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LAYING HEN AND PIG LIVESTOCK CONTRIBUTION TO AERIAL POLLUTION IN SLOVENIA

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Livestock production is a significant contributor to global methane, nitrous oxide, carbon dioxide, and ammonia emissions. Poultry and pig farming in Slovenia needs to undertake a large survey on the emission of aerial pollutants, since monitoring on this field is incomplete. Despite this, measurements of aerial emissions such as ammonia (NH_3), nitrous oxide (N_2O) and carbon dioxide (CO_2) were monitored from representative poultry laying hen, pig weaning and pig fattening farms in Slovenia. Animal category, different technologies, stocking density and body mass variations significantly influenced the outcome emissions. NH_3, N_2O and CO_2 concentrations in the ambiental air directly correlate ($p<0.05$) to variable air streams in stables and mostly exceed the known data from other investigations made in EU. From the hen production the calculated predictions of annual ammonia (28.5 kg lu^{-1} a^{-1}) and nitrous oxide emissions (102 kg lu^{-1} a^{-1}) were higher ($p<0.05$) than pig fattening production (NH_3 2.5 kg lu^{-1} a^{-1} N_2O 58.3 kg lu^{-1} a^{-1}) or pig weaning production (NH_3 6.4 kg lu^{-1} a^{-1} N_2O 67 kg lu^{-1} a^{-1}), still the carbon dioxide emissions were estimated as 21.5-59% higher in pig (fatteners 3960 kg lu^{-1} a^{-1}) than in poultry production. This paper reports about the large variety and intensity of aerial emissions, as for laying hens and pig production depended on animal species and animal category.

Key words: ammonia, nitrous oxide, carbon dioxide, emissions, laying hens, weaners, fatteners, stables

INTRODUCTION

Animal production is considered to be one of the most important sources of ammonia and greenhouse gas pollution of the air in Europe (Milne, 2005). Total agricultural production contributes to approximately 90% on the ammonia (Misselbrook *et al*., 2000) and 20 - 35% on greenhouse gases emissions control level, where animal production shares the main source of methane and nitrous oxide (Brink *et al*., 2001). High nitrous oxide and methane emissions are associated to ecological problems and environmental damages. However, ammonia can be considered as the key air pollutant owing to animal husbandry

(Hutchings *et al.,* 2001). Ammonia emissions contribute to acidification, eutrophication and local disturbance in several regions of Europe. For this reason many activities relate to ammonia and greenhouse gases reduction. The greenhouse effect, also referred to as global warming, is generally believed to come from the buildup of nitrous oxide, methane and carbon dioxide gas in the atmosphere (Johnson *et al.,* 2007). Methane is emitted from human-related activities which include animal husbandry concerning enteric fermentation in livestock, manure and waste management. Depending on the soil type and fertilization, the nitrous oxide in the dung and urine of grazing cattle contributes to 20-40% of total nitrous oxide emissions. Nitrous oxide is produced as a part of (de–) nitrification in manure during storage, or when manure has been applied to the land (Béline *et al.,* 2007). Therefore, nitrous oxide can be released at any stage of livestock production where conditions favor these processes (Shang-Shyng Yang *et al.,* 2003; Chadwick *et al.,* 1999).

In the period 1990–2008 emissions of NH_3 and greenhouse gas emissions were lowered by 18% from EU agriculture. In Slovenia emissions were lowered by 8%, as reported by EEA (European Environment Agency, 2010). Slovenian livestock breeders are limited to maximal annual emission quotes, although supervision is difficult referring to heterogeneous livestock breeding technologies, different meteorological conditions, waste management and disposal technology (Pintarič and Dobeic, 2000; Pintarič and Dobeic, 2001; Gobec *et al.,* 2009). Given that, measurement conditions are significantly permanently changing (Verge *et al.,* 2008).

Very few estimations for aerial pollutants from livestock production in Slovenia were made, thereby the objective measurements and comparisons between ammonia and greenhouse emissions from different animal species and livestock production systems are needed (Wathes *et al.,* 1998). For this reason the measurements of the ammonia and greenhouse gases emissions from typical pig and laying hen farms were performed to set up the fundamental assessment of livestock contribution to aerial pollution in Slovenia (Amon *et al,* 1995; Amon *et al,* 1997). The main object of this study was to undertake a field survey on the emissions within and from livestock buildings, to define the current situation and to establish the severity of individual factors over emissions from livestock production in Slovenia. Emissions from pig and laying hen production depend on animal species, technology, season of the year and animal live weight, the objective of the study was to measure, monitor and estimate pig and laying hen livestock emissions from typical breeds in Slovenia.

MATERIALS AND METHODS

The study comprises three main working tasks: 1. selection of typical laying hen and pig husbandry for Slovenian territory, 2. a field survey on the ammonia and greenhouse aerial pollutants from 7 hen and 11 pig livestock stables in Slovenia, 3. comprehensive study of aerial pollutant emissions. Full-scale measurements were made in winter (December, January and February) and in early spring (March, April).

Measurements of ambient aerial pollutants such as ammonia (NH_3), nitrous oxide (N_2O) and carbon dioxide (CO_2), air temperature (^oC) and air humidity (R.H.%) in each tested stable were carried out two times a week. To cover the random space, 3 measurement locations in each tested stable were chosen getting the proportionate distribution of the stable surface. On each location measurements were made on three altitudes (10 cm, 80 cm, 200 cm above the floor). In addition in each stable measurements were performed inside the 3 exhaust air ducts close to ambient measurement locations, since calculation of emission rates requires the measurements of air flow and gas concentrations (ppm) inside the exhaust air ducts. Measurements of aerial pollutants, air temperature and air humidity were performed three times on the same measurement day getting instantaneous measurement results.

The nitrous oxide measurements were made using free dual wavelength infrared N_2O sensor via personal nitrous oxide gas monitor for rapid detection on the site (Bacharach Model 3010, Nitrous Oxide (N_2O) Monitor, Range: 01,000 PPM N2O; 5 PPM resolution 010,000 PPM N2O for leak detection, USA). Carbon dioxide and ammonia were detected using personal Dräger gas detector by electrochemical sensors measuring the partial pressure of gases under atmospheric conditions (Dräger Multiwarn II, DrägerSensor® XS CO_2 P/N 6809175, DrägerSensor® XS NH_3 P/N 6809145, Germany). The air flow (m/s) through ventilation ducts was measured using a fan wheel anemometer (Testo) on 9 points from the center to the side of the round duct getting the average flow. These data were needed to calculate the capacity of the air outlet (m^3/s) by multiplying with the duct diameter surface (m^2).

Ambient temperature and air humidity were measured using special solid temperature sensors such as temperature-sensitive resistors and humidity transmitters to provide electrical outputs proportional to humidity inputs (Testo® 350-M/XL testo 454 Control Unit) using a 3-function probe for simultaneous measurements of temperature, humidity and velocity, with plug-in head: Meas. range -20 to +70^oC, 0 to +100 %RH, 0 to +10 m/s at the time of sampling on each sampling location, Germany. All apparatus used was regularly calibrated.

Hens

For the field survey 7 resembling stables for hen breeding on deep litter on the same commercial farm were chosen. In the 4 stables hens (age: 151-232 days) were not in the laying phase however in 3 stables hens were in the laying phase (age: 279-457 days).

Housing

The selection criteria for laying hen stables was based on technical implications of classic free range housing typical for the country. Tested stables were populated by 4469 (±339) birds with live body weight of 3.8 kg, kept on wood shavings. Hens were fed and watered *ad libitum* on a commercial feed and had free access to water. The buildings were divided into a littered foraging area and a raised (by about 0.5 m) feeding, drinking and nesting area above a droppings pit.

Ventilation

The ventilation system comprised of 12 (in 4 monitored stables) and 13 (in 3 monitored stables) ceiling extract multi-step fans. The fans and air slot inlets were regulated automatically, controlled by a temperature controller. Slot inlets were positioned along the two side walls just under the eaves.

Monitoring

In 7 tested stables measurements (n=1512) were made in the range of animal age from 151 to 457 days. Since tested stables were settled by the same animal category and same animal weight, using the same breeding procedures and technology, results of monitoring were handled as the total emission from one group of animals.

Pigs

The selection criteria for 11 monitored pig stables was a typical commercial intensive pig production in Slovenia for pig fattening (5 stables) and pig weaning (6 stables).

Housing

The research was performed on a farm for intensive pig production with a yearly capacity of 100,000 animals. The research was performed in pig fattening stables (animal live weight: 35 to 105 kg), populated by 808 fatteners (±201) and in pig weaning stables (animal live weight: 10 to 35 kg), populated by 912 weaners (±26), respectively. Pigs were fed and watered *ad lib*. on a commercial pelleted feed and had free access to water. Concrete slatted floors which were extended under the pens for fatteners or metal mesh slatted floors for weaners with shallow manure channels along the house crossing the central passage for slurry flushing to the external slurry storage pit.

Ventilation

Stables for fatteners were equipped with a mechanically regulated ventilation system consisting 6 in one and 7 extractor fans in the other stables. The air was brought into the house along inlets on both side walls and dispersed out through the ceiling fans ducts. Ventilation in weaners' stables comprise 2 extractor fans located along one side with window inlets alongside the opposite side wall, controlled by a temperature controller and automatic regulation.

Monitoring

Measurements (n=3780) in pig fattenig stables, and measurements (n=2376) in pig weaning stables were performed, thus getting the data representing different animal categories and different animal weights, moreover different breeding procedures and technologies.

Statistical data analysis

The data were analyzed using SPSS (Statistical Package for Social Sciences) 17.0 program. Results are given by descriptive statistical methods (mean value, standard deviation and standard error) considering factors such as the animal production phases, number, weight and age of animals. Comparison between groups with Student's t-test and ANOVA (analysis of variance) was done. Statistical significance was accepted at the level of $p<0.05$.

RESULTS AND DISCUSSION

Climatic characteristics and emission rates from hen houses

Air temperature and humidity

The mean ambient air temperature inside the tested stables (16.8°C) showed rising trends following the opposite trend for relative humidity (mean 61.8%) considering the significant ($p<0.05$) impacts of animal age, ambient ventilation and outdoor climate.

Ammonia

The ambient ammonia concentrations in our study (mean 36.56 ppm) were higher than reported by Groot *et al.* (1998) for England 8.3 ppm, Netherlands 29.6 ppm and Denmark 25.2 ppm. Ammonia concentrations were significantly ($p<0.05$) influenced by the low air moisture, high ambient air speeds and the size of stable population, resulted in faecal material accumulation. In the exhaust air the mean concentration of ammonia (36.74 ppm) was actually close to ambient concentrations.

There was no particular pattern in the ammonia emission rate; still the significant increase of ammonia emissions resulted at the end of the experiment obviously on account of animal age and mass accumulation ($p<0.05$).

Ammonia emission rates varied between 66 and 194 g h^{-1} (mean 112 g h^{-1}) inversely with ventilation rates. Ammonia emission rates were variable and showed the trend of growth with regards to animal age, irrespective on ventilation rates. As for calculation to the livestock units (lu) they were less than half (3.29 g lu h^{-1}) than ammonia emissions reported from England (7.39 g lu h^{-1}) and almost three times less than reported for Netherlands (9.45 g lu h^{-1}) or Denmark (10.89 g lu h^{-1}) in hen stables with deep litter (Groot *et al.,* 1998). They were less even in comparison to emissions reported for deep pit houses (8.2 g lu h^{-1}) (Nicholson *et al.,* 2004). Namely deep litter or deep-pit systems are in general higher emitters of ammonia like belt-scraped or stilt houses (Nicholson *et al.,* 2004), yet the air exchange should dry the upper layer of litter thus making it a minor source of ammonia losses.

In addition, the estimated predictions of annual ammonia emissions in our study were less (mean 28.5 kg lu^{-1} a^{-1}) than reported by Faulkner and Shaw, (2008) (95 – 112 kg lu^{-1} a^{-1}) (Fig. 1). Therefore, the reason for lower ammonia measured emission rates from deep litter in hen stables in our study is most probably due to intensive ventilation, therefore the surface of litter was drying thus conditions for originating ammonia were not favourable.

Nitrous oxide

Nitrous oxide concentrations (mean 51.51 ppm) in tested stables showed significant variability ($p<0.05$) in dependence to ambient air speeds and animal age. Since hens were kept on wood shavings litter, this resulted in the process of (de-) nitrification and significant nitrous oxide losses (Chadwick *et al.,* 1999). The mean concentration of nitrous oxide concentrations (54.6 ppm) in the exhaust air of fan ducts was slightly higher than in the ambient.

The pattern of nitrous oxide emission rates was nearly like for ammonia; however nitrous oxide emission rates (mean 402 g h^{-1}) varied inversely with ventilation rates and in significant ($p<0.05$) relation to the growing animal age. Regarding the calculation we predicted significantly higher annual N_2O emissions (102 kg lu^{-1} a^{-1}) than 3.65 kg N_2O kg $lu^{-1}a^{-1}$ (10 g N_2O lu^{-1} d^{-1}) reported by Chadwick *et al.* (1999) in similar stable conditions (Fig. 2). High N_2O emissions from hen stables determined in our study should be explained by the deep litter technology where in the lack of O_2, N_2O is generated in the de-nitrification process.

If we take into consideration that the annual ammonia (NH_3) emissions were less, but the annual nitrous oxide (N_2O) emissions were higher of those reported for hen stables in EU, we should point out to the significant difference between aerobic conditions in the upper layer and anaerobic conditions in the deep layer of litter in our test, respectively. In the deep layer of the litter the alkaline pH (pH mean 8.73) and high content of water (mean 458 g/kg) presumably leads to intensive N_2O production and consequently to the development of N_2O emission (Groenestein and Van Faassen, 1996).

Carbon dioxide

The carbon dioxide concentrations in the ambient air reached the mean value of 708 ppm and the mean of 758 ppm in the exhaust air of ducts. The emission rates were raised proportional ($r^2=0.42$, $p<0.05$) to ambiental concentrations. Annual emission rates (mean 1.638 kg lu^{-1} a^{-1}) calculated on the basis of cumulative emission on the livestock unit (lu) showed a strong trend ($p<0.05$) of parallel increase with ventilation rates, but not to animal age. Depending on the animal population density and the sum of carbon dioxide lossess, the flock expiration was three fold higher from the beginning to the end of the trial (Fig. 3).

Climatic characteristics and emission rates from the pig fattening stables and pig weaning stables

Air temperature and humidity

The mean air temperature in the groups of fattening (17.5°C) and weaning (23.2°C) stables and the relative humidity (fattening 76.2%, weaning 65.3%) were strongly influenced ($p<0.05$) by animal age, ventilation rates, and the time of the year.

Ammonia

The mean ambient ammonia concentrations in fattening stables were slightly higher (7.74 ppm (5.8 mg m^{-3})) than in weaning stables (7.30 ppm (5.54 mg m^{-3})) and actually alike to concentrations in the exhaust air of ducts (7.1 ppm). Concentrations in fattening stables were lower than reported by Groot *et al*., (1998) (England 12.1 ppm, Netherlands 18.2 ppm, Denmark 14.9 ppm, Germany 14.3 ppm) and by Blanes Vidal *et al*., (2008) (15.0 mg m^{-3}). In the weaning units air carbon dioxide concentrations mostly exceed those reported by

Groot *et al*., (1998) (England 7.8 ppm, Netherlands 4.6 ppm, Denmark 5.3 ppm, Germany 4.5 ppm).

The mean ammonia emission rates (31.5 g h^{-1} (756 g d^{-1})) from the group of fattening stables were growing ($p<0.05$) owing to the lu number raising and were 13% higher than from the group of weaning stables (27.8 g h^{-1} (667.2 g d^{-1})). They were similar (404.9 g d^{-1} and 581.5 g d^{-1}) reported by Guarino *et al.*, (2008) in pig production. The ammonia emission rates showed the trend of growth inversely to ventilation rates and lowering owing to the animal age i.e. animal mass accumulating.

Predictions of annual ammonia emissions, were significantly ($p<0.05$) lower from fattening (mean 2.5 kg lu^{-1} a^{-1}) stables than from weaning stables (6.4 kg lu^{-1} a^{-1}) (Doorn *et al.,* 2002; Faulkner *et al.,* 2008) (Fig. 1). In addition they were lower in comparison to 22.2 kg lu^{-1} a^{-1} reported by Blanes Vidal *et al.,* (2008) from fattening houses and lower from weaning stables in comparison to 11.4 – 16.3 kg lu^{-1} a^{-1} reported by Guarino *et al.* (2008) determined from farrowing stables, as well.

Nitrous oxide

Nitrous oxide concentrations in fattening stables (mean 47.94 ppm (86.24 mg m^{-3})) were higher than in weaning stables (mean of 22.73 ppm (40.89 mg m^{-3}). High nitrous oxide concentrations in the group of fattening stables can be explained by the consumption of animal fodder rich with protein and poor in fat contents. However, they were higher than reported by Guarino *et al.* (2008) from experimental farrowing units (1.18–1.13 mg m^{-3}), respectively.

The nitrous oxide emissions were raised in proportion to animal weight and animal age. They were significantly ($p<0.05$) higher in fattening (mean 666 g h^{-1}) than in weaning stables (mean 143 g h^{-1}). Coming out from the estimation where emissions were calculated per pig (fatteners 0.75 g h^{-1} per pig / weaners 0.29 g h^{-1} per pig) the values were higher than reported (0.3 to 0.2 g h^{-1} per pig) by Groenstein *et al.,* (1996).

However, estimated annual emission rates, gathered by calculation were lower in fattening (mean 58.3 kg lu^{-1} a^{-1}) than in weaning stables (mean 67 kg lu^{-1} a^{-1}) (Fig. 2.). The difference was probably attributed despite to significantly higher ($p<0.05$) ventilation rates in weaning houses and to forced ventilation under the fully slatted floor in fattening stables (Amon *et al.,* 2007). Namely channel aeration partly prevents nitrous oxide emissions from the slurry channels into the air.

Carbon dioxide

In the fattening houses ambient carbon dioxide concentrations (mean 1540 ppm (3026 mg m^{-3})) were slightly higher than in weaning houses (mean 1630 ppm (3202 mg m^{-3})) and strongly correlated ($r^2=0.357$, $p<0.01$) to concentrations in the air of fan ducts in fattening (1971 ppm) and weaning stables (mean 2174 ppm). In general carbon dioxide concentrations gathered in our test were rather higher than reported (2109 mg m^{-3}) by Guarino *et al.,* (2008). Calculated annual emission rates in both fattening (mean 2084 kg lu^{-1} a^{-1}) and weaning stables (mean 3960 kg lu^{-1} a^{-1}) were indicated to decrease owing to stocking density (lu number) and animal age. This was the reason that annual emission rates estimated in our test were even lower than reported (6365 kg lu^{-1} a^{-1}) by Guarino *et al.* (2008).

Comparison between estimated predictions of annual NH_3, N_2O and CO_2 emissions rates from hen and pig stables

Ammonia

In our study the estimated predictions of annual ammonia emissions from hen stables were significantly ($p<0.05$) 91% higher (mean 28.5 kg lu^{-1} a^{-1}) than from pig fattening (2.5 kg lu^{-1} a^{-1}) and 77 % higher than from pig weaning stables (mean 6.4 kg lu^{-1} a^{-1}). Relatively low ammonia emissions can be explained by suitable conditions for nitrification and de-nitrification in hen's deep litter and the surface of pig slurry and consequently to irregular excreta removal from pig production (Fig. 1).

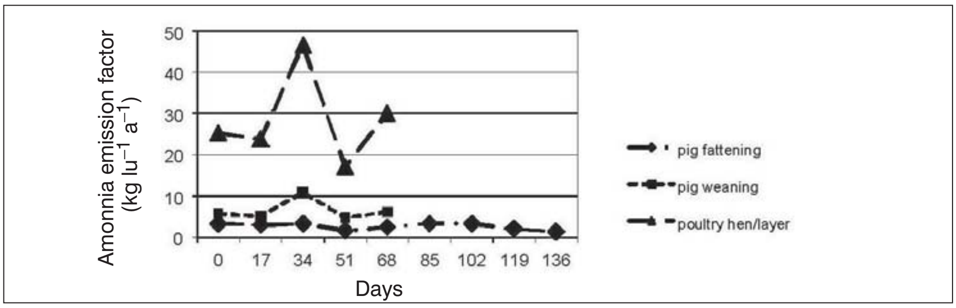

Figure 1. Annual ammonia emissions per animal stocking unit from the pig fattening, pig weaning and in poultry hen/layer stables

Nitrous oxide

The alternate aerobic and anaerobic conditions in deep litter and in the slurry were manifested by relatively high nitrous oxide. Regarding to estimation

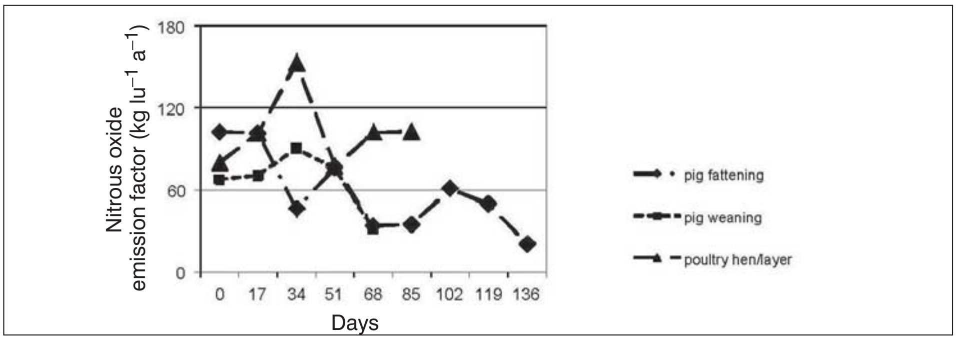

Figure 2. Annual nitrous oxide emissions per animal stocking unit from the pig fattening, pig weaning and in poultry hen/layer stables

annual nitrous oxide emissions from hen production (mean 102 kg lu^{-1} a^{-1}) were 43% higher than in pig fattening (mean 58.3 kg lu^{-1} a^{-1}) and 34% higher than in weaning stables (mean 67 kg lu^{-1} a^{-1}) (Fig. 2).

Carbon dioxide

Predicted carbon dioxide annual emissions were estimated for hen (mean 1.638 kg lu^{-1} $a^{-}1$) production, however in pig fattening stables were higher by 21.5% (2084 kg lu^{-1} a^{-1}) and 59% higher in weaning stables (3960 kg lu^{-1} a^{-1}). Reported emissions can be attributed despite different animal metabolism and different production systems linked to significant gases losses during the breeding period (Fig. 3).

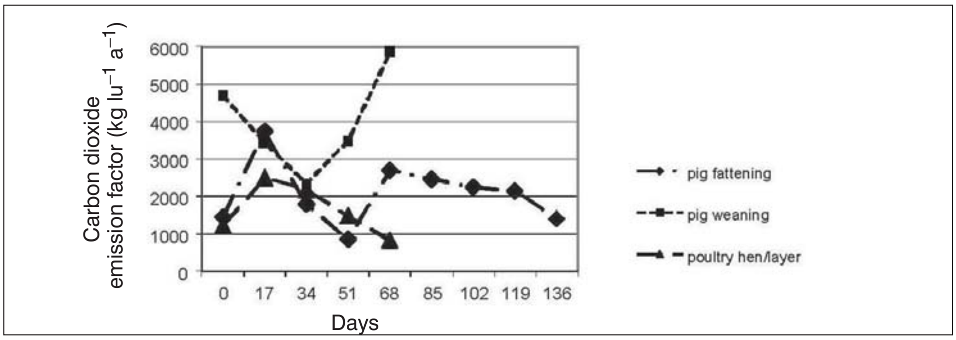

Figure 3. Annual carbon dioxide emissions per animal stocking unit from the pig fattening, pig weaning and in poultry hen/layer stables

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REFERENCES

1. *Amon B, Kryvoruchko V, Fröhlich M, Amon T, Pöllinger A, Mösenbacher I et al.,* 2007, Ammonia and greenhouse gas emissions from a straw flow system for fattening pigs: Housing and manure storage, *Livest Sci*, 112, 199-207.
2. *Amon M, Dobeic M, Misselbrook H, Pain B, Phillips V, Sneath WA,* 1995, A farm scale study on the use of de-odorase for reducing odour and ammonia emissions from intensive fattening piggeries, *Bioresource Technol*, 51, 163-9.

3. *Amon M, Dobeic M, Misselbrook H, Pain B, Phillips V, Sneath WA*, 1997, A farm-scale study on the use of clinoptilolite zeolite and de-odorase for reducing odour and ammonia emissions from broiler houses. *Bioresource technology*, 61, 229-37.
4. *Béline AG, Bioteau T, Maguet KA,* 2007, French inventory of gaseous emissions (CH_4, N_2O, NH_3) from livestock manure management using a mass-flow approach, *Livest Sci*, 112, 252-60.
5. *Blanes-Vidal V, Hansen MN, Pedersen S, Rom HB,* 2008, Emissions of ammonia, methane and nitrous oxide from pig houses and slurry: Effects of rooting material, animal activity and ventilation flow, *Agric Ecosyst Environ*, 124, 237-44.
6. *Brink C, Kroeze C, Klimont Z*, 2001, Ammonia abatement and its impact on emissions of nitrous oxide and methane – Part 2: application for Europe, *Athm Env*, 35, 6313-25.
7. *Chadwick DR, Sneath RW, Phillips VR, Pain BF,* 1999, A UK inventory of nitrous oxide emissions from farmed livestock, *Athm Env*, 33, 3345-54.
8. *Doorn MRJ, Natschke DF, Thorneloe SA., Southerland J*, 2002, Development of an emission factor for ammonia emissions from US swine farms based on field tests and application of a mass balance method, *Athm Env*, 36, 5619-25.
9. European Environment Agency, 2010, European Union emission inventory report 1990-2008 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP), Office for Official Publications of the European Union, 1-88.
10. *Faulkner WB, Shaw BW,* 2008. Review of ammonia emission factors for United States animal agriculture, *Athm Envi*, 42, 6567-74.
11. *Groenestein CM, Van Faassen HG,* 1996, Volatilization of Ammonia, Nitrous Oxide and Nitric Oxide in Deep-litter Systems for Fattening Pigs, *J agric Engng Res*, 65, 269-74.
12. *Groot Koerkamp PWG, Metz J HM, Uenk GH, Phillips VR, Holden MR, Sneath RW et al.*, 1998, Concentrations and Emissions of Ammonia in Livestock Buildings in Northern Europe, *J Agric Engn Res*, 70, 79-95.
13. *Gobec I, Ocepek M, Pogačnik M, Dobeic M,* 2009, Inactivation of *Mycobacterium avium* paratuberculosis in sheep manure, *Slov Vet Res*, 46, 105-13.
14. *Guarino M, Costa A, Porro M,* 2008, Photocatalytic TiO_2 coating - to reduce ammonia and greenhouse gases concentration and emission from animal husbandries, *Biores Technol*, 99, 2650-8.
15. *Hutchings NJ, Sommer SG., Andersen JM, Asman WAH*, 2001. A detailed ammonia emission inventory for Denmark, *Athm Env*, 35, 1959-68.
16. *Jacobson LD, Bicudo JR, Schmidt DR, Wood-Gay S, Gates RS, Hoff SJ,* 2003, Air Emissions from animal production buildings, Proceedings of the XI Int Congress, Mexico City, Mexico, 147-73.
17. *Johnson Jane MF, Franzluebbers AJ, Lachnicht Weyers S, Reciosky DC*, 2007, Agricultural opportunities to mitigate greenhouse gas emissions, *Environ Poll*, 150, 107-24.
18. *Milne JA,* 2005, Societal expectations of livestock farming in relation to environmental effects in Europe, *Livest Prod Sci*, 96, 3-9.
19. *Misselbrook TH, Van Der Weerden TJ, Pain BF, Jarvis SC, Chambers BJ, Smith KA et al.,* 2000, Ammonia emission factors for UK agriculture, *Athm Env*, 34, 871-80.
20. *Nicholson FA, Chambers BJ, Walker AW,* 2004, Ammonia Emissions from Broiler Litter and Laying Hen Manure Management Systems, *Biosystem Eng*, 89, 175-85.
21. *Pintarič Š, Dobeic M*, 2000, Effects of bioenzymatic and mineral additives in bedding material on decreasing ammonia emissions in turkey breeding, *Slov Vet Res*, 37, 133-44.
22. *Pintarič Š, Dobeic M*, 2001, Possibility to reduce odour emission and ammonia in turkey breeding, *Vet Nov*, 27, 477-85.
23. *Shang-Shyng Yang, Chung-Ming Liu, Chao-Ming Lai and Yen-Lan Liu*, 2003, Estimation of methane and nitrous oxide emission from paddy fields and uplands during 1990–2000 in Taiwan, *Chemosphere*, 52, 1381-8.
24. *Vergé XPC, Dyer JA, Desjardins RL, Worth D,* 2008, Greenhouse gas emissions from the Canadian pork industry, *Agric Syst*, 98, 126-34.

25. *Wathes CM, Phillips VR, Holden MR, Sneath RW, Short JL, White RPP et al.*, 1998, Emissions of Aerial Pollutants in Livestock Buildings in Northern Europe: Overview of a Multinational Project, *J Agric Eng Res*, 70, 3-9.

DOPRINOS PROIZVODNJE SVINJA I KOKA NOSILJA ZAGAĐENJU VAZDUHA U SLOVENIJI

DOBEIC M i PINTARIČ Š

SADRŽAJ

U poljoprivredi je uzgoj životinja značajan izvor emisije metana, azot oksida, ugljen dioksida i amonijaka. Monitoring aero-zagađenja u Sloveniji je za sada nepotpun i postoji potreba da se on sprovodi posebno sa aspekta živinarske proizvodnje i uzgoja svinja. Zbog toga smo merili emisiju amonijaka, azot-oksida i ugljen dioksida iz reprezentativnih objekata za koke nosilje kao i objekata za uzgoj prasadi i tov svinja na teritoriji Slovenije. Kategorija životinja, primenjivana tehnologija na farmi i gustina naseljenosti značajno su uticale na stepen emisije ispitivanih gasova. Koncentracije NH_3, N_2O i CO_2 u ambijentalnom vazduhu su u direktnoj korelaciji ($p<0,05$) sa strujanjem vazduha i uglavnom su prevazilazile vrednosti registrovane u nekim drugim, doduše nepotpunim, ispitivanjima u EU.

Vrednosti koje su izračunate kao moguća ukupna godišnja emisija amonijaka (28,5 kg lu^{-1} a^{-1}) i azot-oksida (102 kg lu^{-1} a^{-1}) iz objekata za koke nosilje su u našim ispitivanjima bile veće ($p<0,05$) od onih iz objekata za tov svinja (NH_3 = 2.5 kg lu^{-1} a^{-1}; N_2O = 58.3 kg lu^{-1} a^{-1}) ili uzgoj prasadi (NH_3 = 6.4 kg lu^{-1} a^{-1} N_2O = 67 kg lu^{-1} a^{-1}). Odavanje ugljen dioksida je potencijalno veće iz objekata za tov svinja (3960 kg lu^{-1} a^{-1}) nego iz objekata za koke nosilje i to za 21,5-59%. Takođe smo dokazali velike varijacije u intenzitetu emisije ispitivanih gasova u zavisnosti od vrste i kategorije životinja.