ODOURS IDENTIFICATION IN THE LAYING HEN'S EXPERIMENTAL ROOM AND THE USE OF ALUMINOSILICATES TO DEODORIZATION

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SUMMARY

In the air of the experimental room (vivarium) for laying hens 29 different organic compounds were identified using gas chromatography methods. The concentrations of sulphur organic compounds were between 0,043 and 56,360 $\mu g \cdot m^{-3}$ and the concentrations of other organic compounds were between 0,464 and 111,713 $\mu g \cdot m^{-3}$. The air of the vivarium was purifying with the use of filtering machine (prototype) filled with sorbents (aluminosilicates). The reduction rate of sulphur organic compounds was on the level of 43,4% for bentonite and 59,7% for halloysite. The reduction rate of other identified organic compounds was 26,0% for both sorbents.

INTRODUCTION

Livestock buildings are responsible for enormous emission of gaseous pollutants [2, 7, 16]. For example, in air of the swine confinement buildings more over 160 chemical compounds have been identified [3]. Odours, like phenols, indoles, scatols, thiols, sulphides, aliphatic amines and VFA as well as ammonia emitted from animal faeces can affect both animals and human health [4, 6, 8, 17]. Ammonia emission from agriculture sources is more than 90% of total NH_3 emission and the half of that originates from livestock and related activities [1, 18]. We cannot ignore the fact that emission of aerial pollutants from buildings for intensive animal production represents serious environmental risk. Moreover, elimination of aerial pollutants could have both economic and animal welfare benefits.

To reduce gaseous pollution from livestock buildings we can decrease theirs concentration by filtrating the air inside the buildings or by filtrating the outlet air. We can also reduce it by adding sorbents to bedding material. In both cases the use of aluminosilicates sorbents seems to be a very good solution. It is possible to place sorbents into filtrating machine as a filter bed as well as putting it straight into the litter. The aluminosilicates are the class of clay minerals which have very big sorptive capacity and which are both inexpensive and easy available. Besides, the aluminosilicates do not cause any harmful effects on animals and humans, furthermore their presence in animal excreta increase the value of manure [5, 10, 11].

The aim of this work was to assess the concentrations of organic compounds in the air of the experimental room for laying hens and also to examine the method of the deodorization.

MATERIALS AND METHODS

The investigation was made in the experimental room (vivarium) for laying hens, where 120 laying hens (ISA SHAVER) were kept in the battery system (battery with 3 floors). The conditions in the experimental room met the requirements (i.e. temperature and relative humidity) for laying hens.

The prototype of filtering machine (fot.1) filled with the aluminosilicates sorbents, bentonite or halloysite, were used to purify the air in the experimental room. The time of air purification was 4 hours; the samples of air were collected before and after the use of filtering machine. Each of the sorbents was testing during 7 days. Additionally, the samples of air were also collected during the period of 7 days (blank week) when the air of the experimental room was not purifying.

The samples of air were collected to the Tedlar bags, at height of 1 meter above the floor, with the use of electronic pump (NS-512). The organic compounds from the sample were concentrated by adsorption on the Carbotrap 400 and than after thermal desorption, were dosage into the gas chromatograph HP 5890 with the flame ionization detector (FID) or with the flame-photometric detector (FPD).

RESULTS AND DISCUSSION

During the research, 29 different organic compounds were determined in the air of the experimental room. The concentrations of the sulphur organic compounds (tab.1) were between 0,0430 $\mu g \cdot m^{-3}$ for dipropyl sulphide and 56,360 $\mu g \cdot m^{-3}$ for methanethiol. The concentrations of other 21 identified organic compounds (tab. 2) were between 0,464 $\mu g \cdot m^{-3}$ for 1-butanol and 111,713 $\mu g \cdot m^{-3}$ for 1-pentanol. None of the samples that were examined contained such organic compounds like 1,2,4,5-tetramethylbenzene, dodecane, naphthalene, 1-butanethiol, dimethyl disulphide and carbon disulphide.

The total concentrations of organic compounds were between 69,234 and 331,614 $\mu g \cdot m^{-3}$ and the total concentrations of sulphur organic compounds were between 35,968 and 179,219 $\mu g \cdot m^{-3}$. The range of the total concentrations determined in our investigation was corresponding with the results of other authors. For example, in the air samples from poultry house (7000 laying hens) Tymczyna et al. [12] determined the average total concentration of sulphur organic compounds on the level of 422,8 $\mu g \cdot m^{-3}$ during the spring period and on the level of 248,1 $\mu g \cdot m^{-3}$ during the summer period.

The total concentrations of both organic and sulphur organic compounds in the air samples were always lower after than before the purification of the air in the experimental room. However, the total concentration of the sulphur organic compounds for the blank week was lower than in the period of experiment when halloysite was testing. That could be the effect of microclimate changes inside of the experimental room. The reduction rate of sulphur organic compounds was on the level of 43,4% for bentonite and 59,7% for halloysite. For other organic compounds the reduction rate was on the level of 26% for both tested sorbents. The results clearly prove that the applied aluminosilicates sorbents and the method of their use were efficient in limitation of odours.

The levels of reduction rates for organic compounds determined by many authors were comparable with our results. For example, Tymczyna et al. [14] were purifying the air from hatchery hall with the use of prototype biofilter. The reduction rate for all identified sulphur organic compounds was on the level of 51%. However, the reduction rate for methylethyl sulphide was on the level of 69%, and the highest reduction rates (but not statistically significant) were for ethanethiol and methanethiol. The same authors [15] were using biofilter to optimize the air from poultry farm. The reduction rates obtained for some of the sulphur organic compounds were very high, for methanethiol and ethanethiol the reduction rates were on the level of 74% and for diethyl sulphide even 97%. The use of the prototype open biofilter to purify the outlet air from layer house was also investigated [13]. The average reduction rate for alcohols, aldehydes, aliphatic and aromatic hydrocarbons was on the level of 30% during the 180 days of the experiment. However, better reduction rates were determined for individual compounds. For ethanol, pentanal, penthyloamine and indole the reduction was on the level of 50% and for xylene and trichloroethylene even over 60%. Sheridan et al. [9] applied the biofilter filled with shavings to purify the outlet air from the piggery. The odour's limitation was very efficient and the reduction rate was between 88 and 95%.

It was very important to notice that the most of the methods which were applied to limit the concentration of odours were concerning the outlet air of the livestock buildings. The prototype filtering machine that was applied in our experiment was purifying the air inside of the building; therefore it was not only reducing emission of odours from the experimental room but also inside of it. Taking into consideration the animal and human health the type of filtering process that was examined in our experiment seem to be a better solution.

CONCLUSIONS

The problem of odours and their emission from livestock buildings is still unsolved. Many scientists is paying attention to the process of deodorization, looking for the best and the most efficient method of elimination of gaseous pollutants from animal production. The method investigated in our experiment is on the beginning of the elaboration but the obtained results look promising and require further examination to ensure that the use of sorbents is not only moving the emission problem from livestock building up or down the chain.

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Table 1. The concentrations of the sulphur organic compounds ($\mu g \cdot m^{-3}$) in the samples of air collected before and after the use of sorbents and also during the blank week

The name of compound	Blank week	The name of sorbent			
		Haloysite		**Bentonite**	
		before	after	before	after
Sulphur dioxide	18,575	11,483	6,693	3,562	1,868
Carbon oxysulphide	29,297	3,939	n.d.	5,951	7,166
Methanethiol	19,965	56,630	50,832	24,659	20,857
Ethanethiol	n.d.	40,453	41,235	n.d.	n.d.
Methylethyl sulphide	42,600	48,926	19,309	6,174	2,247
Diethyl sulphide	1,264	n.d.	n.d.	0,393	n.d.
Methylpropyl sulphide	1,427	0,866	0,488	0,914	0,419
Dipropyl sulphide	2,611	5,489	2,815	1,644	0,0430
Total concentration of organic compounds	**122,795**	**179,219**	**131,786**	**48,833**	**35,968**

n.d. – not detected

Table 2. The concentrations of the organic compounds (μg·m^{-3}) in the samples of air collected before and after the use of sorbents and also during the blank week

The name of compound	Blank week	The name of sorbent			
		Haloysite		**Bentonite**	
		before	after	before	after
Methane	7,538	5,894	5,605	8,713	6,215
Ethanol	2,917	16,491	n.d.	3,985	n.d.
2-butylamine	38,704	1,778	n.d.	n.d.	n.d.
Propanol	6,186	n.d.	n.d.	1,672	n.d.
Cyclobutanol	4,062	n.d.	n.d.	n.d.	n.d.
1-butanol	n.d.	n.d.	n.d.	n.d.	0,464
2-pentylamine	2,678	1,716	n.d.	3,213	1,879
Pentanal	2,499	n.d.	n.d.	n.d.	n.d.
2-methyl-1-propanol	15,175	37,192	1,541	n.d.	n.d.
Methylcyclopentan	17,132	n.d.	n.d.	n.d.	n.d.
Benzene	n.d.	10,715	5,662	9,711	5,723
Trichloroethylene	9,189	15,763	0,653	n.d.	n.d.
Toluene	3,530	3,701	2,637	2,423	2,38
Hexanal	3,715	11,941	7,955	9,036	8,529
1-penthanol	111,713	11,994	8,059	12,242	10,529
Indole	22,850	37,697	22,089	36,894	22,674
Ethylbenzene	56,794	17,722	11,822	6,223	2,483
M,p-xylene	3,929	8,997	7,575	6,067	4,349
o-xylene	2,929	0,952	0,666	10,115	n.d.
Phenol	2,911	9,861	3,165	9,137	4,009
3-caren	17,163	n.d.	n.d.	2,807	n.d.
Total concentration of organic compounds	**331,614**	**192,414**	**77,429**	**122,238**	**69,234**

Figure 1. Prototype of filtering machine