Possibilities to reduce the concentration of methane in rearing of laying hens housed in enriched cages

Štefan Boďo, Roman Gálik, Štefan Mihina, Monika Dubeňová

Abstract: *This paper focuses on finding and experimental validation of new extraction methods for exhausting the contaminated air in cage farming technologies, i.e. with conventional air exhaust process, which is commonly used in nowadays farms, in comparison with the use of chopped straw and air exhausting under the cage. The results indicate that significant differences in methane concentration are between air exhausting under the grid and conventional exhausting. Significant differences ware also found between air exhausting under the grid and by using of dropping belt. Between the conventional way of exhausting and the process where chopped straw is used, there was found no statistically significant difference in the concentration of methane.*

Keywords: *Enriched cage, ventilation, methane*

INTRODUCTION

The European Union, for which the new member states have democratically decided, requires adopting equal legislation, for all member states. Bulgaria and the Slovak Republic belong to one of the new entry states. Both are committed to the legislation of the European community, but not only that. These countries are dedicated to improve the welfare of animals as well as the potential to reduce the production of greenhouse gas.

The adoption of Directive 199/74/ES and its transposition into the government regulation of the Slovak Republic number 326/2003 from the Collection of Laws, which amends and supplements the Decree of the government of the Slovak Republic number 736/2002 from the Collection of Laws, which determine the minimum requirements for the protection of laying hens. By acceptance of this directive, the Slovak Republic has committed to improve the welfare of laying hens producing eggs for human consumption.

For environmental protection is important to monitor the production of harmful substances in the breeding of laying hens and to observe the legislation such as the regulation of the European Parliament and European Council Regulation (ES) number 166/2006 from 18th January 2006 on the establishment of an European register for release and transfer of pollutant substances, which changes the Directive 91/689/EHS and 96/61 ES.

The poultry belongs to the main producers of ammonium. It is due to the imperfect metabolism of nutrients. There is proved a general dependence between production of ammonium from the ambient temperature (Dolejš, 2007). It is important to choose appropriate technology of farming. The microclimate control can influence several factors that play an important role in the creation and release of ammonia (Knížatová, 2006). Microclimate is a basic factor in farm production of animals. Its quality is influenced by factors such as structural design of the building, realization of buildings isolation, but also the effectiveness of the ventilation system (Balková, 2009). From those ideas is clear that the production of ammonia is influenced by the number of animals, food, air temperature and humidity, housing technology and a regulation of microclimate.

The aim of our study is to compare in laboratory conditions different farming technologies for hens in terms of concentration of methane (further CH_4).

METHODOLOGY

Experimental measurements have been taken in laboratory conditions on the experimental equipment of the Department of Production Engineering, TF SAU in Nitra. We focused on monitoring the concentration of CH_4 in the zone of animals in summer and autumn periods. In enriched cage, there were placed ten hens of hybrid TERA SL from 480 to 459 days of age. We compared three technologies for hens breeding in terms of improved microclimate in the object, namely: conventional air extraction technology (technology 1), technology with air exhaust by usage of belt with chopped straw (technology 2), and technology with air exhaust under the grid (technology 3).

To measure the concentration of CH_4, there was used a gas analyser INNOVA. Simultaneously with concentration of CH_4 we recorded temperature and humidity in the environment. As regards statistical methods, single and multi-factor analysis of variance was used to evaluate the results.

RESULTS

During the concentration measurement of CH_4 in the summer, the performance of exhaust fan was set to a value of 153 $m^3.h^{-1}$ (technology 3) to 263 $m^3.h^{-1}$ (technology 1 and 2). The speed of airflow ranged between 1,2 and 1,3 $m.s^{-1}$ (technology 1 and 2). With technology 3, the value of air speed in the zone of the animals ranged from 0,13 to 0,15 $m.s^{-1}$. The maximum concentration of CH_4 was observed with the technology 1 – 11,132 $mg.m^{-3}$, technology 2 - 15,42 $mg.m^{-3}$ and technology 3 - 9,129 $mg.m^{-3}$. Due to the limited number of pages in this article, we present only those temperature and humidity graphs in the environments where we recorded by different technologies dependences between the measured indicators.

Fig.1. Course of temperature and humidity, technology 1 - summer

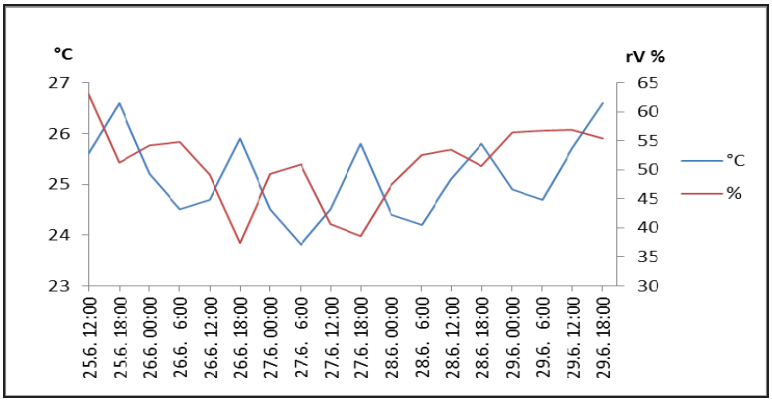

Fig.2. Course of temperature and humidity, technology 3 - summer

Fig.3. course temperature and humidity, technology 3 - autumn

For the measurement of the concentration of CH_4 in autumn, the performance of extractor fan was set to value of 109 $m^3.h^{-1}$ (technology 3), to 139 $m^3.h^{-1}$ (technology 1 and 2). The speed of air flow in the zone of animals ranged between 0,5 and 0,6 $m.s^{-1}$. The air vacuum under the grid cage (technology 3) had values of air speed in the zone of animals from 0,1 to 0,11 $m.s^{-1}$. The maximum concentration of CH_4 was observed with technology 1 - 5,626 $mg.m^{-3}$, technology 2 - 5,621 $mg.m^{-3}$ and technology 3 - 5,901 $mg.m^{-3}$. From the tables 1 and 2 is clear among which technologies are significant differences.

Table.1.

Multiple Range Tests for CH_4 - summer (Method: 95,0percent LSD)

Technology of breeding	Count	Mean	Homogeneous Groups
1	1539	7,211	X
2	1004	10,184	X
3	1411	5,018	X

Table.2.

Multiple Range Tests for CH_4 - autumn (Method: 95,0percent LSD)

Technology of breeding	Count	Mean	Homogeneous Groups
1	2007	3,234	X
2	1020	3,14	X
3	1899	1,516	X

The values of correlation coefficients between the monitored indicators during the summer and autumn period with technology 1 are shown in table 3. The table shows that the dependence was found only between environment temperature and CH_4 concentration (R = 0,65), only in the summer.

Table.3.

Values of correlation coefficients between monitored indicators technology 1

Period	Parameter	CH_4	°C
Summer	rV %	0,131	-0,377
	°C	0,65	-
Autumn	rV %	0,399	-0,268
	°C	0,276	-

From table 4 is clear that in technology 3 was dependence between air humidity and CH_4 in the summer period. The table also shows that in the autumn period we had a dependency between temperature and CH_4 (R = 0,699), between humidity and CH_4 (R = 0,663), and between temperature and humidity (R = 0,636).

Table.4.

Values of correlation coefficients between the monitored indicators technology 3

Period	Parameter	CH_4	°C
Summer	rV %	0,594	0,116
	°C	0,351	-
Autumn	rV %	0,663	0,636
	°C	0,699	-

With technology 2, we did not record any correlation between the monitored indicators in the summer or autumn period.

DISCUSSION

In this paper we present the results of CH_4 concentration measurement in laboratory conditions by three different housing technologies. Results conform to the results achieved by Švenková (2008). According to cited authors the exhaustion of fresh air through the side flaps and subsequently this air enriched by pollutants of animal metabolism is distributed unevenly throughout the building and cause local concentrations by low air flow. At higher speeds, the air flow, especially in summer, may exceed the maximum permissible levels of air flow speed.

CONCLUSION

From obtained results is clear to see that by change of air suction we achieved in technology 3, in the summer and in the autumn period, favourable concentrations of CH_4 at head level of layers as well as lower air flow level. Those results commit us to continue this experiment and to verify other options to achieve improvements of environment by change of farming technology and air exchange in the halls.

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About the author

Ing. Štefan Boďo, PhD., Department of Production Engineering, Faculty of Engineering, Slovak University of Agriculture in Nitra //SUA//, E-mail: Stefan.Bodo@uniag.sk

Докладът е рецензиран.