Effect of stocking density on litter microbial load in broiler chickens

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ABSTRACT

The purpose of this study was to evaluate the microbial load of the litter in broiler houses with different stocking densities. From the 35 to 42 days, forty poultry houses with wood shavings litter were selected at random and litter drag swap samples were collected. The houses were allocated into two groups according to the stocking density. Group I involved 10-13 birds/m^2 and group II involved 14-17 birds/m^2. Mortality figures were recorded for group comparisons. Twenty litter samples from each house were collected throughout the house. Samples were transported in cold chain to the laboratory for analysis. Following the incubations, standard plate counting techniques was used for aerobic, anaerobic, coliform, clostridium, salmonella and mold and yeast counts. Comparative results for Group I and II were $4.5x10^8$ and $4.9x10^8$ for PCA, $1.5x10^4$ and $1.2x10^4$ for E. coli, $3.1x10^6$ and $2.4x10^6$ for Coliform, $3.1x10^6$ and $3.2x10^6$ for Clostridium, $0.9x10^5$ and $1.3x10^5$ for Mold and Yeast, $7.5x10^5$ and $7.1x10^5$ Staphylococci and $3.1\ x10^4$ and $3.3\ x10^4$ for Salmonella. Results show that the stocking density had no significant effect on microbial count in any of the litter samples and it can be concluded that stocking density changing from 10 to 17 birds/m^2 did not affect microbial loads of the broiler litters.

Keywords: Broiler, microbial load, stocking density

INTRODUCTION

The modern broiler house enables producers to have great control over the house environment. Birds can be placed at higher densities as long as the correct environment (temperature, ventilation, humidity) is provided. Factors to consider when determining stocking density include but are not limited to bird size, feeder space, drinker space, house dimensions, bird welfare, nutrition, breed, performance and economic return. The ultimate goal is to maximize meat

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yield of chicken while preventing production losses due to overcrowding. In many cases, producers have to settle for slightly reduced performance to achieve a satisfactory economic return. Another concern with increased stocking density is broiler welfare. Animal activist groups request that broilers be given more space during grow-out and cite behavioral and physiological stress as the reason (Fairchild, B.D., 2005). Increasing stocking density of broilers is a management practice used for reducing costs associated with labor, housing, fuel and equipments. However, crowding of broilers can lead to reductions in performance (Shanawany, 1988). Maintaining a high stocking density is a common practice for the poultry industry because it allows for an increase in economic returns per unit of floor space. However, income per bird often decreases primarily due to reduction in growth rate, increased proportion of downgraded carcasses, and greater risk of health-related problems (Estevez, 1999).

Broilers do not perform to their genetic potential in a poor environment. The quality of the in-house environment is highly dependent upon litter quality. The litter environment is ideal for bacterial proliferation and ammonia production. The two factors that influence litter conditions most are manure and moisture. The manure portion is largely out of a grower's control; however, growers can and must control litter moisture (Ritz *et al*, 2005). The presence of bacteria in poultry litter may contribute to contaminated processed carcasses by increasing the bacterial load of skin and feathers or by providing a source for upper gastrointestinal contamination during preharvest feed withdrawal (Bennett *et al.*, 2003).

One of the most important consequences of increasing density is the environmental change that occurs within the chicken house. An increase in density usually results in corresponding increases in temperature, humidity, CO_2, and ammonia levels. High ammonia levels (over 25 to 50 ppm) reduce growth and increase the incidence of air sac inflammation. High humidity and moist litter increase the incidence of breast blisters, hock burns, and foot pad dermatitis (among other effects). However, the magnitude of the effect of density depends on technical factors (e.g., quality of ventilation and cooling systems) as well as management factors (e.g., litter condition and light programs). This means that increasing the number of birds in a well-prepared house can cause fewer negative effects than an increase in a similar increment in an out-of-date building with poor technical conditions (Estevez, 1999).

The objective of this study was to investigate the effect of stocking density on the microbial load of the broiler litter. Thus, understanding the relationship between stocking density and microbial load will lead more effective litter management practices that can reduce the negative impacts of litter on poultry production.

MATERIAL AND METHODS

At the 35 to 45 days of growing period, forty poultry houses with litter of wood shavings on were selected at random and litter drag swap samples were collected on the basis of availability for sampling in Bolu province which is known with high amount of poultry production. For purpose of analysis, the houses were grouped according to the density of chicks per square meter housed in them. Group I involved 10-13 chicks/m^2 and group II involved 14-17 chicks/m^2 (Table 1).

Table 1 Stocking densities and mean capacities and for 40 poultry houses

	Stocking density (bird/m2)			Capacity of the broiler houses		
	x±Sx	Min	Max	x±Sx	Min	Max
Group I	11.05±0.3	10	13	4755±34.7	2600	10000
Group II	14.80±0.2	14	17	10310±70.1	7000	22000

Twenty samples of litter were collected at random sites throughout each house. Samples were taken throughout the house by moving in a zigzag pattern of a "w." That is, the first sample was taken approximately 30 cm from the walls of the house at one end; subsequent samples were taken at intervals across the house in a diagonal pattern until approximately 1 m from the entrance. At this point, the direction was changed, and the pattern continued until the length and width of the house had been sampled. Sterile drag swabs moistened with nutrient broth (1.05443 Merck-NB) were used for surface sampling of litter. The 20 swabs were pooled in one sterile flask containing 100 ml of sterile 1% nutrient broth as representing sample from one house. Samples were transported in cold chain to the laboratory for analysis. The flasks were shaken and then 10 fold serial dilutions were made on samples for six times. Each dilution were streaked on plate count agar-PCA (1.05463 Merck) for total aerobe bacteria count, TBX agar (CM-945) for E. coli, Violet Red Bile agar-VRBA (Lab 31) for Coliform, Tryptose-Sulfite Cycloserin Egg Yolk agar-TSC (CM 587 oxoid) for Clostridium perfringens, Sabourand Dextrose agar-SDA (1.05438-Merck) for yeast and mold and Baird Parker agar-BP for Staphylococci and incubated. Suspected colonies were inoculated in triple sugar iron agar for confirmation. Following the incubations, standard plate counting techniques was used for aerobic, anaerobic, coliform, clostridium, salmonella and mold and yeast counts. Mortality figures were recorded and evaluated as total numbers at the end of the study.

Statistical analyses were done using SPSS-10 package program designed for windows. All numerical data regarding litter microbial populations were analyzed using Student t-test. Mortality was analyzed by Chi-square test to identify significant ($P < 0.05$) differences.

RESULTS AND DISCUSSION

Mortality figures are shown in Table 2. Significant difference was seen between groups in terms of mortality (P< 0.05). Birds reared under low stocking density exhibited more mortality (9.1%) than that of reared under high stocking density (6.3%).

Table 2 Mortality figures of different stocking densities for broiler chickens

	Group I (10-13 birds/m^2)	Group II (14-17 birds/m^2)	x^2	P
Number of dead birds	8652	13003	760.4	0.00
Total number of birds	95100	206200		
Mortality percentage (%)	9.1	6.3		

P< 0.05, P= Chi-square test

Bilgili and Hess (1995) conducted a study examining densities of 0.8, 0.9 or 1.0 square foot per bird. They observed that mortality was significantly improved (3.6%, 2.1% and 2.0% respectively) when birds were given more space. However, in another study, Feddes *et al.* (2002) demonstrated that stocking density had no effect on mortality. In our study, mortality was lower in high stocking density group (14-17 birds/m^2). Considering the differences of the numbers of the birds and collection of the data from different houses, it seems that many other factors might affect on mortality. Therefore the results could change under a more controlled environment.

In the current study, no significant difference was determined between the groups in terms of litter microbial populations (Table 3). Comparative results for Group I and II were respectively $4.5x10^8$ and $4.9x10^8$ for PCA, $1.5x10^4$ and $1.2x10^4$. for E. coli., $3.1x10^6$ and $2.4x10^6$ for Coliform, $3.1x10^6$ and $3.2x10^6$ for Clostridium, $0.9x10^5$ and $1.3x10^5$ for Mold and Yeast, $7.5x10^5$ and $7.1x10^5$ Staphylococci and 3.1 $x10^4$ and 3.3 $x10^4$ for Salmonella.

Table 3 Microbial contamination of the litter between the groups

	Group I (10-13 chicks/m^2), n=20		Group II (14-17 chicks/m^2), n=20		P
	x	Sx	x	Sx	
Coliform (10^6)	3.1	0.70	2.4	1.64	0.51
Salmonella (10^4)	3.1	0.57	3.3	0.63	1.00
Mold and Yeast ($10^{5)}$	0.9	0.16	1.3	0.35	0.41
Staphylococci (10^5)	7.5	1.27	7.1	1.66	0.85
Clostridium (10^6)	3.1	1.01	3.2	0.89	0.95
PCA (10^8)	4.5	0.71	4.9	0.63	0.71
E. coli (10^4)	1.5	0.35	1.2	0.32	0.51

P< 0.05, P= Student t-test

Thaxton *et al* (2003) reported that the number of flocks housed on the same litter did not significantly alter the microbial population of the litter and the

microbial population of the litter did not increase as the number of birds increased. Likewise, several researchers found no significant change in broiler performance due to stocking density (Beremski, 1987; Mizubuti *et al*.,1994; Parkhurst *et al*., 1977). Coenen et al. (1996) examined the influence of a reduced stocking density on body weight, feed and water intake as well as the dry matter and nitrogen-content (N) of bedding in 3 fattening periods (2 x conventional closed stable, each 36 days, 1 x Louisiana stable, 40 days). In the controls, where stocking density was 38 kg/m^2, the broilers achieved a mean slaughter weight of 1497, 1411 and 1681 g, while in the treatments where the stocking density was 33 kg/m^2, the figures were 1555, 1431 and 1793 g. Feed conversion ratios were better and the mortality during the fattening periods were lower in groups with reduced stocking density than in the controls. They found no remarkable improvement of litter quality during the fattening periods in dependence on reduced stocking density which is in agreement with our findings.

In another experiment, a total of 4,780 broilers were reared at high stocking densities in two consecutive experiments (Shanawany, 1988). In experiment 1, the birds were housed at 10, 20, 30, 40 or 50 birds/m^2 till 6 weeks. In experiment 2 densities of 20, 40 and 50/m^2 were compared; the two higher densities were reduced to 30/m^2 at either 3 or 5 weeks of age. Average food intake over the whole experimental period declined linearly with densities above 20/m^2. A slight but significant improvement in the efficiency of food utilization was recorded from birds at high densities in the first experiment only. Reducing the stocking density from 40 or 50 birds/m^2 to 30 birds/m^2 at 3 weeks increased food consumption and body weight gain and led to a recovery in their body weight by 6 weeks. No significant differences were observed in mortality as a result of high stocking densities in either experiment. This is also in agreement with the results we found. Considering this study, it could be claimed that stocking density at the interval of 10-50 birds/m^2 didn't have any direct effect on mortality.

Kingston, (1981) compared the use of a culture of a 5-g litter sample and the use of drag swab to detect Salmonellae infections in broiler and parent breeding flocks. He detected contamination of 7 of 13 sheds with drag swabs and 5 by litter culture in broiler flocks. In a repeated experiment in broiler sheds, 3 sheds were detected as positive by the culture of litter while 9 were detected by drag-swab culture. All sheds found positive by drag-swab culture of cacae during the life of the broilers. It was concluded that drag-swab culture was a reliable and cheap method of monitoring large numbers of chicken flocks for infections with Salmonella. In our experiment we also used drag-swab for sampling as well and obtained clear results.

Thaxton *et al.* (2003) conducted a study to investigate the relationship of microbiological populations to the number of flocks previously housed on the litter. They determined the total numbers of aerobic and anaerobic bacteria,

coliforms, *Staphylococci*, mold, and yeasts. As a result of the study they found no correlation of flock numbers to any of the litter microbial populations.

Results showed that the stocking density had no significant effect on microbial count in any of the litter samples and it can be concluded that stocking density changing from 10 to 17 birds/m^2 did not affect microbial loads of the broiler litters.

CONCLUSIONS

Consequently, the stocking density had no significant effect on microbial count in any of the litter samples of this study and it can be concluded that stocking density changing from 10 to 17 birds/m^2 did not affect microbial loads of the broiler litters.

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