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Original Paper

Influence of microclimatic environment on production of pollutants from recycled manure solids in laboratory conditions

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ABSTRACT

The aim of this experiment was to analyse influence of climatic factors on production of harmful gases from organic litter. The sample of separated sludge slurry was collected from lying area of dairy housing. Measurement of produced harmful gases was carried out in laboratory conditions in the environmental chamber, where the amount of released gas concentrations from sample of separated sludge was monitored under different microclimatic conditions by setting the temperature. The photoacoustic multi-channel analyser INNOVA 1309 with accessories was used for the measurement of gas concentrations. It has been shown, that increasing air temperature in the climatic chamber increase release of all monitored gases. Most of this was reflected CH_4 and NH_3 in the measurement of dry samples of separated manure, where the concentration growing rapidly at air temperature of 20 °C. Minimum ammonia concentration of 0.53 $mg.m^{-3}$ was at air temperature of -10°C and maximum of 5.11 $mg.m^{-3}$ at air temperature of 40°C. The concentrations of monitored gas increased continuously with the temperature of the air when measuring of moist samples of separated manure. Minimum ammonia concentration of 0.93 $mg.m^{-3}$ was at air temperature of -10 °C and maximum of 5.8 $mg.m^{-3}$ at 40 °C air temperature. Statistical analysis of the results showed there is a significant dependence between air temperature and ammonia concentrations and other monitored gases ($P < 0.05$). The gas production from the wet recycled manure solids sample was significantly higher ($P < 0.05$).

KEYWORDS*:* dairy cattle, recycled manure solids, bedding

JEL CLASSIFICATION: Q15

INTRODUCTION

In livestock production, the use of manure is currently being used not only as a source of nitrogenous fertilizers but to be recovered in other agricultural activities [4]. There were bedding livestock housing systems prevalent in our country, while the loose housing is housing with cubicle beddings or pens with bedding layer [1]. Bedding material is very a

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costly part of dairy farming and has a significant impact not only on animal health but also to the environment.

It is increasingly difficult problem to ensure a reliable source of bedding for farmers. Dairy farms are therefore constantly under increasing pressure to improve their management of manure. The separated slurry of manure - also called "green litter" is used for bedding in areas where the availability of classic bedding material is decreasing. It is a separated raw slurry or separated digested slurry from the biogas plant [5]. Farmers using this material report greater cow comfort than with other bedding materials they have used, and the potential financial savings are substantial [3]. They indicate a significant improvement of animals housing welfare, in that animals create natural bed in the organic plastic material and separated slurry handling is very simple [4]. With the arrival of recycled manure solids (RMS) use, the question forms associated with the risk of harmful gas production, because dairy cattle barns are a major source of NH_3 emissions and greenhouse gases (GHG) to the atmosphere. Previous studies have also shown that the bedding material used in the barn can influence the magnitude of NH_3 emissions, but little is known about which bedding characteristics are important in this respect [6].

MATERIAL AND METHODS

For our experiment, the samples of the separated slurry of manure were taken in the center of the lying cubicles in dairy barn. Repeatedly had been sampled 2 litters of 10 selected boxes for two weeks. The experiment was conducted under laboratory conditions in a climatic chamber FEUTRON 3522/51, where the amount of gas released from sample of recycled manure bedding was monitored under different microclimatic conditions by setting the air temperature from -10°C up to +40°C and humidity (RH = 50%). The photoacoustic multi-channel analyzer INNOVA 1309 with accessories was used for the measurement of gas concentrations of N_2O, NH_3, H_2S, CH_4. Five measurement points were chosen directly in the chamber and one place outside the chamber (Fig. 1). The measured data were evaluated by Statistica 10, the gas concentrations and air temperature dependence were determined by correlation analysis. Using the F test the differences in the production of pollutants from the bedding sample with a dry matter content of 58% and 24% were evaluated.

Figure 1 Sample of litter placed in a climatic chamber and instrument for measuring gas concentrations

RESULTS AND DISCUSSION

The air temperature is a very important variable in the development of ammonia and GHG production, because of temperature change can influence the mass flow of ammonia significantly. As follows from measurements, it has been shown, that increasing air temperature in the climatic chamber increase release of all monitored gases. Most of this was reflected CH_4 and NH_3 in the measurement of dry bedding samples (dry matter content 58 %), were the concentration growing rapidly from air temperature of 20 ° C (Fig. 2). Minimum ammonia concentration of 0.53 $mg.m^{-3}$ was at air temperature of -10°C and maximum concentration of 5.11 $mg.m^{-3}$ was at air temperature of 40 °C.

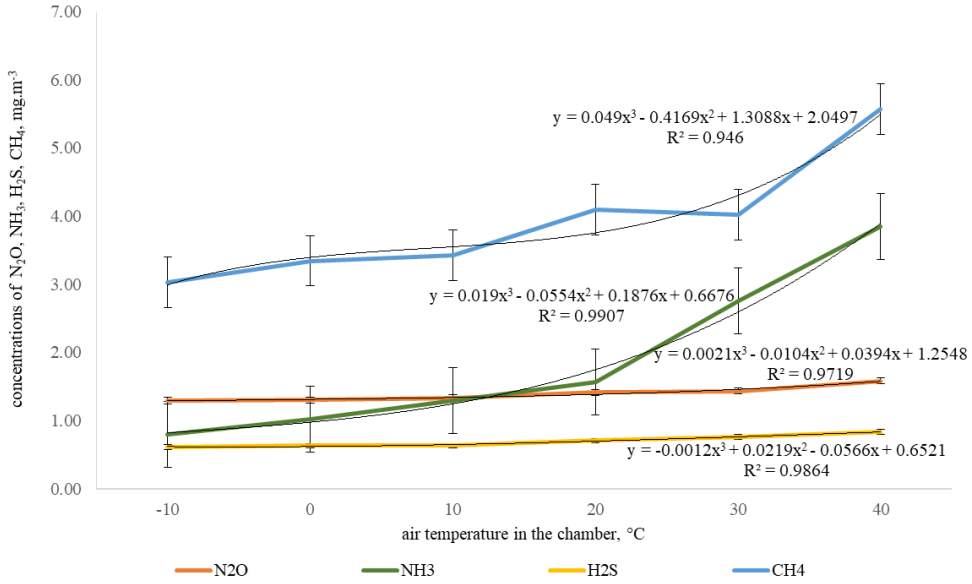

Figure 2 The course of gas concentrations in climatic chamber in raising of the air the temperature - measurement of the dry RMS

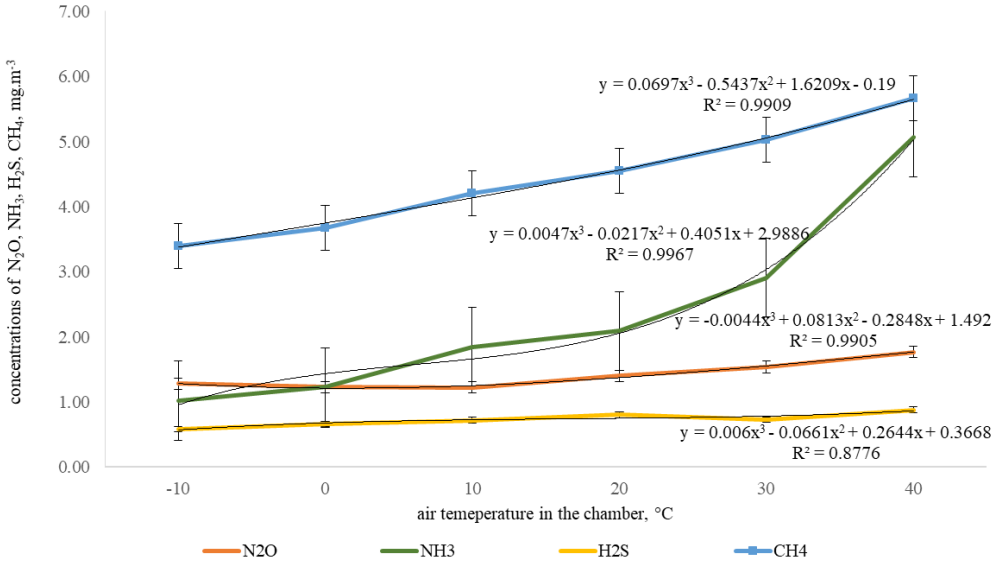

Figure 3 The course of gas concentrations in climatic chamber in raising of the air the temperature - measurement of the wet RMS

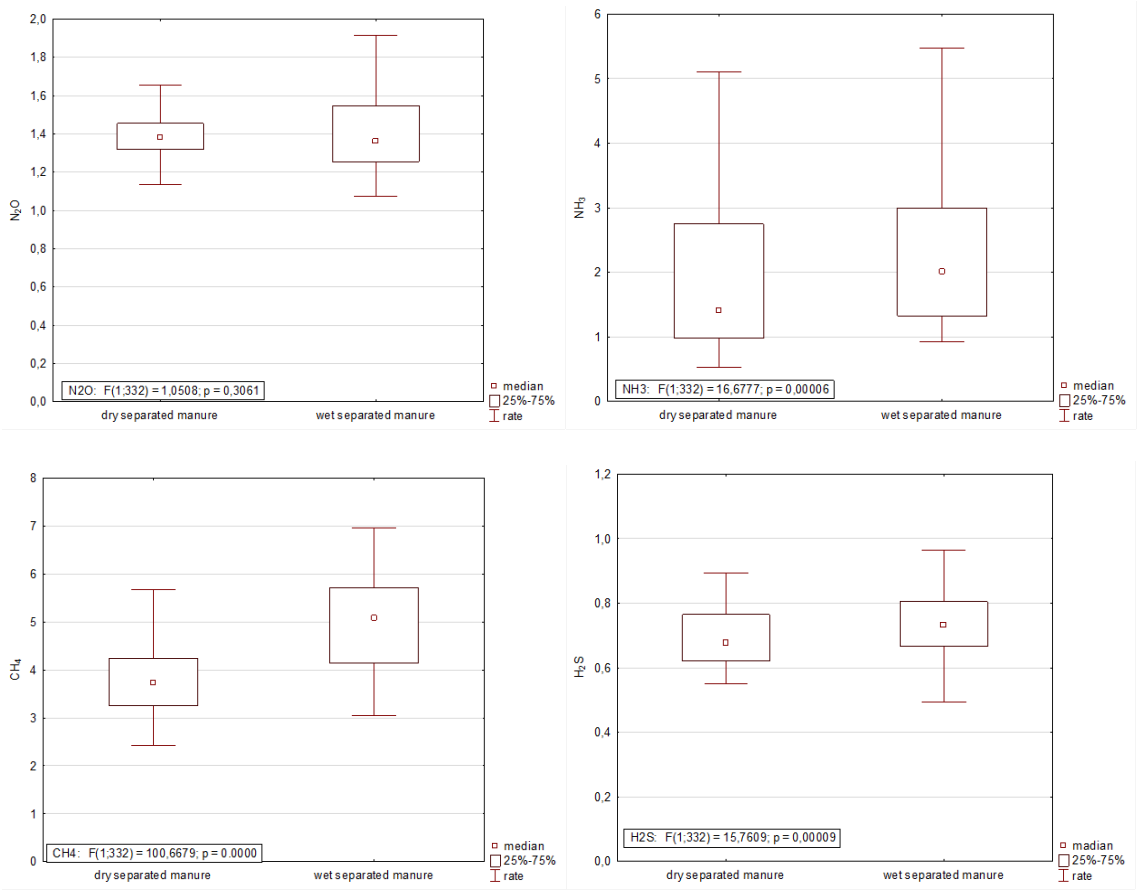

Figure 4 Comparison of gas production from a dry and wet sample in a climatic chamber (Statistica 10, F test, Anova, P <0.05)

The gas concentrations increased continuously with the temperature of the air when measuring of moist bedding samples (dry matter content 25 %). Minimum ammonia concentration of 0.93 mg.m^{-3} was at air temperature of -10°C and maximum of 5.8 mg.m^{-3} was at 40 ° C air temperature (Fig. 3). Statistical analysis of the results showed that there is a significant dependence between air temperature and ammonia concentrations and other monitored gases ($P < 0.05$). The gas production from the wet recycled manure solids sample was therefore somewhat higher. In Figure 4 there are shown significant differences in the production of NH_3, CH_4 and N_2O from dry and wet sample ($P < 0.05$). As reported Redwine et al. [8] litter temperature and humidity are factors that influencing amounts of the released ammonia. The optimum conditions for this process are temperature above 20 °C, humidity of bedding 40 – 60 %. Temperature and humidity are stressors that occur at increased levels in confined spaces and poorly ventilated housing systems.

The results of our experiment are in accordance with the conclusions of Zhao et al. [10] and Harper et al. [2], who claimed that ammonia production is increasing with increasing air temperatures. Wu et al. [9] indicated that the concentration of ammonia in naturally ventilated barns is mostly influenced by temperature and air movement. The growth of temperature increases urease activity thus raising ammonia emission from manure [7]. Research acknowledged that the level of ammonia is influenced by the air temperature and the humidity

of the bedding material in the case of the use of the separated manure solids as litter, as it is in the case with using of straw litter. However, the levels of the produced gas concentrations are at the same level in scale of tested bedding moisture and there is no reason to worry about using of separated manure into cubicle beddings due to emissions of ammonia and GHG.

CONCLUSIONS

The experiment was carried out in laboratory conditions and was aimed to obtain knowledges about the effects of climatic factors on production of harmful gases released from sample of recycled manure solids. Measurements of pollutant production showed that the concentrations of monitored gases increased with increasing air temperature, and using wet litter with dry matter content of 28%, the production of pollutants was higher and continually increased from the air temperature to 10° C.

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