BIOLOGICAL POLLUTANTS OF AIR IN POULTRY HATCHERY HALL

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SUMMARY

The egg-poultry industry, whose production technology is based on the biological material, constitutes a potential source of not only chemical pollutants but primarily of microorganisms and their toxins. These agents appear as a bioaerosol constituent, in particular of organic dusts. They are carried off through the ventilation installation outdoors, where they maintain at the high level up to one kilometre from the emission source. Numerous poultry diseases, among others the air-borne respiratory tract infections, may reach distant sites outlying even three kilometres from a place of their origin. It is hazardous not only for health of the plant workers but for the inhabitants of neighbouring areas.

The objective of the present work was to establish the biological pollutants concentration in the hatchery air. The researches were conducted in the Plants of Poultry Hatchery in Poland with the annual production output 20–25 mln chickens of meat hens Cobb and Ross lines.

As the present researches showed, the technological and engineering progress in the hatchery plants caused a substantial decrease of air contaminants, in that dust pollutants. Relatively slight dustiness assayed in the hatchery room averaged 1.0 mg/m^3. The studies proved that a mean concentration of bacteria in the hatchery room is 4.0 x 10^3 cfu/m^3 with a relatively high contribution of Gram-negative bacteria (nearly 6.5 x 10^2 cfu/m^3) and bacterial endotoxins (11.15 ng/m^3). Among them the following bacteria were identified: *Acinetobacter, Citrobacter, Enterobacter, Escherichia, Flavobacterium, Klebsiella, Pseudomonas, Leclerca, Sphingomonas, Xantomonas, Agrobacterium* and *Pantoea*.

Keywords: dust, bioaerosol, hatchery, endotoxin

OBJECTIVE

The animal breeding environment constitutes a perfect „laboratory" for microbe generation and multiplication. The egg-dairy industry whose production technology is based on the biological material also makes a potential source of not only the chemical pollutants but, or primarily, microorganisms and their toxins(among others, endotoxins).These agents occur as a bioaerosol constituent, mainly of organic dusts. They are vented through the ventilation installation outdoors where they persist at the high level up to a kilometre from the emission source. A number of poultry diseases, among others the air-borne respiratory tract infections are drifted over long distances, even up to three kilometres from the place of their origin [Schlegemilch, 2005; Seedorf, 1998; Wathes, 1998b].That pose a serious health threat not only for the plant workers but the inhabitants of the near-by region.

An air microbe count is one of the major index of confined space contamination. However, it is hard to estimate a bioaerosol concentration owing to a great number of parameters affecting

directly or indirectly the aeromicroflora count. The finer bioaerosol particulates, the deeper they deposit in the respiratory system and thus appear more difficult to eliminate from organism at exhalation. An infection depends not only on a particulate size but the microorganism count and kind as well. A bioaerosol influence on the higher organisms is subject to a microbial count in the air, their quality, dispersion level as well as solid and liquid particulates serving as a condensation nucleus for microorganisms [Wathes,1998a; 1998b].

The objective of the present work was to establish the biological pollutants concentration in the hatchery air.

METHODS

The study was conducted at the Poultry Hatchery in Dębówka, 20km south of Warsaw, Poland. The hatchery has an annual output of 20 to 25 million Cobb and Ross meat hens, which represents 4% of the national production. Five series of experiments were carried out in the hatchery room, which was equipped with 8 hatchers (AS-4H, Petersime, Zulte, Belgium) and 12 incubators (AS-4S, Petersime, Zulte, Belgium) with an input of 115th eggs. In each series of experiments, 4 air samples were collected in 2 place (A and B) in the hatchery room. A – point in the centre hall, B point in the outlet ventilation system.

In the air samples, concentrations of dust and microbial pollutants as well as endotoxins were determined. Dustiness was established by weight method, whereas a bacteria concentration and species composition using a filter method with surface inoculation on the following agar media:

- blood agar to determine total bacteria count and mesophylic actinomycetes
- eosin methylene blue (EMB) agar to identify Gram-negative bacteria
- tryptic soy (TS) agar with half reduced nutrients to determine thermophylic actinomycetes.

The microbe colonies incubated on each medium were assayed macro- and microscopically first after the Gram staining method. Afterwards, a number of morphological types was established and their concentration in 1 m3 of the air sample was estimated and expressed as colony forming unit – cfu/m3.The bacterial isolates were identified using the biochemical assays API 20E and API 20 NE (bioMerieux, Marcy l`Etoile, France) for the Gram- negative bacteria and Gram-positive cocci. Mesophylic actinomycetes were determined by the micro- and macroscopic methods.

An endotoxin concentration was measured using the *Limulus* test kit (bioMerieux, Marcy l`Etoile, France).

The pollutants concentrations at the site A were compared to those at the site B using the Wilcoxon nonparametric test.

RESULTS

The present researches confirmed that the technical and engineering progress in the hatchery plants has substantially reduced air dust pollutants. In the hatchery hall, there were determined rather low dustiness levels that averaged 0,95 cfu/m^3 in the livestock buildings [Baykov and Stoyanov, 1999; Chang 2001; Kalingan, 2004; Wathes, 1998a; Zucker, 2000].That indicates lesser hazard of the respiratory system diseases incidence in the workers employed there and in turn, lower burden of the outdoor environment.

In the hatchery halls, alike the poultry houses, the dusts comprise fine particulates of faeces, feathers and epidermis introduced to the halls along with the fertilized eggs. They are also produced at chick hatching. The organic pollutants get into the productive environment together with fungi and their spores, bacteria and their toxins (endotoxins), viruses and parasites. The performed researches revealed a mean concentration of bacteria at the level of 4 thousand cfu/m^3 in the hatchery hall, including Gram-negative and positive bacteria, cocci and Gram-positive rods as well as actinomycetes. The investigated air samples exhibited predominance of staphylococci and streptococci (Streptococcus faecalis in particular) –Gram-negative cocci that averaged over 3 thousand cfu/m^3. A bioaerosol composition studied in the hatchery room showed a relatively high content (16%) of the Gram-negative bacteria with mean concentration of 651 cfu/m^3. Among them, beside sporadically reported pathogens *Salmonella* genus, the presence of enteric rods (*Enterobacteriaceae*), aerobic rods of *Alcaligenes* and *Acinetobacter* genera was confirmed. The studies of the other authors indicate that these bacteria often constitute the microflora of air in the livestock buildings. They are widely distributed in soil, water and in the bacterial microflora of healthy human skin (mainly *A. johnsonii*, *A. lwoffii*, *A. radioresistens*). More rarely these bacteria colonize the gastrointestinal tract and nasopharyngeal cavity. The bacteria of *Acinetobacter* most often develop pneumonia, sepsis, urinary tract infection, dermatitis or wound infection. It is most likely that the bacteria of this genus make up one of the major sources of endotoxins penetrating the hatchery air.

A mean concentration of bacterial endotoxins in the hatchery hall air reached 11,5 ng/m^3. According to Rylander [1977], this level is a potential risk factor of the respiratory system disease incidence in human exposed to it. The Dutch Expert Committee on Occupational Standards recommended the maximum allowable exposure limits for endotoxins at 8-hour working time at 4.5 ng//m^3 level, that is twofold lower compared to that reported above [Heederick and Douwes, 1997]. As the inspection of the hatchery plants revealed, this standard is very difficult or just impossible to comply with.

The statistical analysis did not show any differences between the pollutants concentration determined at the air sampling sites (for $p \leq 0,05$).

CONCLUSIONS

The studies of the bioaerosol composition at the hatchery hall showed a relatively high percentage of the Gram-negative bacteria and their toxins (endotoxins). The disinfection procedures practiced in such plants do improve the sanitation status of the rooms and reduce microorganism count, yet they do not eliminate their residuals, i.e. endotoxins.

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Table 1. Concentration of dusts, endotoxins and bacteria in the hatchery hall air

Group/type		**Total**		**A Hall centre**		**B Ventilating device outlet**	
		M	**SD**	**M**	**SD**	**M**	**SD**
Dust [mg/m^3]		0,95	1,29	0,51	0,34	1,39	1,78
Endotoxin [ng/m^3]		11,15	17,12	11,03	19,18	11,27	17,08
Bacteria [cfu/m^3] including:		4051,85	5439,00	3785,20	7155,34	4318,50	3896,70
G (–) rods	*Pseudomonas putida*	651,45	723,99	475,20	560,95	827,70	887,16
	Pseudomonas sp.						
	Pseudomonas vesicularis						
	Salmonella spp.						
	Sphingomonas paucimobilis						
	Sphingomonas multivorum						
	Acinetobacter baumannii						
	Acinetobacter lwoffii						
	Agrobacterium radiobacter						
	Enterobacter cloacae						
	Escherichia coli						
	Flavobacterium meningosepticum						
	Leclercia adecarboxylata						
	Citrobacter youngae						
Gram (+) cocci	*Enterococcus faecalis*	3292,10	5050,47	3525,80	6824,45	3058,40	3268,27
	Micrococcus spp.						
	Staphylococcus spp.						
Gram (+) rods	*Brevibacterium otitidis*	85,4	214,75	25,4	52,94	145,4	290,19
	Brevibacterium spp.						
	Corynebacterium spp.						
Gram (+) bacilli	*Bacillus spp.*	13,75	33,71	22,00	45,23	5,50	9,86
Mesophylic actinomycetes	*Streptomyces albus*	6,15	9,02	6,80	7,86	5,50	10,95
	Streptomyces spp.						
Thermophylic actinomycetes	*Thermoactinomyces thalpophilus*	3,00	6,75	0,00	0,00	6,00	8,94

A – hall center, B – vent air outlet