GREENHOUSE GAS EMISSIONS FROM POULTRY AND PIG PRODUCTION IN SLOVENIA

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SUMMARY

Greenhouse gases carbon dioxide (CO_2), ammonia (NH_3), methane (CH_4) and di-nitrogen oxide (N_2O) were monitored in seven broiler and seven layer stalls, seven pig weaning and fourteen pig fattening stables. Large differences in emissions among stables due to technology, production phases, number, weight and age of animals in poultry and pig production were established. In majority significant ($P<0,05$) climate changes due to variable air streams in stables, which were directly correlated to N_2O concentrations in the air were ascertained. Air stream in fan exhausters was responsible to significant ($P<0,05$) changes in CO_2, NH_3 and N_2O concentrations on exhauster openings. Methane (CH_4) was determinate just in few cases. Enormous N_2O concentrations can be reported in some pig-fattening stables and low infrequent appearance of CH_4 emission.

Keywords: greenhouse gases, emission, climate, poultry, pig production

INTRODUCTION

Animal production is considered to be one of the most important sources of greenhouse gas pollution to the air in Europe. Agriculture's production contribute to 8% greenhouse gases on emissions control level, where animal production share the main source of methane and nitrous oxide (41% each) (1). High ammonia, methane and nitrous oxide emissions into the atmosphere are associated with ecological problems and environmental damage. Besides local impacts emissions from livestock farming contribute to acidification, eutrophication and local disturbance in several regions of Europe. Ammonia can be considered as the key air pollutant as it is emitted in the highest quantities. For this reason most activities on the emissions reduction from animal housing relate to ammonia reduction. (1,2,5) Methane is emitted from human-related activities which beside other include animal husbandry concerning enteric fermentation in livestock, manure and waste management. These activities release significant quantities of methane to the atmosphere. Methane is a greenhouse gas, it affects the ozone layer in the atmosphere and it contributes to global warming or global climatic change (2,3,4). Nitrous oxide is produced as part of the denitrification process of manure, during storage and when manure has been applied to the land (2,3,4). This is the most aggressive greenhouse gas contributing to global warming. Environment burdening policy in Slovenia dealing with national legislation which imposes liability to livestock breeders to report about methane, ammonia and nitrous oxide emissions. Annual permitted emission quotes were described, although measurements can not be executed due diffusion and different sources. Referring to animal age and a detailed inventory of other influences emissions can be estimate. The methodology of livestock breed evaluations as for emission potentials is not settled in legislation thus evaluation of united assessment greenhouse gases from different housing systems in Slovenia is not possible. In EU legislation maximum and minimum greenhouse emission values can be traced however they vary due to animal housing, meteorological conditions and waste disposal technology what is the reason why they are not useful for real comparison to evaluation in Slovenia. In spite of all that we are further in condition to use only EU values which are not always considered as feasible in practical circumstances.

OBJECTIVES

For a reason to set up fundamentally assessment of greenhouse emissions from livestock production on typical pig and poultry farms in Slovenia a study examining greenhouse emissions was to define existent situation and to establish the meaning of severally individual separate factors over emissions from livestock production in Slovenia. The purpose of this paper was to estimate greenhouse gases and climate in seven broilers, and seven layer stalls, as well as seven pig weaning and fourteen pig fattening stables in Slovenia. To do this, following steps were involved. First, all in- and outdoor measurements we pursued, were monitored in winter (December, January, February) and in early spring (March, April). For this purpose climate (Testo) – temperature (^{0}C), relative humidity (%), air speed (m/s), greenhouse gases (Dräger Multiwarn, Bachrach monitor N_2O) – carbon dioxide (CO_2), ammonia (NH_3), methane (CH_4) and di-nitrogen oxide (N_2O) were monitored. Measurements were performing inside of stables at three points and in three altitudes (10 cm, 80 cm, 200 cm above the floor), meanwhile gas concentrations and air exchange capacity (m^3/h) were determinate inside of fun exhausters. When results were gathered we evaluate the data considering following factors such as farm technology, animal production phases, number, weight and age of animals in time of monitoring. As the fact we look out for hypothesis that emissions from pig and poultry production depend on climate, fodder, sort, category, animal live weight and farming technology, as well as emissions were the highest from pig farms and mutual due to enumerated factors, the objective of study was to establishing recommendations for greenhouse gas emission evaluation from livestock production in Slovenia.

EXPERIMENTAL DATA AND DISCUSSION

Emission data from poultry layer and broiler stables

CO_2, NH_3, CH_4, N_2O concentrations in stables and exhaust air were defined. Each measurement covers average of three broiler stables (age: 14–28 day). Two groups of stables for layer/egg production were defined: Four stables where younger hens (age: 149–232 day) still not lay and three stables where older hens start and resume to lay (age: 279–457 day). In all stables it can be defined that indoor microclimate were strongly influenced ($P<0,05$) to outdoor climate and to stage of age of animal especially according to temperature growth and relative moisture decline. At this time air movement in stables increases progressively.

In average CO_2 concentrations in layer stables represent 0,07 vol% and 0,15 vol% in broiler stables. NH_3 concentrations were higher (15,6 to 95,3 ppm) in stables with younger in the contrast to stables with older hens (14,6 to 92,9 ppm). The same can be concluded for broiler stables where younger categories emitted 5,77 to 14,84 ppm in the contrast to older ones 0,22 to 4,4 ppm.

In average NH_3 concentrations represent 36,61 ppm in all layer and 5,88 ppm in broiler stables. This was significantly ($P<0,05$) linked to lower moisture and higher air movement in layer and broiler stables. Methane CH_4 (5 vol%) was ascertained only 10 centimetres up to the floor in stable for layers when hens were 232 days old, and in stable for broilers when chicken were 18 days old in all three measuring altitudes. N_2O measurements indicate the parallel growth with animal age by concentrations in range from 10 to 98,3 ppm. In layer stables we calculate average N_2O concentrations of 51,85 ppm, in broiler stables 13,70 ppm.

Microclimate parameters and N_2O concentrations in stable air significantly ($P<0,05$) depend to ventilation rates. CO_2, NH_3 and N_2O concentrations in exhaust air significantly ($P<0,05$) depend to ventilation rates as well. Average concentrations in exhaust air emitted from stables for layers were following: CO_2 0,069 vol%, NH_3 37,67 ppm, CH_4 0,00, N_2O 53,61 ppm. Average concentrations from exhaust air of stables for broilers were following: CO_2 0,15 vol%, NH_3 5,88 ppm, CH_4 0,00, N_2O 13,70 ppm.

Calculation considering ventilation rates of total emissions from 10 stables for broiler and layer production has shown that CH_4 emissions can be nearly neglected, meanwhile emissions of N_2O arise with age of animals and achieve nearly 600 ppm in the period when hens reach age of 300 days. After this period emissions of N_2O decline to lower level. With regard to enlarged ventilation rates in ahead of this period this fact is comprehensible, however emissions of N_2O still arise. In broiler stables N_2O emissions did not exceed 50 ppm what can be explained to the time of measuring in early stage of broiler breeding. On the other hand emissions of NH_3 from broiler and layer stables were arising with animal age constantly. Figure 1 show representative results of CO_2, NH_3, CH_4, N_2O emissions from layer and broiler stables considering air streams calculations.

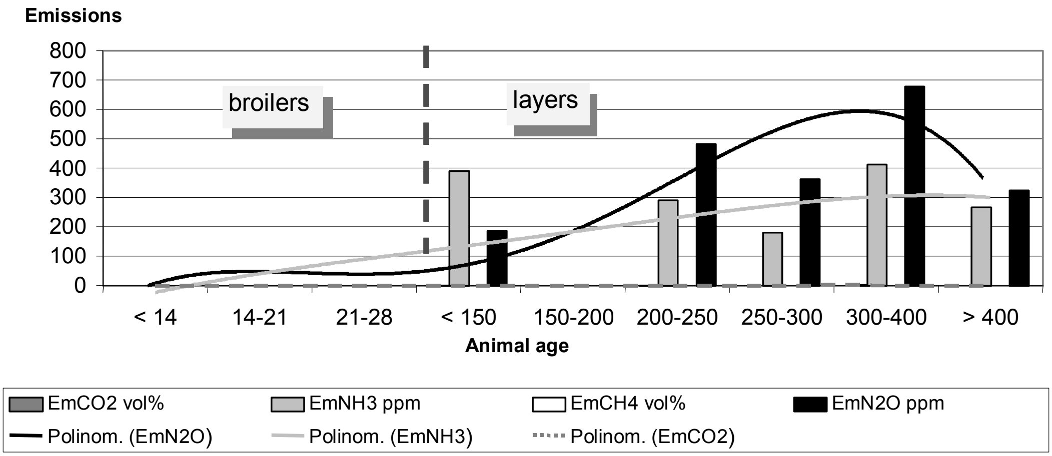

Figure 1. CO_2, NH_3, CH_4, N_2O emissions from layer and broiler stables

Emission data from pig fattening and weaning stables

Two groups for fattening and weaning breeding stables were defined: Fourteen stables where number of fatteners vary between 640 and 900 (body weight: 35 to 105 kg) and seven stables where number of weaners vary between 872 in 962 kg (body weight: 10 in 35 kg). In all stables it can be defined that indoor microclimate were strongly influenced ($P<0,05$) to outdoor climate and to stage of age of animal especially according to temperature growth and relative moisture decline.

In average CO_2 concentrations vary between 0,01 and 2,28 vol% in stables settled by fatteners (in average 0,128 vol%), and 0,002 and 0,358 vol% in stables settled by weaners (in average 0,15 vol). NH_3 concentrations were in range 0,49 to 47,0 ppm (in average 9,7 ppm) in fattening stables and 0,06 – 17,71 ppm (in average 7,31 ppm) in weaning stables. CH_4 was detect once on altitude of 2m up to the floor (0,14 vol%) when fatteners had 80 kg and in two cases when weaners had 20 kg in average concentration of 0,064 vol%. When weaners had 15 kg in CH_4 was ascertain in average concentration of 0,58 vol% as well as in stable for weaners when they weigh 27 kg (0,14 vol%). N_2O measurements indicate the growth with animal age through concentrations in the range of 1,09 to 170 ppm (in average 42,34 ppm) in fattening and 1,1 to 63,33 ppm (in average 21,29 ppm) in weaning stables.

CO_2, NH_3 in N_2O concentrations and microclimate parameters in stables air significantly ($P<0,05$) depend to ventilation rates, concentrations in exhaust air significantly ($P<0,05$) depend to ventilation rates as well. Average concentrations from exhaust air from fattening stables were following: CO_2 0,13 vol%, NH_3 8,0 ppm, CH_4 0,00, N_2O 52,9 ppm, beside average concentrations in exhaust air from weaning stables indicate: CO_2 0,19 vol%, NH_3 6,82 ppm, CH_4 0,00, N_2O 36,92 ppm

Calculation considering ventilation rates of total emissions from 21 stables used for pig fattening and pig weaning has shown that CH_4 emissions can be measured just in few cases, meanwhile emissions of N_2O arise with the age of animals and achieve more than 2000 ppm in the period when pigs reach the weights around 100 kg. After this period emissions of N_2O decline to lower levels. Regarding enlarged ventilation rates and hotter outdoor climate influence in ahead of this period this fact is comprehensible however emissions of N_2O were probably still arising. In weaning stables N_2O emissions did not reach 1000 ppm what can be explained due to younger animals and their weight. On the other hand emissions of NH_3 from fattening and weaning stables were arising with animal weight constantly. Figure 2 show representative results of CO_2, NH_3, CH_4, N_2O emissions emissions from pig fattening and weaning stables.

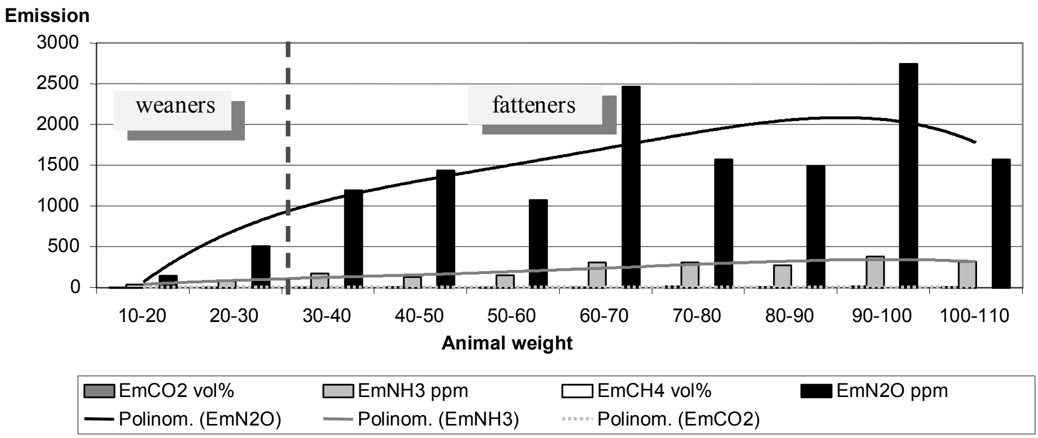

Figure 2. CO_2, NH_3, CH_4, N_2O emissions from pig fattening and weaning stables

CONCLUSIONS

In generally results represent lower greenhouse gases emissions from broiler production, especially N_2O concentrations in comparison to layer-egg production. Moreover lower emissions of greenhouse gases were monitored from pig-weaner production such as in pig-fattening production, as well, where N_2O emissions in some cases were extremely high. We can consider differences in emissions among stables due to farm technology, animal production phases, number, weight and age of animals like in poultry so as in pig production. We can report enormous N_2O concentrations in some pig-fattening stables, and low infrequent appearance of CH_4 emission. In majority we consider significant ($P<0,05$) microclimate changes due to variable air streams in stables, directly correlated to N_2O concentrations in the air. Air stream in fan exhausters was responsible to significant ($P<0,05$) changes in CO_2, NH_3 in N_2O concentrations on openings, where air exhausts from fan exhausters. Methane (CH_4) can be established just in few cases.

REFERENCES

1. Grimm E., Kypke J., Martin I., Krause, H.K. Germah regulations concerning air pollution Control in animal production – an overview. Regulation of Animal Production. KTBL 1999, 234–243
2. European Commission. Integrated Prevention Pollution Control. November 2002. 4–35
3. Martinez J., Burton C. Future management and treatment: an overviev of the european situation. Proceedings of XI Int. Congress in Anim. Hyg., ISAH 2003, Mexico City 2003. 119–135
4. Jacobson L.D., Bicudo R.J., Schmidt D.R., Wood-Gay S. Gates R.S, Hoff S.J. Air emissions from animal buildings. Proceedings of XI Int. Congress in Anim. Hyg., ISAH 2003, Mexico City 2003. 147–169
5. Hendriks, J., Andries A., Berckmans D., Vincikier D.C. Estimation of a Cost Curve of a Amonnia Emmision Reduction Plan for Flanders. Regulation of Animal Production. KTBL 1999, 215–221