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Nutritional strategies to reduce ammonia and carbon dioxide production in intensive livestock production

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ABSTRACT

Poultry production is an example of mass livestock production, so intensive production of fattening broilers involves raising broilers on farms with a capacity of 5,000 to 50,000 units or more at a density of 0.06 m^2 per bird. Modern poultry farms are constructed with the task of reducing heat loss, i.e. improving energy efficiency, which very often in combination with reduced ventilation can lead to increased levels of ammonia (NH_3), carbon dioxide (CO_2) and other air pollutants, and thus adversely affect animal health and productivity. The speed of gas emissions is influenced by many factors, such as the composition of feed and the efficiency of feed use (conversion), the quality of the litter and the microclimatic conditions on the farm. The litter on intensive poultry farms usually contains 4 to 6% of nitrogen, most of which is in NH_3 or NH_4^+ form. The mixture of litter and manure is a storage of nitrogen which is released in the form of ammonia under appropriate conditions. On the other hand, the main source of carbon dioxide in livestock is the product of animal respiration, so there is a connection between the levels of animal metabolism and CO_2 production on farms. The production of carbon dioxide in birds is proportional to their metabolic heat production, and thus to the metabolic body mass of the bird, which is affected by temperature and activity. The aim of the study was to examine the effect of a nutritional supplement, Eubiotic, added to broiler feed on the NH_3 and CO_2 emissions in a broiler farm. The values of NH_3 and CO_2 emissions in the facility for breeding fattening broilers that received Eubiotic in feed were numerically lower, which can be explained by better digestibility of basic nutrients, primarily proteins, present in feed.

1. Introduction

Poultry production is an example of mass livestock production, so the intensive production of fattening broilers implies raising broilers on farms with a capacity of 5,000 to 50,000 individuals or more at a density of 0.06 m^2 per bird. The way broilers are raised has a direct impact on pollution with harmful compounds, dust emissions and microbiological pollution on farms, and among them chemical pollutants are hazards that are equally dangerous for human and animal health. Modern poultry farms are constructed with the task of reducing heat loss, i.e., improving energy efficiency, which very often in combination with a reduced level of ven-

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tilation can lead to increased levels of ammonia (NH_3), carbon dioxide (CO_2) and other air pollutants, and thus negatively affect the health and productivity of animals (*Brouček and Čermák*, 2015). The production and emission of gases in poultry or any animal housing facility involves complex biological, physical and chemical processes. The rate of gas emission is influenced by many factors, such as feed composition and feed utilization efficiency (conversion), litter quality and microclimatic conditions on the farm.

2. Ammonia production on broiler farms

Litter on intensive poultry farms typically contains 4 to 6% nitrogen, most of which is in the NH_3 or NH_4^+ form. The mixture of litter and manure is a storehouse of nitrogen (N) which, under suitable conditions, is released in the form of ammonia. Many factors, such as season, facility temperature, relative humidity and broiler health, can affect the level of ammonia release in broiler farms. Ammonia is formed by the decomposition of nitrogenous waste products in manure (undigested protein from food and uric acid) under the action of exogenous enzymes produced by microorganisms. Factors that exert direct control over these processes are the pH of the manure, and the temperature and humidity of the facility, and they are strongly influenced by the age of the flock, that is, the age of the birds (*Knížatová et al.*, 2010b). It has been proven that the rate of ammonia emission increases with the age of the flock from an almost zero value at the beginning of the production cycle, to a maximum value at the end. Lower ammonia concentrations and higher ventilation rates were noted during warm summer months, while ammonia concentrations were higher during cold weather when low ventilation rates provided less fresh air for ammonia dilution (*Gates et al.*, 2005). Elevated concentrations of ammonia on broiler breeding farms, in addition to having a negative impact on the smell component in the facility, reduce food intake and slow down the growth rate of animals, and have a negative effect on the respiratory tract, increasing susceptibility to Newcastle virus and *Mycoplasma gallisepticum*, as well as the incidence of airborne sacculitis and keratoconjunctivitis (*Liu et al.*, 2009). The main source of ammonia is the urine of animals, while 70% of nitrogenous substances in excrement come from urine and 30% from faeces.

3. Production of carbon dioxide on broiler farms

CO_2 is one of the main products of burning fossil fuels and makes a major contribution to the greenhouse effect, which is why it is directly linked to climate change. The main source of CO_2 in animal husbandry is animal respiration, so there is a connection between the level of animal metabolism and the production of CO_2 on farms. CO_2 production in birds is proportional to their metabolic heat production, and thus to the bird's metabolic body mass, which is affected by temperature and activity (*Knížatová et al.*, 2010a). On farms with inadequate ventilation, oxygen becomes a limiting factor in broiler health, production performance and welfare. On the other hand, animal health conditions including factors such as CO_2 and oxygen levels are known to influence the occurrence of ascites in broilers. It is interesting that the research showed no difference in CO_2 emissions in relation to the age of the animals, i.e. the period of fattening.

4. Objective of the study

The aim of the conducted research was to examine the influence of the nutritional supplement Eubiotic added to feed for broilers on emissions of NH_3 and CO_2 in a facility for breeding broilers.

5. Materials and methods

The experiment was carried out on a farm for growing fattening broilers in Žablje, in two buildings with a capacity of 8500 broilers each, with an area of 530 m^2. Broilers of Cobb 500 provenance were used, which were fed complete mixtures of standard raw materials and chemical composition that fully corresponded to the nutritional needs depending on the age of the animals. The experimental group, unlike the control group, received Eubiotic in the feed during the entire fattening period, at the level of 1 kg/ton of feed. Measurements of gas emissions (NH_3 and CO_2) in the buildings were carried out on days 28 and 35 in the morning hours with a multigas detector manufactured by Dräger — Germany.

6. Results

Determined values of NH_3 and CO_2 emissions in the broiler breeding facility after 28 days of the production cycle are reported in Tables 1–6.

Table 1. NH_3 emissions at the entrance to the facility on day 28 (ppm)

Group	$\overline{X}$	Measurements				
		Sd	Se	X_{min}	X_{max}	C_v (%)
Control	5.36	0.086	0.035	5.25	5.45	1.61%
Experimental	5.07	0.211	0.086	4.87	5.31	4.17%

Table 2. NH_3 emissions in the central part of the facility on day 28 (ppm)

Group	$\overline{X}$	Measurements				
		Sd	Se	X_{min}	X_{max}	C_v (%)
Control	10.74	0.250	0.102	10.25	10.98	2.33%
Experimental	10.12	0.203	0.083	9.88	10.42	2.01%

Table 3. NH_3 emissions at the end of the facility on day 28 (ppm)

Group	$\overline{X}$	Measurements				
		Sd	Se	X_{min}	X_{max}	C_v (%)
Control	5.38	0.110	0.045	5.19	5.49	2.04%
Experimental	5.09	0.166	0.068	4.88	5.31	3.27%

Table 4. CO_2 emissions at the entrance to the facility on day 28 (ppm)

Group	$\overline{X}$	Measurements				
		Sd	Se	X_{min}	X_{max}	C_v (%)
Control	1371.00	74.080	30.240	1240.00	1448.00	5.40%
Experimental	1334.00	36.660	14.970	1293.00	1382.00	2.75%

Table 5. CO_2 emissions in the central part of the facility on day 28 (ppm)

Group	$\overline{X}$	Measurements				
		Sd	Se	X_{min}	X_{max}	C_v (%)
Control	1890.00	51.500	21.030	1828.00	1984.00	2.72%
Experimental	1834.00	132.900	54.240	1655.00	1952.00	7.24%

Table 6. CO_2 emissions at the end of the facility on day 28 (ppm)

Group	$\overline{X}$	Measurements				
		Sd	Se	X_{min}	X_{max}	C_v (%)
Control	1546.00	20.750	8.470	1519.00	1574.00	1.34%
Experimental	1502.00	53.830	21.980	1441.00	1602.00	3.58%

Determined values of NH_3 and CO_2 emissions in the broiler breeding facility after 35 days of the production cycle are shown (Tables 7–12).

Table 7. NH_3 emissions at the entrance to the facility on day 35 (ppm)

Group	$\overline{X}$	Measurements				
		Sd	Se	X_{min}	X_{max}	C_v (%)
Control	12.36	0.836	0.341	11.36	13.50	6.76%
Experimental	11.67	1.199	0.490	10.52	13.29	10.28%

Table 8. NH_3 emissions in the central part of the facility on day 35 (ppm)

Group	$\overline{X}$	Measurements				
		Sd	Se	X_{min}	X_{max}	C_v (%)
Control	17.72	2.283	0.932	14.63	20.26	12.89%
Experimental	16.67	1.543	0.630	14.99	18.75	9.26%

Table 9. NH_3 emissions at the end of the facility on day 35 (ppm)

Group	$\overline{X}$	Measurements				
		Sd	Se	X_{min}	X_{max}	C_v (%)
Control	15.53	0.978	0.399	14.63	17.22	6.29%
Experimental	14.68	0.651	0.266	14.01	15.80	4.43%

Table 10. CO_2 emissions at the entrance to the facility on day 35 (ppm)

Group	$\overline{X}$	Measurements				
		Sd	Se	X_{min}	X_{max}	C_v (%)
Control	1343.00	43.590	17.800	1281.00	1384.00	3.25%
Experimental	1305.00	42.770	17.460	1245.00	1361.00	3.28%

Table 11. CO_2 emissions in the central part of the facility on day 35 (ppm)

Group	$\overline{X}$	Measurements				
		Sd	Se	X_{min}	X_{max}	C_v (%)
Control	1790.00	56.790	23.180	1737.00	1883.00	3.17%
Experimental	1734.00	135.500	55.330	1502.00	1892.00	7.82%

Table 12. CO_2 emissions at the end of the facility on day 35 (ppm)

Group	$\overline{X}$	Measurements				
		Sd	Se	X_{min}	X_{max}	C_v (%)
Control	1511.00	84.440	34.470	1400.00	1622.00	5.59%
Experimental	1467.00	76.960	31.420	1390.00	1585.00	5.25%

7. Conclusion

From the results shown, we can conclude that the emission values of NH_3 and CO_2 in the facility for growing fattening broilers that received Eubiotic in their feed were numerically lower, which can be explained by the better digestibility of basic nutrients, primarily proteins present in the feed. The above results indicate that the use of Eubiotic has a positive effect on the zoohygienic conditions of the environment and thus consequently leads to an increased resistance of broilers to diseases caused by emissions of harmful gases and all accompanying effects.

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