INFLUENCE OF ANIMAL AGE AND SEASON ON BIO-AEROSOL CONCENTRATIONS IN A BROILER HOUSE

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Introduction

Broiler houses are often referred to as livestock houses with the highest concentrations of organic pollutants (bioaerosols) in the air. This is particularly assumed for the last week of the fattening period. Fact is, however, that conditions are changing considerably in the course of a production cycle and that the season has also an important influence on the level of pollution. This paper reports on concentrations of inhalable and respirable dust, endotoxins in both dust fractions and of the total microbial count in the air of a forced ventilated broiler barn during 6 fattening periods, 2 in summer and 4 in winter time.

Materials and methods

The measurements were carried out in one of the broiler houses of the Field Research Station Ruthe of the University of Veterinary Medicine Hanover with about 9400 birds (Lohman. Guxhaven. Germany) resulting in a density of 13 birds/m². Samples were taken in two different sampling heights at the end of each week of the 7 fattening periods over 24 hours for dust and endotoxins, bacteria were sampled during day time only. The summer period was defined between May and September. The other months were taken as winter. Dust was collected by means of pumps (ASF Thomas, Memmingen, Germany) with a flow rate of 2.0 l/min and glass fibre filters (Whatman International Ltd., Maidstone, UK) in IOM dust samplers (Institute of Occupational Medicine, Edinburg, UK) for the ID fraction and in cyclone dust samplers (SKC Ltd., Blandford Forum, UK) for the RD fraction. The filters were weighed before and after sampling in a controlled environmental laboratory at 22°C (± 2°C) and 45% (± 5%) relative humidity. After sampling the dust filters were transported at the same day to the laboratory for conditioning. Next day they were weighed and subsequently worked up according to a standardised procedure and analysed by the Limulus Amebocyte Lysate test on endotoxin (ET). Micro-organisms were sampled on polycarbonate filters in IOM collecting heads with subsequent incubation at 37 C for 48 h. The positions of the sampling points were 1.5 m above the ground representing approximately the inhaling height of humans and about 30 cm representing approximately the height of the birds. Four sampling points two in each height were installed in the buildings and one position outdoor as a control. The results at the two sampling points in each height were averaged.

Results

The temperatures in the broiler barn varied slightly only between winter (30 C in the first week, 19 C in 5th week) and summer season (28 C to 19 C) because of the automatic ventilation and heating system. The deviation of the temperature from the means at the sampling days never exceeded 1 C. The relative humidity, both in winter and summer time, was frequently below the recommended minimum level of 60 % for broiler houses. This was probably caused by the efficient heating devices.

Table 1 summarises the results of the dust measurements in summer and winter. The arithmetic mean (a) and standard deviation (s) of the inhalable (ID) and respirable (RD) dust concentrations at the end of week 1 through to week 5 of the fattening period are given (N=12). The highest ID resp. RD concentrations were found at the end of the fattening

Tab. 1: Arithmetic mean (a) and standard deviation (s) values of the inhalable (ID) and respirable (RD) dust concentrations at 4 locations measured every week at two different sampling heights and two seasons (1.5m-0.3m), N=12

	Dust fractions	Sampling height	1st week (**a** ± s)	2nd week (**a** ± s)	3rd week (**a** ± s)	4th week (**a** ± s)	5th week (**a** ± s)
Summer	**ID**	1.5m	**1.3**± 0.13	**3.6** ±0.13	**4.7**±0.25	**5.6** ±0.01	**5.4** ±0.4
		0.3m	**1.4**±0.17	**3.8** ±0.24	**5.8**±0.27	**6.4**±0.02	**4.4**±0.3
Winter	**ID**	1.5m	**1.4**±0.01	**4** ±0.15	**4.8** ±0.13	**9**±0.06	**8.1**±0.3
		0.3m	**1.7**±0.01	**4.8**±0.14	**5.8** ±0.09	**10** ±0.25	**9.3** ±0.1
Summer	**RD**	1.5m	**0.4**±0.05	**0.7** ±0.08	**0.8** ±0.25	**0.7** ±0.2	**0.75**±0.1
		0.3m	**0.4**±0.06	**0.75**±0.1	**0.7**±0.2	**0.6**±0.15	**0.7**±0.3
Winter	**RD**	1.5m	**0.4**±0.05	**0.8**±0.1	**0.9**±0.2	**1.5**±0.15	**1.3**±0.3
		0.3m	**0.3**±0.03	**0.6**±0.07	**0.8**±0.08	**1.2**±0.07	**0.8**±0.1

periods in winter, the lowest in week one. The ID concentrations in the fifth week in summer are only about half of the concentrations found in winter which is possibly due to the higher ventilation rate in summer time. The 24 h inhalable resp. respirable dust concentrations ranged between 1.3 resp. 0.4 in the first week and 5.6 resp.0.7 mg/m³ in the 4th week in summer and 1.4 resp. 0.4 to 10 resp. 1.5 mg/m³ in winter. A concentration difference exists between the two different sampling heights all over the year. The dust concentrations for ID were higher in 0.3 m than in 1.5 m sampling height. But on the other hand we observed that RD concentrations are higher in 1.5 m height than in 0.3 m high. The German OHL (occupational health limit) for ID (4 mg/m³) is regularly exceeded from the second week of the fattening periods in winter and from the third week during summer. The OHL for RD (1.5 mg/m³) is reached in winter season at the end of the fattening period.

The results of the measurements of the airborne micro-organisms are shown in Table 2. After the first week the bacteria concentrations remain below 1 million. However, the concentrations in summer are distinctly lower than in winter. This is a general trend. Only in the 2nd week a reverse situation was detected which could not fully explained. In the 4th week in winter the highest concentrations with up to 115 million cfu/m³ were found which coincides with the dust results. There is also clear evidence that the bacteria concentrations at sampling height 1.5 m is always lower than in height 0.3 above the floor.

Tab. 2: Arithmetic mean (a) and standard deviation (s) values of the airborne total microbial count (x 10^6 cfu/m³) at 4 locations measured every week. N=12

	Sampling height	1st week (**a** ± s)	2nd week (**a** ± s)	3rd week (**a** ± s)	4th week (**a** ± s)	5th week (**a** ± s)
Summer	1.5m	**0.25**±0.03	**24.1**±0.07	**55.9**±27	**62.6**±30	**47.4**±24
	0.3m	**0.36**±0.03	**31.3**±0.08	**65.8**±26	**77.7**±33	**58.4**±27
Winter	1.5m	**0.8**±0.04	**14.5**±0.07	**56.2**±22	**85.3**±30	**80**±26
	0.3m	**0.81**±0.03	**19.1**±0.1	**67.1**±20	**115.2**±28	**79**±20

Table 3 gives the results of the endotoxin (ET) measurements in the ID and RD dust fractions.

Tab. 3: Arithmetic mean values (a)and standard deviation (s) of endotoxin units (EU) per m³ of air in both the inhalable (ID) and respirable (RD) dust fractions of the broiler house air at 4 locations in two different sampling heights (1.5m-0.3m) and two seasons, N=12.

	Dust fractions	Sampling height	1st week (**a** ± s)	2nd week (**a** ± s)	3rd week (**a** ± s)	4th week (**a** ± s)	5th week (**a** ± s)
Summer	**ID.**	1.5m	**756**±251	**4041**±1020	**3249**±550	**2919**±261	**6980**±424
		0.3m	**1044**±205	**3016**±1125	**3829**±140	**3642**±219	**6816**±1180
Winter	**ID.**	1.5m	**648**±10	**7451**±843	**11267**±2636	**7810**±2395	**5719**±535
		0.3m	**1057**±39	**5275**±934	**8623**±1333	**9059**±518	**5302**±194
Summer	**RD.**	1.5m	**299**±143	**839**±433	**559**±195	**658**±380	**612**±597
		0.3m	**325**±187	**1062**±919	**414**±137	**445**±216	**443**±385
Winter	**RD.**	1.5m	**295**±13	**1510**±64	**1510**±144	**1662**±520	**1357**±245
		0.3m	**234**±17	**710**±205	**866**±183	**1135**±161	**898**±386

With the increasing age of the birds the ET concentrations increase and reach in the 3rd week a maximum of more than 11.000 EU/m³ (EU= endotoxin unit). All concentrations exceed the formerly recommended OHL values of The Netherlands of 50 EU/m³.

Figure 1 shows the relationship between the RD concentration (mg/m³) and the endotoxin level in this dust fraction. With increasing dust amounts the endotoxin units are increasing too. The correlation coefficient is R^2 = 0.75. When the OHL for respirable dust (RD) of 1.5 mg/m³ is reached the air contains more than 1400 EU/m³. Assuming that a normal adult human inhales about 9 l of air per min, he inhales at the same time 12.6 EU. During an eight hour working day the total load is 6048 EU.

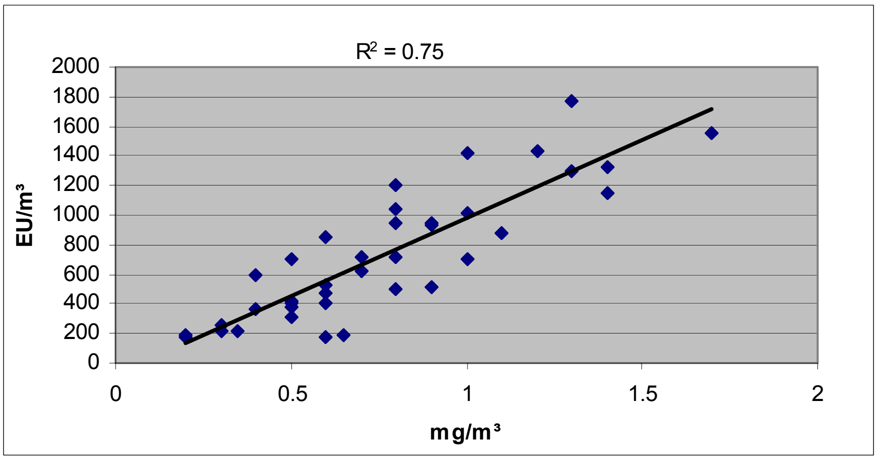

Fig. 1: Correlation between respirable dust (mg/m³) and respirable endotoxine concentration on this dust fraction (EU/m³). N=36.

Discussion

The results of this investigation show that there are high concentrations of inhalable (ID) and respirable dust (RD), micro-organisms and endotoxins in the air of a mechanically ventilated broiler house. All pollutants increase with the age and weight of the birds. The highest amounts are reached in the 4th week of fattening. The OHL for ID is regularly exceeded after the 3rd week. In the 5th week a slight reduction of pollutant concentrations are observed. This is probably due to the high stocking density in the last days of the fattening period reducing the activity of the birds which leads to lower emission amounts of bioaerosols. There is a clear influence of the season to observe with distinctly lower dust, bacteria and endotoxin concentrations in summer compared to the cooler times of the year. The very high amounts of ET (>11.000 EU/m³) demonstrate the noxious potential of broiler house air for humans compared to the formerly proposed OHL of 50 EU/m³. There are also environmental aspects to consider when these bioaerosols are emitted into the surrounding of the animal house.

Conclusions

Bioaerosols are present at all times in the air of broiler houses during the fattening period. They increase considerably with the growing animals. Some of them such as ID exceed regularly OHL. In forced ventilated buildings the influence of the season is relatively low. The temperatures were always in the optimal range. There is a risk that relative humidity falls below the optimal values when the ventilation rate increases in summer. More attention should be paid to the very high ET levels and levels of micro-organisms which may cause health hazards inside and outside the buildings when the bioaerosols are emitted into the environment.

*For **References** please contact the author.*