Pertanika 13(2), 171-175 (1990)

Effect of Increasing Stocking Density on Performance and Heterophil/Lymphocyte Ratios in Broilers

K.K. KUAN, S. ADNAN and H. RAMLAH

Department of Animal Sciences
Faculty of Veterinary Medicine and Animal Science
Universiti Pertanian Malaysia
43400 UPM Serdang, Selangor Darul Ehsan Malaysia

Key words: broilers, stocking density, tropics, performance, heterophil/lymphocyte ratio.

ABSTRAK

Satu eksperimen telah dilakukan ke atas ayam pedaging jenis Orgal untuk mengkaji kesan ruangan 0.095, 0.071, 0.057 dan 0.048 m²/ayam ke atas berat hidup, pengambilan makanan dan penukaran makanan dari umur 4 minggu hingga 10 minggu. Nisbah heterofil/limfosit (H/L) juga dikaji sebagai ukuran tegasan bagi menentukan sama ada tegasan berhubung dengan kesesakan dapat memberi kesan ke atas nisbah ini. Pada minggu pertama dan kedua eksperimen, peningkatan ketumpatan stok mengurangkan pengambilan makanan tetapi sebaliknya meningkatkan penukaran makanan dengan tiada perubahan yang bererti pada kadar pertumbuhan. Keseluruhannya, ayam yang diberi ruangan yang paling luas (0.095 m²/ayam) mempunyai kadar pertumbuhan yang paling tinggi (39.2 g/hari), tetapi ini dicapai dengan pengambilan makanan yang tertinggi (127.9 g/hari) dan seterusnya penukaran makanan terendah (3.3). Sebaliknya, ayam yang dibela di dalam ruangan ketumpatan stok tertinggi (0.048 m²/ayam) menunjukkan kadar pertumbuhan (32.2 g/hari) dan pengambilan makanan (90.6 g/hari) terendah sekali. Ayam yang dibela di dalam dua ruang ketumpatan tertinggi didapati sentiasa dalam keadaan tegasan, sebagaimana ternyata oleh perubahan nisbah H/L yang bererti, dari minggu ke empat seterusnya; kedua-dua perlakuan ini juga mempunyai kadar kematian yang tinggi. Hasil kajian menunjukkan bahawa tegasan ekoran kesesakan ruangan mengurangkan prestasi ayam pedaging. Pembahagian ruang seluas 0.071 m²/ayam adalah mencukupi untuk pemeliharaan ayam pedaging dalam sangkar di negara ini.

ABSTRACT

An experiment on space allowance of 0.095, 0.071, 0.057 and 0.048 m²/bird on wire mesh cages was conducted to study their effects on live-weight, feed intake and feed conversion of Orgal broilers from the age of 4 to 10 weeks. Heterophil/lymphocyte (H/L) ratio, an indicator of stress, was also studied to determine whether over-crowding would effect this ratio. During the first 2 weeks of the experiment, increasing stocking density reduced feed intake and improved feed conversion without significantly affecting growth rate. Overall, birds on the most liberal floor space allowance (0.095 m²/bird) had the best growth rate (39.2 g/day) but this was achieved at a significantly higher feed intake (127.9 g/day) and poorer feed conversion (3.3). Conversely, birds on the highest stocking density (0.048 m²/bird) had the poorest performance in terms of growth rate (32.2 g/day) and feed intake (90.6 g/day). Birds on the two higher stocking densities were constantly under stress, as indicated by their relatively high H/L ratios from the fourth week of the study onwards; these two treatments also had higher mortalities. The results of the present study showed that stress associated with overcrowding reduced performance in broilers. A space allowance of 0.071 m²/bird is sufficient under our local conditions for broilers reared in raised floor cages.

INTRODUCTION

The Malaysian broiler industry is undergoing rapid expansion. Concurrent with this development is a noticeable shift from rearing under deep litter system to rearing on raised floor (Engku Azahan, 1983). With increasing cost in the construction of poultry houses and also the general increases in other production costs, there is a tendency amongst farmers to increase stocking density.

Under temperate environmental conditions it is recommended that broilers reared on raised floor or in cages be allotted between 0.074 to 0.078 m^2 of floor space per bird (Bolton *et al*, 1972; Proudfoot, *et al.* 1979). There is a lack of documented information concerning floor space allowance for optimum bird performance under local environmental conditions. However, in the hot humid tropics, it is thought that space provision should be more liberal than that recommended under temperate climates. A floor space of about 0.12 m^2/bird is usually practised by commercial broiler farms in Malaysia.

The objective of the present study was to document the effects of increasing stocking density on broilers in raised floor wire mesh cages. Concurrent with the performance traits, blood cell changes in terms of heterophil/lymphocyte (H/L) ratios were also studied. This latter part of the study was to determine whether a high stocking density would induce stress in the birds by influencing the H/L ratio. Changes in neutrophil (heterophil)/lymphocyte ratio have been used as indicators of stress response in domestic animals (Wolford and Ringer 1962: Schalam *et al.* 1975; Gross and Siegel 1985).

MATERIALS AND METHODS

Husbandry

The broiler sheds used were open-sided with glavanized zinc roof insulated with wooden planks on the under side. The wire-mesh cages were 0.7 m above concrete floors. Each cage measured 120 cm long, 95 cm wide and 50 cm high. Feed and water troughs were suspended outside the cages.

Broiler Stock and Experimental Design

A total of two hundred and sixteen three-week-old broilers of a commercial genotype *(Orgal)* were used in the experiment. The birds were initially reared on deep litter. They were vaccinated against Ranikhet disease at the ages of one day and three weeks. After the second vaccination the birds were transferred from the deep litter pens to the experimental cages. One week was allowed for the birds to get over the stress due to handling and transportation.

The average weight of the birds at the start of the experiment was 442.2 g (± 34.5). The four stocking densities tested were 0.095, 0.071, 0.057 and 0.048 m^2/bird (12, 16, 20 and 24 birds per cage) with the feeder space of 10.2, 7.6, 6.1 and 5.1 cm/bird respectively. Each stocking density treatment was triplicated with cage location picked at random. Equal number of male and female birds were allotted to each cage.

The duration of the experiment was six weeks. Birds from each cage were mass weighed at weekly intervals. Weekly feed consumption was recorded and feed conversion calculated.

Performance traits measured were body weight gain, feed intake, feed conversion and mortality rate.

Diet and Feeding

A commercial pelleted finisher diet (crude protein, 18.5%, metabolizable energy, 3000 kcal/kg) was fed throughout the experimental period. Feed and water were supplied *ad libitum.*

Heterophil/lymphocyte (H/L) Ratios

Blood samples were collected weekly from six birds per treatment (two per replicate). Selection of the birds were made at random. Blood was obtained by pricking the brachial vein with a 33-gauge needle and collected into tubes containing EDTA.

Differential white blood cell counts were performed on blood smears stained with May-Grunwald-Giemsa stain (Lucas and Jamroz 1961) and the H/L ratios were calculated by dividing the number of heterophils by the number of lymphocytes.

Statistical Analysis

Treatment effects were assessed by analysis of variance and comparisons were made between treatment means using least significant difference (LSD) test (Steel and Torrie 1960). Differences in performance between sexes were not analysed since the number of birds used was small and the birds were weighed in groups. Statements of statistical significance were based on $p < 0.05$.

RESULTS

Performance data at the end of the second, fourth and sixth week of the experiment are presented in Table 1. From the second week of the experiment onwards, there was a steady decline in the average daily gain (ADG) with an increase in stocking density. There was also a significant drop in average daily feed intake with an increase in stocking density; during the entire experimental period, birds on the lowest stocking density (0.095 m^2/bird) consistently consumed the most amount of feed. Spillage of feed was minimal. Feed conversions by birds on the three higher stocking densities at the end of the second week of the experiment were significantly better than that of the birds on the lowest stocking density. This superiority in feed conversion was however, reduced at the end of the fourth week. By the end of the sixth week of the experiment, birds on the two lower density treatments had significantly better feed conversion than those on the two higher density treatments.

The summarised weekly performance results of the six-week experiment are presented in Table 2. When the space allowance was 0.095 m^2/bird, the mean ADG and final live-weight were better than, but not significantly different from, the corresponding values from the treatment with 0.071 m^2/bird. However, feed consumption was significantly higher and consequently feed conversion significantly poorer in the birds on the lower density treatment when compared to that of birds on the higher density treatment. Percent mortalities between these two treatment groups were identical. The performance of birds kept on 0.057 m^2/bird floor space was poorer than, but not significantly different from that of birds on the 0.071 m^2/bird treatment. The poorest performance in terms of mean ADG and final live-weight and percent mortality was observed with birds housed on 0.048 m^2/bird floor space.

TABLE 1
Effect of space allowance on live-weight gain, feed intake and feed conversion at the 2nd, 4th and 6th week of the experiment

	Space allowance (m^2/bird)			
	0.095	0.071	0.057	0.048
2nd week of experiment				
Average daily gain (g)	44.6±1.16^a	40.8±2.60^b	40.7±1.50^b	40.7±0.52^b
Average daily feed (g)	127.0±0.81^a	91.1±0.12^b	83.8±1.27^b	75.8±0.81^c
Feed conversaion	2.9±0.06^a	2.3±0.17^b	2.1±0.06^{bc}	1.9±0.01^c
4th week of experiment				
Average daily gain (g)	42.6±1.45^a	40.6±2.60^a	34.5±1.85^b	33.2±2.43^b
Average daily feed (g)	146±1.97^a	117.2±4.05^b	112.8±0.06^b	104.5±2.54^c
Feed conversion	3.5±0.12^a	2.8±0.12^b	3.3±0.17^{ac}	3.2±0.23^c
6th week of experiment				
Average daily gain (g)	32.6±1.91^a	27.7±1.10^b	26.6±2.02^b	24.2±2.37^b
Average daily feed (g)	142.1±0.64^a	118.6±7.63^b	125.1±4.16^b	118.2±4.39^b
Feed conversation	4.4±0.23^a	4.3±0.12^a	4.8±0.35^b	4.9±0.64^b

Within rows, treatment means (+SE) not followed by same superscript differ significantly ($P < 0.05$)

TABLE 2
Summary of performance results based on space allowance

	Space allowance (m^2/bird)			
	0.095	0.071	0.057	0.048
Average daily gain (g)	39.2±0.69[a]	36.5±0.35[ab]	35.0±0.06[bc]	32.2±1.16[c]
Average daily feed (g)	127.9±1.2[a]	102.5±0.75[b]	100.9±0.69[b]	90.6±0.46[c]
Feed conversion	3.3±0.06[a]	2.8±0.06[b]	2.9±0.06[b]	2.8±0.12[b]
Mean final liveweight (kg)	2.12±0.06[a]	2.00±0.02[ab]	1.91±0.12[b]	1.79±0.04[c]
Mortality (%)	8.33	8.33	11.67	13.80

Within rows, treatment means (±SE) not followed by same superscript differ significantly ($P < 0.05$)

TABLE 3
Effect of reduction in floor space on heterophil/lymphocyte ratios (mean ±S.D)

	Space allowance (m^2/bird)			
Week of experiment	0.095	0.071	0.057	0.048
1	0.65±0.02	0.63±0.03	0.64±0.02	0.66±0.03
2	0.67±0.03	0.61±0.04	0.64±0.06	0.72±0.04
3	0.71±0.05	0.63±0.03	0.66±0.09	0.71±0/06
4	0.61±0.03[a]	0.62±0.03[a]	1.17±0.15[b]	1.13±0.11[b]
5	0.64±0.02[a]	0.65±0.02[a]	1.02±0.06[b]	1.04±0.03[b]
6	0.64±0.03[a]	0.69±0.04[a]	1.06±0.02[b]	1.03±0.04[b]

Within rows, treatment (±SD) not followed by same superscript differ significantly ($P < 0.05$).

Results of the H/L ratios on a weekly basis are presented in Table 3. During the first three weeks of the experiment, there was no significant difference in the H/L ratios between treatments. From the fourth week onwards, the H/L ratios of birds on the two higher density treatments were significantly greater than those of birds on the two lower density treatments.

DISCUSSION

Mortality recorded in this experiment was high for all treatments. This was attributed partly to a mild outbreak of leucocytozoonosis at the third week of the experiment. The disease affected birds on all four treatments. Diamenton sodium in water was used for treatment. Mortality which could be directly attributed to the disease was low; only two of the dead birds had post morten lesions consistent with the disease. However, it is not possible to quantify the overall effect of the infection. Some of the birds that died later in the experiment could have been weakened earlier by the disease. The higher stocking density seemed to stress the birds, thereby reducing their immunity to diseases and producing a higher mortality. This observation agreed with the results of other researchers(Curtis 1983).

The depression in live-weight at the higher stocking densities is consistent with the findings of other workers (Hansen and Becker 1960; Andrews and Goodwin 1969; Bolton *et al.* 1972; Proudfoot *et al.* 1979). In our experiment, the feeder space varied from 5.1 to 10.2 cm/bird. Feeder space was observed to have no influence on live-weight gain in broilers given 2.54, 3.81 or 5.08 cm/bird (McCluskey and Johnson 1958) or when the feeder space was increased from 1.27 to 7.62 cm/bird (Hansen and Becker 1960). The

feeder space in our experiment was more liberal. Therefore, the reduction in the growth rate seemed unlikely to be due to the insufficiency of feeder space.

Although birds on the lowest stocking density (0.095 m^2/bird) had the best growth rate, this was achieved at the expense of consuming significantly more feed and returning significantly poorer feed conversion than birds on the higher stocking densities. With more liberal space allowance, birds are likely to expend more energy on unproductive movements. This was in fact observed in the present study where the birds on the lowest stocking density were more flighty and active. Conversely, birds on higher stocking densities were relatively less active and stayed close to each other; this act probably served to miminize heat loss resulting in a lower caloric demand and hence, reduced appetite. Younger birds when densely packed as observed at the highest stocking density (0.048 m^2/bird) had at the end of the second week of the experiment consumed the least amount of feed but utilized it most efficiently. Feed conversion for all the treatments at the end of the experiment, however, was very poor.

The significantly higher H/L ratios of birds on the higher stocking density treatments (0.057 and 0.048 m^2/bird) from the fourth week of the experiment coincided with the time of a significant drop in the ADG by these groups as compared to the other groups. This shows that stress from overcrowding which might result in a drop in performance can be assessed by examining the H/L ratio.

The results of this study indicate that under the conditions of this study, a space allowance of 0.071 m^2/bird is sufficient for broilers reared on raised floor cages.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the technical assistance given by Zainal Jamin and Hamid Abdul Rahman during the course of this study.

REFERENCES

ANDREWS, L.D. and T.L. GOODWIN. 1969. The Effect of Debeaking, Floor Space and Diet Energy Levels on Broiler Growth. *Poult. Sci.* **48**: 191-196.

BOLTON, W., W.A., DEWAR, R.M. JONES and R. THOMPSON. 1972. Effect of Stocking Density on Performance of Broiler Chicks. *Brit. Poult. Sci.* **13**: 157-162.

CURTIS, S.E. 1983. *Environmental Management in Animal Agriculture.* Ames, Iowa: Iowa State University Press.

ENGKU AZAHAN. 1983. Evaluation of the Deep Litter System of Rearing Broilers. *Proc 7th Ann. Conf. Malaysia Society of Animal Production* p. 283-243. Port Dickson.

GROSS, W.B. and P.B. SIEGEL. 1983. Evaluation of Heterophil/Lymphocyte Ratio as a Measure of Stress in Chickens. *Avian Dis.* **27**:972-979.

GROSS, W.B. and P.B. SIEGEL. 1985. Effect of Initial and Second Periods of Fasting on Heterophil/ Lymphocyte Ratios and Body Weight. *Avian Dis.* **30**:345-346.

HANSEN, R.S. and W.A. BECKER. 1960. Feeding Space, Population Density and Growth of Young Chickens. *Poult. Sci.* **39**:654-661.

LUCAS, A.M. and C. JAMROZ. 1961. Atlas of Avian Heamatology. United States Dept. of Agriculture, Washington, U.S.A.

MCCLUSKEY, W.H. and L.E. JOHNSON. 1958. The Influence of Feeder Space upon Chick Growth. *Poult. Sci.* **37**:889-892.

PROUDFOOT, F.G., H.W. HULAN and D.R. RAMEY. 1979. Effect of Four Stocking Densities on Broiler Carcass Grade, the Incidence of Breast Blisters and Other Performance Traits. *Poult. Sci.* **58**:791-793.

SCHALM, O.W., N.C. JAIN and E.J. CARROL. 1975. *Veterinary Haematology,* 3rd edn. Philadelphia: Lea and Febiger.

STEEL, R.G.D. and J.H. TORRIE. 1960. *Principles and Procedures of Statistics.* 2nd edn., New York: McGraw Hill Book Co. Inc.

WOLFORD, J.H and R.K. RINGER. 1962. Adrenal Weight, Adrenal Ascorbic Acid, Adrenal Cholesterol and Different Leucocyte Counts as Physiological Indicators of Stressors Agents in Laying Hens. *Poult. Sci.* **41**:1521-1529.

(Received 30 August, 1989)