INTRODUCTION

International negotiations on mitigation of greenhouse gases (GHG) emission (Kyoto,…) and ammonia emission (Göteborg,…) are discussed by Nations which could present an inventory with reliable figures about sources on their territory. Among the different sources, agriculture and livestock production represent a major source of emission for both pollutants, *i.e.* 40% for methane and nitrous oxide and 90% for ammonia (Morard, 2000).

Management of manure and slurries on wet or dry basis can influence the behaviour of compounds in term of transformations into gaseous molecules. Such transformations can occur during the accumulation of manure in livestock building according to the building design and to its management through ventilation rate or litter material and quantity. The main purpose of this study was to collect data on gaseous emissions, especially GHG and ammonia, from broilers building with different material of floors, and to compare end-litter characteristics.

MATERIALS AND METHODS

Measurements of gaseous emission were made on an experimental poultry station of the AFSSA (French Agency for Sanitary Security of Food) at Ploufragan in North Brittany. The broilers building was designed to have 3 separated raising rooms of 240 m^2 each, which can be divided in 2 floors of 120 m^2 each one; 5000 chicken are raised in each room (density of 21 animals.m^2). These 3 rooms result of separations in a conventional growing poultry building. They can be distinguished according to the kind of soil : clay (conventional), concrete (new design), and insulted electrical heating concrete floor (not more developed yet).

Each room is equipped with the same ventilation system, composed of 4 fans, respectively 1 ventilating 3000 $m^3.h^{-1}$, 1 ventilating 6000 $m^3.h^{-1}$ and 2 ventilating 12000 m^3.h-1 each. Ventilation rate was adjusted daily according to several criteria (animal's growth and age, atmosphere parameters,…) and by combining fans number and working cycling periods. High and low values allowed limitations for excess or default on climatic parameters. Normal rates of ventilation varied from 72 $m^3.h^{-1}$ to 13370 $m^3.h^{-1}$ for a raising period of 40 days (0.36 to 1.5 $m^3.h^{-1}.kg^{-1}$).

Woodchip was used as litter on a 1 $kg.m^{-2}$ basis for concrete floors and on a 5 $kg.m^{-2}$ for clay. Evolution of temperature was programmed to evolve from 32°C on the first day, to 27°C after 2 weeks, 23°C for the 4th week, down to 18°C during the end of the raising period. Air heating in rooms with no heating floor was realised during the first 4 weeks, using gas supplied heaters.

Emissions of CH_4, CO_2, N_2O and NH_3 were performed in the concrete floor room. Outlet air flow was continuously sampled and pumped directly into a Non Disperses InfraRed (NDIR) spectrometer for CH_4, CO_2, and N_2O determinations and to a trapping system for ammonia determination. Data from NDIR spectrometer were only recorded when logger received information from ampermetric sensors which were switched on during the working periods of the fans. The information used in real time via microprocessor control solenoid valves which enable trapping of ammonia in sulphuric acid. Moreover a septum was installed in line to manually take gas samples which were analysed in the laboratory using gas chromatography equipment for CH_4 and N_2O.

All fan's rates were experimentally determined, at the end of the experiment in the used configurations.

RESULTS AND DISCUSSION

Each raising room was filled with 5000 chicks of about 40 grams each and were remove after only 35 days weighing 1,770 kg on average. At the end of the experiment, the total amount of litter in this room was 5130 kg and there was no major difference between the northern and southern side of the floor for any parameter. Determination of parameters was only carried out on manure samples from 3 different areas in the rooms, corresponding to the areas where gaseous emissions where sampled using accumulation boxes. No samples were taken in the manure trailer. The total weight of each component was obtained by multiplying nutrient concentration of each area by total manure weight. We proceeded using the same method in the clay soil room. Composition of litters is reported in Table 1.

Continuous analyses using the NDIR spectrometer never allows the determination of air CH_4 and N_2O concentrations because of the threshold detection level (5 ppm). Gas samples taken manually showed outlet N2O concentration higher (0,08 ppm) than inlet one, on one date. Inlet air N_2O concentration varied between 0,272 and 0,364 ppm. Methane concentration didn't exhibit any more significant differences between outlet and inlet air : ± 0,35 ppm. Such figures are comparable with results obtained by Groot Keorkamp et al. (1997) who found a difference between outlet and inlet air lower than 0,1 ppm for CH_4. Neser et al. (1997) preferred not to establish a balance due to low concentration variation either for CH_4 or N_2O. Macke et al. (1997) concluded that N_2O concentrations were lower than 0,4 $mg.m^{-3}$, which was the detection level of the system They used.

Outlet contents of CO_2 varied from 0,7/0,8 % at the beginning of the period to 0,2/0,3 % after 3 weeks. It was not possible to know the quantity produced by animals or by heaters.

Outlet ammonia rate were characterised by a fast evolution from the 1st day (0,04 g $N\text{-}NH_3.m^{-3}.h^{-1}$) to the 10th day (4,02 g $N\text{-} NH_3.\ m^{-3}.h^{-1}$). This high emission rate was nearly constant during 10 days, until of the ventilation rate was changed. Except from day 20 to day 25, hourly emission rate was increasing to reach more than 70 grams of $N\text{-} NH_3$ per hour for 5000 animals (Figure 1). In the same time the load due to animals per surface area increased from 0,840 $kg.m^{-2}$ to 12,5 $kg.m^{-2}$. Groot Koerkamp et al. (1997), and Von

Wachenfert (1994) observed the same trend especially after 3 weeks. They explained such phenomena by excreta accumulation and microbial growth in the litter. Groot Koerkamp concluded to an estimated emission of 41 g of N- NH_3 per animal place per year. Dutch standard emission of ammonia is fixed at 7,6 $mg.h^{-1}$ per animal. Our study leads to establish emission at a rate of 6,91 mg of NH3 per hour and per animal (5,71 mg N-$NH_3.h^{-1}$.per animal).

As no reliable figures were available from the two other rooms, we asked to the farm workers to compare general ambience. There was an unanimous perception of a very much higher content of ammonia in the air only in the monitored room. Moreover, according to zootechnical data there was no explanations for such a difference of composition of end-litters (*i.e.* 26 kg of N). Such differences (organic and inorganic matters) could be partially explained by the difference of start litter quantity and because clay added in the litter during the clean out. Difference in nitrogen mass balance can on the other hand be explained by high ammonia volatilisation in the monitored room (24 kg N)(figure 2).

Figure 1: Hourly Ammonia Emission Rate (g N-NH_3)

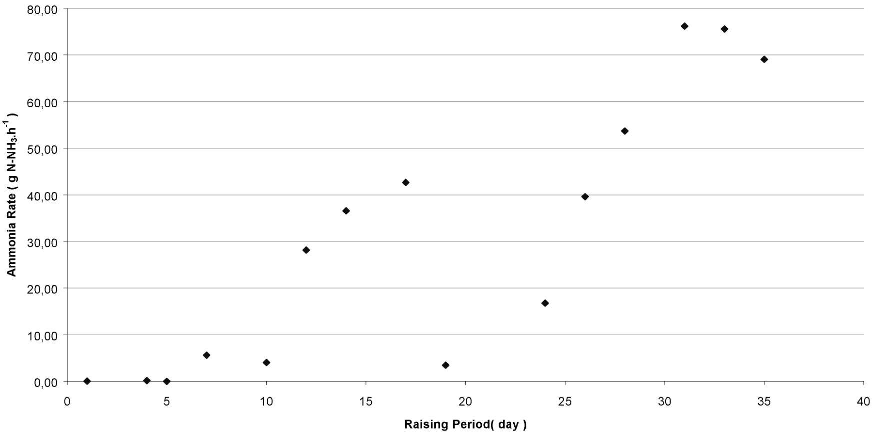
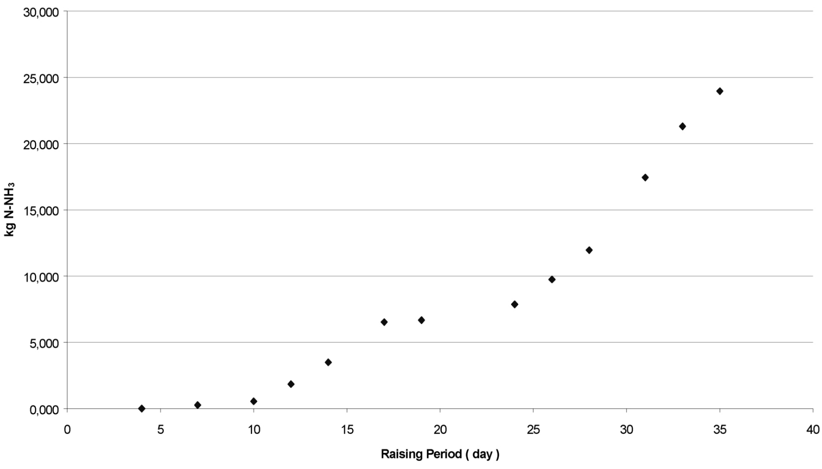


Figure 2: Cumulated Ammonia Emission (kg N-NH_3)



After the removal of the chicken, and before litter cleaning out, we carried out more observations on CH_4 and N_2O emission using accumulation boxes at typical points of the room : drinking area, eating area and sleeping area (Aubert et Guiziou, 1997). We made measurements during the 1st day and during the 3rd day, expecting changes in behaviour of the litter. Emissions were closed 0 for CH_4 and N_2O and no reliable figures were usable to conclude to a modification of the behaviour of the litter after animals removal. These results indicate that no nitrification / denitrification could be measured in the litter.

Table 1: Composition of Litters

Soil		Clay		Concrete		Deviation
Started Litter		Woodchips : 5 kg.m^{-2} 1200 kg		Woodchips : 1 kg.m^{-2} 240 kg		Earth - Concrete 960 kg
Raw Litter						
	Weight	6560		5130		1430,0
Water	content(%)	35,01		39,03		
	Weight(kg)	2296		2002		294,3
Dry Matter	content(%)	64,99		60,97		
	Weight(kg)	4264		3128		1135,7
Organic Matter	content(%)	52,47		49,01		
	/ Dry Matter (%)		**80,73**		**80,37**	
	Weight(kg)	3442		2514		927,7
Aches	content(%)	12,53		11,97		
	/ Dry Matter (%)		**19,28**		**19,63**	
	Weight(kg)	822		614		208,0
Total Nitrogen	content(°/$_{00}$)	27,82		30,46		
	Weight(kg)	182,47		156,27		26,2
Organic Nitrogen	content(°/$_{00}$)	22,74		24,26		
	/ Total Nitrogen(%)		**81,75**		**79,64**	
	Weight(kg)	149,17		124,44		24,7
Ammoniacal Nitrogen	content(°/$_{00}$)	5,08		6,20		
	/ Total Nitrogen(%)		**18,25**		**20,36**	
	Weight(kg)	33,29		31,82		1,5

CONCLUSION

According to our results, there was no detectable amount of CH_4 and N_2O emitted during the broilers raising, probably due to a low microbial activity in the litter. However, ammonia emissions of 5,71 mg N- $NH_3.h^{-1}$ per animal were measured on concrete floor. In comparison with the litter composition, diminution of started litter mass on non insulated concrete floor leads to modifications of litter behaviour and can initiate an increase of ammonia production and emission. Verification of such figures requires further attention.

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