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AIR QUALITY MEASUREMENTS IN LAYING HENS HOUSING

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ABSTRACT

Ensuring good environmental conditions of the poultry houses can be costly for the farmers, but without it losses due to poor bird health and performance due to poor air quality can be much more detrimental to net returns. The goal of this study was to investigate the variations in air quality in various areas inside the laying hen houses. Ten houses with laying hen conventional battery cages were measured for O_2, H_2S, CO, NH_3, temperature, relative humidity, CO_2, airflow and luminance. The results of the physical measures showed that temperatures in the houses were between 15.31–25.6°C, the relative humidity 48.03-81.12%, while the luminance rarely exceeded 8 lux. As for the gasses, the values for NH_3 rarely exceeded 8 ppm, although at some measuring points it reached 26 ppm. O_2 was generally at 20.9 %, and the levels of CO_2 were very low. No presence of H_2S and CO was detected. In this study it was concluded that the measurement of the air quality in a house can vary depending of the places this measures are taken. Multiple measurement points are important because they may make the staff aware of the problems connected to low ventilation and culmination of harmful gases. The air quality in different positions in the houses is of great importance not only for the animal welfare, but also for the safety of the staff.

Key words: laying hens, ammonia, temperature, air quality

INTRODUCTION

In intensive poultry housing systems, laying hens should be kept in good environmental conditions, ensuring good care, in order to ensure that laying hens are performing to their maximum yield capacities within their genetic potential (1, 13). Maintaining a proper ventilation can be costly for the farmers, but without it poor bird health and performance due to poor air quality can be much more detrimental to net returns. A part of the environmental conditions is the areal environment (8). The areal conditions in

the poultry houses depend on physical (temperature, relative humidity, luminance, ventilation and dust) and chemical factors (compound of the air such as ammonia, carbon dioxide and oxygen) (1, 2).

In poultry houses, harmful gases like ammonia, carbon dioxide, methane, hydrogen sulfide and nitrous oxide, are generated by the hens and their waste (1, 2). These gases may accumulate and reach toxic levels which may cause risk to the health of both chickens and the workers, therefore an adequate ventilation must be maintained. Levels of CO_2 such as 12000 ppm were observed to have effect on weight loss in broilers (3). For the CO level of 1500 ppm in the air can cause death in an hour (4, 5, 6). Levels of ammonia as low as 20 ppm have been shown to increase the susceptibility of chicken to diseases (7). Although poor aerial conditions normally don't cause disease directly, they do reduce the chickens' immune defenses, therefore making them more susceptible to existing viruses and pathogens (8).

The most common air contaminant in the poultry facilities is ammonia. The concentration

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varies depending on many factors, among which are manure handling, temperature, humidity and ventilation rate of the facility. Hens exposed to high levels of ammonia can show reduction in feed consumption, feed efficiency, weight gain, and egg production (8-12).

In the process of regulating temperature, relative humidity and gases, ventilation is of great importance. In laying hen houses the recommended optimal temperature is 18°C (13). The measures of performance such as body weight, consumption of feed and water, feed intake, egg production, and egg weight, have been correlated with the environmental temperature (14). It is possible that under heat stress, a reduction of egg production occurs due to the alterations in the respiratory pattern (15).

It is advised that the optimal relative humidity in laying hen houses should be between 50-70% (16). If the relative humidity drops below the advised levels increases of mortality, and in some cases respiratory diseases can accrue (16).

The goal of this study was to investigate the variations of air quality, except dust levels, in various areas inside the laying hen houses.

MATERIAL AND METHODS

Ten houses with laying hen conventional battery cages were measured for the air quality. Seven of the houses were completely closed with no windows and had tunnel ventilation type. Two of the houses (G1, G2) had windows which were open in order to increase the ventilation and a fan at each corner that was sucking air out of the house, and one house (D)

had fans pumping air out of the house on one side and openings on the other side where fresh air was entering the house. Detailed information about the houses are given in Table 1.

All the measurements were taken in October and November in the period between 9 a.m. and 12 a.m. when the eggs were collected. The measuring was performed inside the houses at 9 points at multiple cage heights. The points of measurements were: 3 at the corridor next to the left wall, 3 at the corridor in the middle of the batteries, and 3 points at the corridor next to the right wall. At each corridor, measurements were taken at the beginning, at the middle and at the end of the battery. The measurements of O_2, CO and NH_3 were done with a portable detector MultiRAE (RAE systems, US) and temperature, relative humidity, CO_2, airflow and luminance was measured with TESTO measurement instrument (Testo Inc., US) with multiple sensor probes. For every house, an average value and the standard variation were calculated for each measure.

RESULTS

Summary of the results from the measurement of the physical parameters are shown in Table 2. The temperature in the houses was in the range between 15.31°C and 25.6°C with the highest standard deviation of 3.09°C. The deviation in temperature in a house depended on the heights of the battery and the air flow. The relative humidity was between 48.03% and 81.12% with the maximum standard deviation of 4.89%. The luminance was between 1.83 and 28.25 lux with maximal standard deviation

Table 1. Information about the houses where the study air quality measurements were performed

House	Hybride	Age (weeks)	Population	House size in meters (W x L x H)	Ventilation method	Manure menagement
House A	Dekalb brown	69	35600	10 x 70 x 4,20	Tunel	Belt
House B1	Lohmann white	30	13000	9 x 72 x 3,6	Tunel	Belt
House B2	Lohmann white	88	15000	9 x 72 x 3,6	Tunel	Belt
House C1	ISA Brown	48	11000	12,5 x 80 x 4,6	Side vents	Scraper
House C2	ISA Brown	30	11000	12,5 x 80 x 4,6	Tunel	Scraper
House D	Lohmann white	72	9800	8 x 50 x 4,20	Tunel	Belt
House F1	Lohmann white	53	54600	23 x 72 x 6,5	Tunel	Belt
House F2	Lohmann white	40	59300	23 x 72 x 6,5	Tunel	Belt
House G1	Lohmann white	52	22100	12 x 83,5 x 2,4	Modification	Scraper
House G2	Lohmann white	84	22100	12 x 83,5 x 2,4	Modification	Scraper

Table 2. Summary measured values for the physical parameters in the houses

Farm	Temperature (°C)				Relative humidity (%)				Luminance (lux)				Air flow (m/s)			
	average	min	max	stdev	average	min	max	stdev	average	min	max	stdev	average	min	max	stdev
House A	21.80	18.94	22.63	0.99	58.40	54.79	61.28	1.84	8.68	2.00	17.00	4.94	0.41	0.03	0.93	0.24
House B1	20.80	17.82	22.16	1.21	64.72	58.84	73.68	4.08	4.23	2.00	10.10	2.10	0.33	0.07	0.79	0.20
House B2	20.46	16.50	22.86	1.92	64.89	59.96	74.48	4.89	3.89	2.60	7.00	1.30	0.26	0.03	0.54	0.14
House C1	25.38	24.57	26.27	0.41	49.69	43.57	55.08	0.34	4.02	2.00	5.90	1.00	0.05	0.01	0.11	0.03
House C2	25.60	24.50	26.12	0.60	48.03	45.69	50.98	2.32	4.02	2.00	5.90	1.00	0.23	0.05	0.61	0.20
House D	24.47	21.40	25.40	1.52	81.12	78.70	84.00	1.80	1.83	1.00	2.00	0.41	0.36	0.12	1.06	0.37
House F1	22.36	19.00	25.45	1.89	69.52	61.26	76.92	4.29	6.66	1.90	20.60	4.85	0.35	0.03	1.06	0.29
House F2	16.45	12.96	19.23	2.16	64.00	56.64	74.64	4.33	4.60	1.20	12.60	2.74	0.22	0.07	0.37	0.15
House G1	16.49	15.00	19.23	1.02	48.50	39.13	54.99	3.85	28.25	2.00	362.00	83.69	0.24	0.03	0.73	0.18
House G2	15.31	13.27	16.89	1.08	49.98	43.05	53.52	2.86	5.83	2.00	16.80	4.04	0.51	0.04	1.25	0.38

Table 3. Summary of the measured values in the houses for the gasses

Farm	NH_3 (ppm)				O_2 (%)				CO_2 (ppm)			
	average	min	max	stdev	average	min	max	stdev	average	min	max	stdev
House A	1.04	0.00	3.00	0.85	20.80	19.40	20.80	0.54	1139.88	926.00	1322.50	123.88
House B1	0.94	0.00	1.00	0.20	20.90	20.90	20.90	0.00	1046.99	855.40	1211.40	92.87
House B2	0.39	0.00	1.00	0.50	20.90	20.90	20.90	0.00	930.64	556.70	1179.80	206.51
House C1	8.50	1.00	26.00	7.16	19.36	18.50	20.60	0.75	747.51	625.60	934.70	84.79
House C2	8.17	1.00	18.00	5.98	21.22	21.20	21.30	0.04	696.20	549.00	789.00	111.29
House D	6.33	4.00	12.00	3.01	20.90	20.90	20.90	0.00	750.00	725.00	771.00	18.90
House F1	5.04	1.00	11.00	2.68	19.96	19.50	20.50	0.31	1158.99	838.10	1436.10	195.28
House F2	1.44	0.00	3.00	0.64	20.09	19.40	20.90	0.53	1466.56	886.80	1832.10	321.39
House G1	8.00	2.00	17.00	4.68	20.90	20.90	20.90	0.00	840.28	620.50	1067.40	112.14
House G2	4.00	1.00	9.00	7.94	20.90	20.90	20.90	0.00	836.91	630.40	1092.20	138.15

83.69 lux. Different cages were getting different amounts of luminance. The ones that were the closest to the light source had higher value for luminance, as the lower cages got the lower value for luminance. In one of the houses one of the sides was allmost open, at this point values of 362 lux was measured. The airflow was between 0.05 m/s and 0.51 m/s with maximal standard deviation of 0.38 m/s.

Summary of the results from the measurement of the gases are shown in Table 3. The NH_3 was between 0.39 ppm and 8.17 ppm with the biggest standard deviation of 7.94 ppm. The O_2 was between 19.36% and 21.22% with the biggest standard deviation of 0.75%. The CO_2 was between 696.2 ppm and 1466.56 ppm with the biggest standard deviation 321.39 ppm. In all the farms, it was noted that there were blind spots of ventilation. In one of the houses there was a point where the air flow was at minimum as low as 0.01 m/s, and at this point the highest concentration of NH_3 (26 ppm) was measured. Also the amount of oxygen in most of the farms was at the level of 20.9%, which is same as fresh air. However in one of the farms an alarmingly low level (18.5%) of O_2 was measured. This was the same farm that had the lowest ventilation rate. CO and H_2S were not detected in any of the houses.

DISCUSSION

The average temperature in the farms did not vary more than 3°C below, and 8°C above the recommended values. The highest value measured was 26.27°C. Oarad et al. (17) stated that temperatures above 27°C can reduce the productive performance of the hens, and temperatures over 35°C can lead to pronounced decrease of feed consumption and egg shell thickness. According to Talukder (18) feed consumption and egg weight gradually decrease with relative humidity above 70%, which was the case only in one of the houses. Although the mean value exceeded 70% in 4 other houses the maximum values exceeded this relative humidity. As for the luminance it generally had low values which are reported to reduce the risk of pecking (19). However the variation between the values was dependent on the distance of the measuring point from the light source. In one of the houses, at one of the sides, the panel for the opening fell off and thus did not block any light, and the values were close to those of daylight. The highest level CO_2 measured in any of the houses was 1436 ppm and it was never close to concentrations that can be harmful for the health (3). The average levels of NH_3 in the houses did not exceeded 8 ppm.

94

However in one of the houses, at one measuring point, the NH_3 level reached 26 ppm, a concentration which has been recorded to have adverse effects on the health of the birds and the workers (9, 20, 21, 22).

During the measurements of the houses with the tunnel ventilation a pattern was noticed. The maximum values for temperature, relative humidity and the minimal values of airflow were recorded at the measurement points located at the back end of the houses, especially at the corners. At these measurement points the maximal values for the NH_3 were recorded, which is according to the literature where the levels of the NH_3 is dependent of temperature, relative humidity and airflow (23).

CONCLUSION

In this study it was concluded that the air quality in a house can differ depending of the places this measurements are taken. Multiple measurement points are important because they may make the staff aware of the problems connected to low ventilation and culmination of harmful gases. The air quality in different positions in the houses is of great importance not only to the animal welfare, but also to the safety of the staff. Although there was no repeated detection of gasses at levels that can be harmful in this study, it does give an insight to the places in the house where they are most likely to accrue.

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