Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(4): 366-369
Received: 04-05-2019
Accepted: 06-06-2019

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Evaluation of adequate stocking density for maximum productivity of broilers raised in summer season

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Abstract
In present investigation, 480 day old chicks of Ven Cobb-400 strain were raised for 6 weeks during summer season on deep litter system representing equal number in both sexes and were divided randomly into four groups. Each group had four replications (N=30/replications) which were housed at stocking densities of 0.50 ft^2/ bird, 0.75 ft^2/ bird, 1.00 ft^2/bird and 1.25 ft^2/ bird, respectively.
Studies revealed that at stocking density of 1.0 sq. ft/ bird, various growth parameters *viz.* body weight (2244.83±97.29 g), weight gain (614.22±99.97 g) and feed conversion ratio (1.88±0.004) were significantly higher (P<0.05). The feed consumption (1295.91±0.30 g/bird/week) were also significantly higher (P<0.01) at above mentioned stocking density. Among the different biochemical and haematological parameters, significant findings (P<0.05) were observed at stocking density of 1.25 sq. ft/ bird for % calcium retention (59.07±3.34%) and serum cholesterol (114.37±3.33 mg/dl). However, the glutahione (mole/g Hb) and lipid peroxidation (mole/g Hb) activity were found to be significant (P<0.05) at 0.75 and 1.0 sq. ft/ bird floor space respectively. At floor space of 1.0 sq. ft/ bird, the lowest mortality and highest benefit cost ratio were observed and thus found to be most adequate for maximum productivity of broilers raised in summer season.

Keywords: Broilers, stocking density, summer, growth parameters and maximum productivity

Introduction
Specialization and intensification of animal husbandry has lead to an efficient production of high quality of animal product (Blokhuis *et al.*, 1998) [2]. Broiler industry throughout the world has registered a spectacular growth and has transformed itself from a mere backyard proposition into an agribusiness states.
Genetic development for rapid growth together with intensive husbandry condition have expedited the growth of broiler and is primarily oriented towards economic gains. However, the animal and welfare concerns have received increased attention because of ethical reasons and new economic insights (Odendaal, 1994) [5]. Concern about the welfare of intensively reared poultry is a topic of current interest. At the same time, stocking density or floor space allowance per bird is under some debate (Thomas *et al.*, 2004) [11]. In broiler production, floor space per chicken is very important welfare factor which directly and indirectly influences and determines the level of growth of chicken (Okezie and Blime, 2005) [6]. It is also related to other welfare indicators such as biochemical blood parameters indicating a condition of stress. A number of studies have examined the effect of stocking density on the performance parameters in broiler chicken (Tirkey *et al.*, 2001) [12]. Therefore, broilers should have the necessary space in order to express their genetic potential and make the best use of feed. However, high stocking densities reduce the fixed costs of production and produce more kilograms of broiler per area. Therefore, up to a critical point, profitability increases with stocking density. Besides this, in a study, seasonal effect was found to be significant on 4th to 6th week of age in commercial broiler strains (Singh *et al.*, 2014) [9]. The significantly higher body weight was observed in cold season as compared to hot season. Therefore, the present investigation has been designed to evaluate adequate stocking density for maximum productivity of broilers raised in summer season.

Materials and Methods
Day old chicks of commercial strain, Ven Cobb-400 were reared in summer (1st May- 11th June) under standard management conditions for 6 weeks on deep litter system under existing agro-climatic condition of Chhattisgarh plains (Durg region). A total of 480 day old chicks representing equal number in both sexes were randomly divided into four groups.

Each group consisting of 120 chicks was divided into four replications and each replication had 30 chicks. Chicks were housed at stocking densities of 0.50 sq. ft/ bird, 0.75 sq. ft/ bird, 1.00 sq. ft/bird and 1.25 sq. ft/ bird. One additional replicate of each stocking density was maintained as extra birds for replacement of dead birds in experimental pens so as to maintain a constant density in the present study.

Before arrival of chicks from hatchery, the experiment house was cleaned and disinfected properly. A total of 600 day old chicks was housed as per the experimental design. The temperature was adjusted to 95^0F at first week and gradually reduced by 5^0F every week up to 6 week of age. Rice hulls with saw dust were used on the floor as litter materials. The compounded feed was given to the chicks in the present investigation. During brooding period feed was spread on flat paper and then chicks were fed in feeding troughs. Chicks were provided measured quantity of feed in the morning daily. The leftover feed of previous day was weighed and subtracted from the total feed offered earlier to estimate the actual feed consumption. Adequate water was given by nipple waterers. Chicks were vaccinated as per the standard schedule. The chicks were weighed immediately after hatching and subsequently at weekly interval for a period of 6 weeks of age. Feed containing 18.83% protein and 3075 Kcal ME/ kg, consumed (g) by chicks was recorded daily by subtracting the refusals daily from total quantities of feed offered to each treatment. Weekly feed consumption was calculated by adding weekly intake with earlier week feed consumption. The gain in body weight was calculated by subtracting the initial weight at the end of every week. Feed conversion ratio was calculated from the recorded observation for proximate analysis by the method as recommended by A.O.A.C. (1995). Statistical analysis was done as per standard method (Snedecor and Cochran, 1994) [10].

Result and Discussion

Growth performance parameters

The significantly (p<0.01) heaviest body weight i.e. 2300.54±104.8 g was recorded at a floor space of 1.0 sq.ft/bird followed by 2244.83±97.27 g, 2170.63±58.91 g and 2168.42±98.37 g respectively at 1.25 sq.ft/bird, 0.75 sq.ft/bird and 0.5 sq.ft/bird at 6th weeks of age (Table-1).

Further analysis postulated that except at 5th week of age, birds reared on 1.0 sq.ft floor space per bird performed highest growth as compared to other stocking densities under different age groups. The lower body weight was observed at 1.25 sq.ft./bird at 6th week than those of birds raised on 1.0 sq.ft./bird stocking density, which might be due to more space available for extra movement of the birds resulting more energy loss. The minimum body weight observed in the birds maintained on the stocking density of 0.5 sq.ft./bird might be due to more temperature produced by over crowding resulting reduced feed intake as one of the reasons for lower growth. These present findings were in agreement with Shanawany (1988) [7] and Weaver *et al*. (1982) [13] where they had observed similar trends on broiler birds. The present findings indicated that broiler birds might be provided 1.0 sq.ft. floor space/bird for proper growth up to 6th week of age in summer season.

The mean values of weekly feed consumption per bird reared under different floor spaces during various periods of growth are presented in the Table-1. The effect of summer on feed consumption was found to be significant (p<0.01) on 2nd, 4th, 5th and at 6th week of age. The feed intake was recorded 1293.52±0.15 g, 1293.28±0.15 g, 1295.91±0.30 g and 1292.24±0.93 g at floor spaces of 0.5 sq.ft/bird, 0.75 sq.ft/bird, 1.0 sq.ft/bird and 1.25 sq.ft/bird respectively at 6th week of growth period. There was no definite pattern of feed consumption with increase in the floor space was observed. However, the feed consumption of birds reared on 0.5 sq.ft/bird was more during some age groups which might be attributed to more competition in taking of feed due to less availability of floor space. This finding was in accordance with Shiva Kumar *et al*. (2004), who found that birds kept under higher stocking densities consumed more feed. The increased feed intake with increased stocking density postulated that density packed birds insulate each other from heat loss and this together with any reduction in the movements of birds will tend to reduce caloric demand and hence appetite.

The mean values of body weight gain are presented in the Table-1. The body weight gain was significantly higher (P<0.05) at stocking density of 1.0 sq.ft/bird i.e. 614.22±99.97 g at 6 weeks of age. However, no definite pattern of body weight gain was observed in birds of other age groups. The reason for increase in growth during the starter period is not fully understood. However, this improvement in growth may be associated with metabolic heat production (Kuenzel and Kuenzel, 1997) [4]. Additional chicks at higher densities probably increases the heat production which in turn increases growth rate. Because chicks did not attain the homeothermic condition until approximately 14 days of age (Whittow, 1986) [14] and poorly insulated during neonatal period, they were capable of using excess heat for growth (Davidson *et al.*, 1980). Furthermore when the fast growing birds grow to their potential in a lower stocking density situation, they may probably dominate the slower growing less aggressive birds at the feeder. Low stocking densities appeared to allow for different growth rates with in the flock and therefore lower flock uniformity. The higher body weight gain of birds at lower floor densities was also a response from increased feed conversion.

The mean value of FCR (Table-1) ranged from 1.88 (1.0 sq.ft/bird) to 1.99 (0.5 sq.ft/bird & 0.75 sq.ft/bird) at 6th week age. There was significant effect (P<0.05) of summer on FCR. The study indicates that feed conversion ratio was improved with increasing stocking density of birds up to 1.0 sq.ft./bird. Shiva Kumar *et al.* (2004) had also observed better feed efficiency at stocking density of 1.0 sq.ft./bird followed by 1.25 sq.ft./bird which showed the similarity with the present findings. However, over spacing leads to a lot of exercise which tends to reduce feed conversion rate, since much of the energy would be used in moving around from place to place.

Table 1: Average growth performance at different age groups of broilers under various stocking densities in summer

Density (ft^2)	Week					
	First	Second	Third	Fourth	Fifth	Sixth
	Average body weight (g)					
0.5	176.12±3.33	421.55±7.5	820.2±18.98	1287.93±31.1	1706.14±55.14	2168.42±98.37
0.75	175.72±2.42	426.73±6.21	813.22±16.99	1275.66±29.46	1682.35±51.25	2170.63±58.91
1.00	178.68±2.83	427.45±8.88	820.23±19.87	1278.73±37.14	1673.68±59.36	2300.54±104.8
1.25	176.42±3.17	420.28±5.98	810.39±15.2	1268.98±35.61	1668.83±51.87	2244.83±97.29
Significance	NS	NS	NS	NS	NS	*
	Feed consumption (g/bird/week)					
0.5	146.52±0.15	309.52±0.15	546.08±3.05	872.52±0.15	1080.51±0.15	1293.52±0.15
0.75	146.28±0.15	309.28±0.15	539.53±3.35	872.28±0.15	1080.28±0.15	1293.28±0.15
1.00	148.91±0.30	311.90±0.30	539.54±4.75	874.90±0.30	1080.91±0.30	1295.91±0.30
1.25	146.05±0.15	309.05±0.15	540.23±5.46	872.05±0.15	1079.17±0.99	1292.24±0.93
Total	146.94±0.32	309.94±0.32	541.34±2.04	872.93±0.32	1080.71±0.42	1293.73±0.41
Significance	NS	**	NS	**	**	**
	Average weekly body weight gain					
0.5	127.50±10.04	234.84±7.43	389.80±8.49	468.27±6.89	433.72±27.17	458.19±75.28
0.75	121.23±6.32	246.28±4.24	378.27±12.75	460.75±20.93	421.04±4.24	479.54±26.68
1.00	134.51±10.47	245.60±2.74	383.07±12.36	448.00±7.79	418.40±22.06	614.22±99.97
1.25	123.82±7.35	240.63±9.57	379.13±14.87	458.02±56.67	411.31±34.90	572.51±63.63
Total	126.76±9.36	241.84±7.55	382.57±11.99	458.76±28.42	421.12±23.71	531.11±92.25
Significance	NS	NS	NS	NS	NS	*
	Feed conversion ratio					
0.5	1.09±0.004	1.2±0.004	1.29±0.004	1.5±0.004	1.77±0.004	1.99±0.004
0.75	1.11±0.004	1.18±0.004	1.29±0.004	1.01±0.004	1.8±0.004	1.99±0.004
1.00	1.09±0.004	1.2±0.004	1.28±0.004	1.52±0.004	1.81±0.004	1.88±0.004
1.25	1.09±0.004	1.2±0.004	1.29±0.004	1.52±0.004	1.81±0.004	1.92±0.004
Total	1.09±0.004	1.19±0.004	1.28±0.004	1.5±0.004	1.79±0.004	1.94±0.004
Significance	*	*	*	*	*	*

Means having different superscripts differ significantly **(P<0.01), *(P<0.05)

Stress (Haematological/ Biochemical/ Enzymatic) parameters

As shown in Table-2, among the different haematological parameters pertaining to stress factors *viz*. WBC, RBC, haemoglobin, packed cell volume, heterophil, lymphocyte, HL ratio, monocyte, basophil, eosinophil, none of the parameters had shown significant effect.

The significant findings (P<0.05) was observed at stocking density of 1.25 sq.ft/ bird for % calcium retention (59.07±3.34%) and serum cholesterol (114.37±3.33 mg/dl). However, the glutahione (mole/g Hb) and lipid peroxidation (mole/g Hb) activity were found to be significantly best (P<0.05) at 0.75 and 1.0 sq. ft/ bird floor space respectively. At floor space of 1.0 sq. ft/ bird, the lowest mortality (14.16 %) and highest benefit cost ratio was observed.

The net income per bird raised on 1.0 sq.ft/bird stocking density (irrespective of the season effect) was observed maximum (Rs. 63.26) followed by 1.25 sq.ft/bird (Rs. 60.0), 0.75 sq.ft/bird (Rs. 57.96) and 0.5 sq.ft/bird (Rs. 47.76) stocking densities.

Table 2: Average biological parameters of broilers at various age groups under various stocking densities in summer

Particulars	Density (ft^2)				
	0.5	0.75	1.00	1.25	Significance
% Retention (Nitrogen)	55.90±3.29	59.86±6.00	56.57±4.20	65.31±0.70	NS
% Retention (Calcium)	46.08±2.57	49.64±1.95	45.32±2.35	59.07±3.34	*
% Retention (Phosphorus)	22.72±4.60	17.26±10.38	10.33±11.92	25.02±7.44	NS
WBC ($x10^4$/µl)	1.11±0.03	1.28±0.03	1.38±0.05	1.18±0.04	NS
RBC ($x10^6$/µl)	2.37±0.06	2.38±0.05	2.56±0.07	2.64±0.09	NS
Hemoglobin (g/100 ml)	6.48±0.24	6.83±0.25	7.1±0.38	7.28±0.16	NS
Packed cell Volume (%)	35.03±1.09	37.44±1.03	37.84±1.05	38.78±1.19	NS
Heterophil (%)	12.13±0.4	13.5±0.46	14.13±0.74	15.13±0.67	NS
Lymphocyte (%)	29.88±2.86	40.38±1.16	46.63±1.66	67.88±1.69	NS
HL Ratio	0.43±0.04	0.34±0.02	0.31±0.02	0.22±0.01	NS
Monocyte (%)	2.75±0.31	3.5±0.46	4±0.5	3.88±0.58	NS
Basophil (%)	2.88±0.55	3.25±0.62	2.88±0.52	2.63±0.46	NS
Eosinophil (%)	2.5±0.33	3.38±0.46	3.25±0.37	3.88±0.69	NS
Serum cholesterol (mg/dl)	119.58±4.90	119.80±2.65	116.21±4.34	114.37±3.33	*
Serum cortisole (ng/dl)	6.94±0.19	6.35±0.22	6.55±0.11	3.94±0.23	NS
Free fatty acid (mg/dl)	16.86±0.28	16.60±0.54	15.25±0.18	15.41±0.08	NS
GSH (mole/g Hb)	2.68±0.27	4.39±0.38	3.06±1.03	4.34±0.82	**
LPO (mole/g Hb)	18.10±0.87	19.74±1.15	17.12±1.22	25.87±2.12	**
Mortality (%)	16.66	17.40	14.16	16.60	NS

Means having different superscripts differ significantly **(P<0.01), *(P<0.05)

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