ANNALES
UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA
LUBLIN – POLONIA
VOL. XXVII (1) SECTIO EE 2009

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Microbial contamination of laying hen litter in relation to bird age

Bakteriologiczne zanieczyszczenie pomiotu kur niosek w zależności od ich wieku

Summary. An increasing amount of wastes associated with poultry raising in highly intensive farming environment has been the growing cause of concern. Huge, modern poultry farms face grave problems concerning the disposal of poultry litter, noxious odour emission, pollution of water, soil and air. The objective of the present research was to determine the effect of layer hens` age on quantitative and qualitative contamination of litter. The experimental material was constituted by the litter samples collected from three hen facilities (three age groups) in the farm of laying hens of Hy-line. The microbial analysis included: meso- and psychrophylic bacteria, bacteria from coli group, thermotolerant, proteolytic, etc. In the indoor sampling sites, there were also measured chosen microclimatic factors. The microbiological evaluation revealed the highest microbial contamination of litter, analyzing three age groups of laying hens, in the hen building K3 (birds aged 54 weeks), followed by K2 hen house (30-week-old birds) and the lowest in the K1 (6 weeks of age).

Key words: laying hen, litter microbial contamination, poultry farm

INTRODUCTION

Intensive animal production with high stocking density creates significant adverse impact on, among others, natural environment. The land neighbouring to farms is frequently polluted microbiologically [Trawińska *et al*. 2002, 2006]. Transition into the intensive level of poultry industry and further rationalization of production methods was possible due to the implementation of modern management systems of birds. However, poultry production growth has been constrained by some aspects arising from the environmental effects of the management systems applied. The farms with high bird population density produce not only enormous amount of meat and eggs but wastes as well

[Herbut and Krawczyk 2000]. Besides, the poultry industry intensification and preferred concrete floor bedding induced generation of liquid waste – slurry, which proves to be very hazardous owing to the presence of pathogens. The group dominant among the pathogenic bacteria was *Enterobacteriaceae* genus: *Escherichia coli*, *Salmonella* spp., *Shigella* spp., *Klebsiella* spp., *Proteus* spp. Slightly lower numbers were detected of Gram-negative cocci: *Staphylococcus* spp., *Bacillus* spp., anaerobic *Clostridium* spp., fungi of the genus *Aspergillus*, *Penicillium*, *Trichoderma*, *Geotrichum* as well as anascogenic *Candida* or *Cryptococcus* [Latała *et al*. 1999, Roy *et al*. 2002]. Microbes were also recovered from the birds themselves, bedding material, feedstuffs supplid and water. Appropriate raising conditions of chicken broilers require the optimal indoor microclimatic conditions and administration of proper feed mixtures [Gornowicz 2004]. Litter proves to be a determinant of bird`s welfare, affects their health, performance as well as the microclimate in birds` facilities. It is agreed that litter quality depends on numerous factors and its management practices are of great weight in poultry industry [Bieda *et al*. 2005, Świerczewska and Siennicka 2004].

The objective of the present research was to assess the influence of laying hens` age on the quantitative and qualitative microbial pollution of litter.

MATERIAL AND METHODS

The material for study included litter samples collected from three hen houses in the farm of layer hens Hy-line. The birds were caged in the facilities of 100/12,5 m size. The samples were taken from 6-week-old hens in hen building (K1), 30-week-old birds in K2 and 54-week-old ones from K3, sampling site close to the first cage in the ¼ and ½ building length (PI, PII, PIII). The samples were delivered for laboratory examinations, i.e. quantitative and qualitative microbiological analyses which included meso- and psychrophilic bacteria, bacteria from coli group, thermotolerant, proteolytic and others. In the indoor sampling sites, there were performed measurements of chosen microclimatic factors. Besides, air temperature and relative humidity as well as litter moisture in the hen facilities were evaluated. Sample collection, transportation and analysis were performedin compliance with the obligatory norms [PN-ISO-9308-1, PN-Z-19000-1].

RESULTS AND DISCUSSION

Both, liquid and solid wastes from birds in the hen facilities constitute the greatest hygienic and sanitary load. Total bacteria counts in animal wastes vary and in the case of hens, it averages 2.29 million cfu in 1g of fresh mass [Kluczek 1999]. Regarding all the intensive management systems of animals, the greatest bacteria numbers were determined in the poultry houses, irrespective of the management practices [Whyte 1993].

Analyzing the findings of the microbiological evaluation performed in the laying hen farm in three age groups (Tab. 1), the highest count of mesophilic bacteria was recorded in the most age advanced hens – 54-week-old ones in the K3 hen house, the sample PII (1.20×10^8). Then the samples PIII (1.15×10^8) and in PI (1.05×10^8) in the same hen building. A lower number of the bacteria was detected in the facility K2 which housed the 30-week-old birds, whereas the lowest in KI where 6-week-old hens were caged. Evaluation of psychrophilic bacteria occurrence in the litter, the greatest amount was also reported in K3 in the litter from 54-week-old birds in the samples PII, PIII, PI (3.70×10^8, 3.02×10^8, 2.3×10^8, respectively) followed the hen house K2 and K1. The highest count of the coli group bacteria was also observed in the oldest birds (K3) in the samples PII, PIII, PI (1.80×10^6, 1.40×10^6, 1.50×10^5), while in the hen facility K2 in the sample PIII (1.50×10^5) and PII (1.20×10^5), whereas in the youngest birds – no presence of the bacteria was reported. Alike, thermotolerant coli bacteria was most abundant in the hen house K3 in the sample PII (1.10×10^5), then in PIII (6.20×10^4) and PI (4.20×10^4). These bacteria were not detected in the 6-week-old birds either. The highest numbers of proteolytic bacteria were also noted in the litter from 54-week-old hens in the samples PI (4.22×10^4), PII (3.80×10^4) and PIII (2.90×10^4), less in the wastes from 30-week-old ones and the least – 6-week-old birds, except for the samples PIII. In this litter, proteolytic bacteria count appeared to be higher in the manure produced in the hen facility K1 (1.80×10^4) than in K2 (1.40×10^4). Besides, in all the litter samples collected from the 6-week-old hens, *Enterobacter aerogenes* bacteria were detected, while *Escherichia coli* from the other birds.

Summing up, it was found that the highest count of all the analyzed bacteria was detected in the litter obtained from the oldest hens – aged 54 weeks. Similar research results were reported by other authors [Kluczek and Szejniuk 1999] who indicated that the highest number of microbes in litter occurs in the late raising period of birds, in that laying hens. The authors state that bacteria detected in the last raising week might pose a threat for birds` health. The microbes presence was caused by accumulation of great quantity of litter and its moisture rate increase. There was also detected growth of air ammonia concentration in the poultry facilities as the birds aged [Whyte 1993]. In the cage management system of birds, a lower concentration of some air pollutants was observed as compared to deep litter system. Similar findings were reported about fungi and bacteria [Madelin and Mathes 1989]

Microclimate in the hen facilities depends on macroclimate, bird stocking management practices and thermal characteristics of a building (heating system and ventilation). Besides, indoor microclimate is affected by the physical, chemical, mechanical and biological factors [Mazanowski 2008, Wójcik 2008]. The recommended optimal air temperature for adult hens should average 18–20°C, for layer hens 14–21°C, while optimal relative air humidity – 65–75%. Analyzing the results of temperature and air relative humidity measurements (Tab. 2), it was found that the highest means were recorded for the hen house K3, lower in K2 and the lowest values for K1. However, except for the K3 hen facility where the samples PII and PI were collected, in the other sampling sites air relative humidity values appeared to be lower than the optimal ones. The highest indoor median air temperature was noted in the hen building K3 followed by K2 and K1; all of them were lower compared to the optimal ones. The highest litter mean moisture was recorded in the hen house K3 (8.28%), K2 (17.32%) and K1 (17.01%). It should be emphasized that moist litter makes a perfect medium for the pathogen growth that in turn, implicates serious economic losses in the poultry production [Świerczewska and Siennicka 2004].

Table 1.Quantitative and qualitative bacteriological analysis of litter samples
Tabela 1. Ilościowa i jakościowa analiza bakteriologiczna próbek pomiotu

Specification Wyszczególnienie	K1			K2			K3		
	PI	PII	PIII	PI	PII	PIII	PI	PII	PIII
Mesophillic bacteria Bakterie mezofilne	1.70×10^7	1.90×10^7	2.10×10^7	1.85×10^7	2.10×10^7	2.30×10^7	1.05×10^8	1.20×10^8	1.15×0^8
Psychrophilic bacteria Bakterie psychrofilne	3.40×10^7	2.90×10^7	4.40×10^7	3.70×10^7	4.60×10^7	6.03×10^7	2.30×10^8	3.70×10^8	3.02×10^8
Bacteria from coli group Bakterie z grupy coli	0	0	0	0	1.20×10^5	1.50×10^5	1.50×10^5	1.80×10^6	1.40×10^6
Coli thermotolerant Coli termotolerancyjne	0	0	0	0	8.90×10^3	1.80×10^4	4.20×10^4	1.10×10^5	6.20×10^4
Proteolytic bacteria Bakterie proteolityczne	1.1010^4	2.80×10^2	1.80×10^4	2.80×10^4	1.30×10^4	1.40×10^4	4.22×10^4	3.80×10^4	2.90×10^4
Other bacteria Inne bakterie	*Enterobacter aerogenes*	*Enterobacter aerogenes*	*Enterobacter aerogenes*	0	*Escherichia coli*	*Escherichia coli*	*Escherichia coli*	*Escherichia coli*	*Escherichia coli*

K1 – birds aged 6 weeks – kury 6-tygodniowe
K2 – birds aged 30 weeks – kury 30-tygodniowe
K3 – birds aged 54 weeks – kury 54-tygodniowe
PI – litter collected in the immediate vicinity of hen house entrance – pomiot pobrany bezpośrednio przy wejściu do kurników
PII – litter collected in ¼ length of hen house – pomiot pobrany w ¼ długości kurników
PIII – litter collected in ½ length of hen house – pomiot pobrany w ½ długości kurników

Table 2. Some microclimatic parameters inside hen house
Tabela 2. Wybrane parametry mikroklimatyczne wewnątrz kurników

Specification Wyszczególnienie	K1				K2				K3			
	PI	PII	PIII	średnia mean	PI	PII	PIII	średnia mean	PI	PII	PIII	średnia mean
Wilgotność względna powietrza (%) Air relative humidity	56.50	56.00	58.00	56.83	46.50	55.50	62.50	54.83	57.00	68.50	68.00	64.50
Temperatura powietrza (^{o}C) Air temperature	9.40	9.60	9.95	9.65	10.35	10.20	10.95	10.50	9.75	11.85	12.50	11.37
Wilgotność pomiotu (%) Litter moisture	16.96	14.93	19.16	17.01	20.54	15.75	15.68	17.32	20.03	18.37	16.46	18.28

Symbols like in Tab. 1 – Symbole jak w tab. 1

Poultry production performance is dependent on numerous factors, like genetic advances, health state, nutrition or zoohygienic conditions that also determine good body condition of birds. Besides, the status of bird health and performance are affected by low quality of litter, which may be a reservoir for a number of pathogenic bacteria [Lipiński and Mituniewicz 2008]. Therefore, the modern technologies for poultry production aim is to improve the zoohygienic conditions so that bird infection rate, and human in turn, could be minimized [Tomczyk 2006].

CONCLUSIONS

1. The highest microbiological contamination of litter from three analyzed age groups of layer hens was found in the hen facility K3 housing 54-week-old birds followed by K2 and K1.
2. The results obtained from the bacteriological evaluation (both, quantitative and qualitative) were also affected by air temperature and air relative humidity, whose highest values were reported in the hen building K3.

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Streszczenie. Stale wzrastająca masa odchodów towarzysząca rozwojowi fermowej produkcji drobiarskiej coraz bardziej zagraża otoczeniu. Duże, nowoczesne fermy drobiu mają ogromne problemy z pozbywaniem się tak dużej ilości pomiotu, jego dokuczliwym odorem, skażeniem wody, gleby i powietrza. Celem podjętych badań było określenie wpływu wieku kur niosek na ilościowe i jakościowe bakteriologiczne zanieczyszczenie pomiotu. Materiał do badań stanowiły próbki pomiotu pobrane z trzech kurników (od trzech grup wiekowych) w fermie kur nieśnych linii „Hy-line". Analiza bakteriologiczna obejmowała: bakterie mezo- i psychrofilne, bakterie z grupy coli, termotolerancyjne, proteolityczne i in. W miejscach poboru próbek dokonano również pomiarów wybranych czynników mikroklimatycznych. Stwierdzono, że największe zanieczyszczenie mikrobiologiczne pomiotu występowało w kurniku K3 u ptaków 54-tygodniowych, niższe w kurniku K2 u kur 30-tygodniowych, a najniższe w K1 – u 6-tygodniowych.

Słowa kluczowe: kury nioski, zanieczyszczenie bakteriologiczne pomiotu, ferma drobiu