J. Animal and Poultry Prod.., Mansoura Univ., Vol. 7 (12): 491–497, 2016

Effect of Stocking Density and Probiotic Supplementation on Broiler Performance

Mahmoud, R. M. [1] **and T. K. El-Rayes** [2]
[1] **Anim. Prod. Res. Inst., Agric.Res. Center, Egypt.**
[2] **Anim. Prod.Dept., Fac. of Agric., Tanta Univ., Egypt.**

ABSTRACT

An experiment, with a factorial arrangement of treatments (3×3), was conducted to evaluate the response or Ross broiler chicks to three stocking densities and three levels of probiotic added in drinking water. Two basal diets were formulated and fed to chicks during the starter and finisher periods. A total of 540 chicks was randomly divided into nine experimental groups, kept in floor pens at three stocking densities (10, 12 or 14 birds/m^2) and given probiotic (0.0, 1.0, or 2.0 ml/liter of water). Each group had three equal replications. All birds had free access to feed and water, and managed similarly. Growth performance, economic efficiency, carcass traits and blood parameters were determined. Increasing stocking density from 10 to 14 birds/m^2 during the entire experimental period led to significant increases in feed intake, mortality rate, and plasma total lipids, triglycerides and cholesterol but negatively affected feed conversion ratio, body weight gain, and concentrations of total protein, albumin and globulin in blood plasma. But stocking density did not affect carcass traits of birds. Water-added probiotic positively affected feed intake, feed conversion ratio, body weight gain and mortality rate, and caused a significant increase in total protein, albumin and globulin but significantly reduced plasma levels of total lipids, triglycerides and cholesterol. Added probiotic, however, had no effect on carcass traits. When growth performance and economic aspect are taken into consideration, it can be concluded that a stocking density of 10 birds/m^2 proved to be the best level. Probiotic addition produced further improvement in growth and economic efficiency of broiler chickens.

Keywords: stocking density, probiotic, performance, carcass traits, broilers

INTRODUCTION

Feed cost represents 60-70% of poultry production costs. So, nutritionists look for new and cheaper feed ingredients in order to improve the production performance and profitability. Optimal nutrition leads to increasing growth performance and improving the efficiency of feed utilization and economic efficiency of feeding.

Stocking density may affect the performance, health and welfare of broiler chickens. The appropriate stocking densities depend mainly on the inputs and outputs prices and thus on the cost-benefit analysis (Estevez, 2007). The scientific literature contains various reports on the effects of stocking density on broiler performance. In general, broilers are kept at a considerably high stocking density. Such intensive housing systems may act on the birds as a crowding stress that causes various functional disorders. Thus, increasing stocking density may induce some stress and consequently depress immuno-competence in the birds.

Most growth promoters such as probiotic, prebiotic and symbiotic can modify the intestinal flora have been reported to positively affect the health and performance of poultry. On the other hand, the imbalance between pathogenic and non-pathogenic bacteria may depress feed conversion and growth of chickens due to competition with the host for the nutrients in the intestinal tract, degradation of host enzymes and reduction of the absorptive surface area (Bedford, 2000). In addition, Fuller (1992) defined the probiotic as a live microbial feed supplement which beneficially affects the host animal. In this respect, Tolba *et al.* (2004) found that broiler chick performance was improved when they added probiotics to their diets. Therefore, the present study was undertaken to evaluate the effects of stocking density and probiotic added in drinking water on growth performance, carcass traits and blood parameters of broiler chickens.

MATERIALS AND METHODS

A total of 540 broiler chicks (Ross) were individually weighed and distributed into three groups according to stocking density (10, 12 and 14 birds/m^2). Each group was divided into three subgroups according to levels of added probiotic (0.0, 1.0 or 2.0 ml/liter of water). Thus nine experimental groups, each with 3 replications, in a factorial arrangement of treatments (3×3), were housed in clean floor pens. The study continued for 6 weeks of birds' age, from day old to 42 days old. A daily photoperiod of 23 h light: 1 h dark was used. Birds had free access to feed and water. All groups were kept under similar conditions. Basal starter and finisher diets having 3014 kcal ME/kg and 23.04% CP (1-21 days old) and 3204 kcal ME/kg and 19.28% CP (21-42 days of age) were formulated and used (Table 1). Growth performance were evaluated as live body weight (LBW), body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR). At the end of study, blood was taken from four chicks per treatment. Plasma was separated by centrifugation at 3000 rpm for 15 minutes. Concentrations of plasma total lipids, cholesterol, triglycerides, total protein and albumin were determined using commercial kits, as described by Frings and Dunn (1970), Allain *et al.* (1974) and Fossati and Prencipe (1982), Doumas *et al.*, 1981) and Doumas *et al.* (1971), respectively. Level of plasma globulin was obtained by subtracting the plasma albumin concentration from that of plasma total proteins. When the birds were 6 weeks of age, four birds from each treatment were individually weighed and then they were slaughtered and immediately eviscerated. The individual weights of carcass yield and edible organs were determined. Thus, carcass yield was calculated as the percentage of carcass weight relative to pre-slaughter live body weight. Dressing percentage and percentages of lymphoid organs and abdominal fat pad were also determined. Data were statistically processed by using a two-way analysis of variance by means of the SAS procedure (SAS, 1999). The significant differences among means different measurements were identified at P≤0.05 using the multiple range test (Duncan, 1955).

Table 1. Composition and calculated analysis of the experimental diets

Ingredients	Starter	Finisher
Yellow	53.50	61.28
Soybean meal (48% CP)	33.50	25.00
Corn gluten meal (60%CP)	6.50	5.50
Vegetableoil	2.50	4.40
Ground limestone	1.50	1.50
Dicalcium phosphate	1.70	1.50
Salt (NaCl)	0.30	0.30
Vit. and Min. Permix*	0.30	0.30
DL-methionine	0.10	0.15
L-Lysine	0.10	0.07
Total	100	100
Calculated analysis**		
Crude protein(%)	23.04	19.28
Metabolizable energy (kcal/kg)	3014.0	3204
Ether extract (%)	2.64	2.82
Crude fiber (%)	3.80	3.34
Calcium(%)	1.04	0.97
Available phosphorus (%)	0.44	0.42
Lysine (%)	1.26	0.99
Methionine (%)	0.61	0.62
Methionine + cystine(%)	0.91	0.85

***Each 3 kg of premix contained: vit. A 12000 IU, vit.D_3 2200 IU, vit.E 10 mg, vit.K_3 2000 mg, vit.B_1 1000 mg, vit.B_2 5000 mg, vit.B_6 1500 mg, vit. B_{12} 10 mg, pantothenic acid 10 mg, niacin 30 mg, folic acid 1000 mg, biotin 50 mg, choline chloride 300 mg, manganese 60 mg, zinc 50 mg, copper 10 mg, Iron 30 mg, Iodine 1000 mg, selenium 100 mg, cobalt 100 mg and $CaCO_3$ to 3 kg**

**** according to NRC. 1994.**

RESULTS AND DISCUSION

Growth Performance

Live body weight and weight gain

The effects of stocking density, added probiotic and their interaction on performance traits of broiler chicks are presented in Tables 2 and 3. Data revealed that 21-day-old LBW of birds was significantly (P≤0.05) decreased by 2.77 and 9.39% by increasing stocking density from 10 to12 or 14 birds/m^2, respectively. The same trend was observed in final 42-day-old LBW of chicks was significantly (P≤0.05) lower by 5.64 and 14.80% due to increasing stocking density from 10 to12 or 14 birds/m^2. At the entire experimental period, broilers gained significantly (P≤0.05) less weight as stocking density increased from 10 to 14 birds/m^2.

Table 2. Live body weight of broiler chicks as affected by stocking density and probiotic supplementation from one to 42 days of age.

Treatments	Initial LBW one-day old	LBW at 21 days old	Final LBW at 42 days old
Main effects	g	g	g
Stocking density (A)			
10 birds/m^{2}A1	40.2	667.9^a	2071.3^a
12 birds/m^2 A2	40.2	649.4^b	1954.5^b
14 birds/m^2 A3	40.0	605.2^c	1764.7^c
SEM	0.9	5.2	10.2
Significance	NS	*	*
Added probiotic (B)			
Without probioticB1	40.2	613.4^c	1845.6^c
1.0ml/L water B2	40.1	641.2^b	1921.2^b
2.0ml/L water B3	40.1	668.0^a	2023.7^a
SEM	0.9	5.2	9.7
Significance	NS	*	*
AB Interactions			
A1 B1	40.3	630.1	1966.8
A1 B2	40.2	668.9	2055.4
A1 B3	40.1	704.9	2191.8
A2 B1	40.2	626.3	1870.1
A2 B2	40.1	649.4	1933.3
A2 B3	40.2	672.5	2060.0
A3 B1	40.1	583.8	1700.0
A3 B2	39.9	605.3	1775.0
A3 B3	39.9	626.6	1819.2
SEM	10.1	5.1	0.9
Significance	NS	*	*

a – c : For each of the main effects, means in the same column bearing different superscripts differ significantly (P<0.05)
NS : Not significant, * :Significant at P<(0.05,
**** : Significant at P<0.01, SEM : Standard error. L : Liter.**

Table 3. Body weight gains (BWG), feed consumption (FI), feed conversion ratio (FCR) of broiler chicks as affected by stocking density and *probiotic* supplementation from one – 42 days of age.

Treatments	Starter Period From 0 – 21 days of age			Finisher Period From 21– 42 days of age			Total Period From 0 – 42 days of age		
Main effects	BWG	FI	FCR	BWG	FI	FCR	BWG	FI	FCR
Stocking density (A)									
10 birds/m^2 A1	627.77^a	1046.51^b	1.68^a	1403.37^a	2451.25^b	1.755^a	2031.1^a	3497.76^{bc}	1.729^a
12 birds/m^2 A2	609.23^b	1043.31^c	1.72^a	1305.07^b	2473.16^a	1.902^b	1914.3^b	3516.47^a	1.842^b
14 birds/m^2 A3	565.27^c	1067.58^a	1.89^b	1159.50^c	2436.91^c	2.105^c	1724.8^c	3504.49^{ab}	2.035^c
SEM	5.3	8.1	0.06	6.8	9.9	0.05	9.2	11.9	0.05
Significance	*	*	*	*	*	*	*	*	*
Added probiotic (B)									
Without probiotic B1	573.2^c	1078.98^a	1.885^c	1232.23^c	2571.19 ^{c}	2.096^c	1805.4^c	3650.17^a	2.028^c
1.0 ml/L water liter B2	601.1^b	1051.18^b	1.754^b	1280.03^b	2471.85 ^{b}	1.939^b	1881.1^b	3523.03^{ab}	1.880^b
2.0 ml/L water liter B3	627.9^a	1027.25^c	1.641^a	1355.67^a	2318.28 ^{a}	1.727^a	1983.6^a	3345.53^c	1.699^a
SEM	5.2	8.6	0.05	7.3	9.8	0.04	9.3	11.8	0.06
Significance	*	*	*	*	*	*	*	*	*
AB Interactions									
A1 B1	589.8	1081.12	1.833	1336.7	2609.32	1.952	1926.5	3690.44	1.915
A1 B2	628.7	1040.19	1.655	1386.5	2490.24	1.796	2015.2	3530.43	1.752
A1 B3	664.8	1018.22	1.532	1486.9	2254.19	1.516	2151.7	3272.41	1.521
A2 B1	586.1	1075.41	1.835	1243.8	2589.11	2.082	1829.9	3664.52	2.002
A2 B2	609.3	1032.13	1.694	1283.9	2475.13	1.928	1893.2	3507.26	1.853
A2 B3	632.3	1022.40	1.617	1387.5	2355.23	1.697	2019.8	3377.63	1.672
A3 B1	543.7	1080.40	1.987	1116.2	2515.14	2.253	1659.9	3595.54	2.166
A3 B2	565.4	1081.22	1.912	1169.7	2450.18	2.095	1735.1	3531.40	2.035
A3 B3	586.7	1041.13	1.775	1192.6	2345.41	1.967	1779.3	3386.54	1.903
SEM	5.0	9.1	8.9	0.04	9.5	7.05	0.04	9.1	5.0
Significance	*	*	*	*	*	*	*	*	*

a-c : For each of the main effects, means in the same column bearing different superscripts differ significantly (P<0.05)
NS : Not significant, * :Significant at P<(0.05, ** : Significant at P<0.01, SEM : Standard error. L : Liter.

The negative effect of high stocking density on body weight and weight gain of chicks is related to the reduced chance of birds to get their nutritional requirements. Our results were confirmed by several authors (Feddes *et al*., 2002; Dozier *et al*., 2006), who found that final body weight of broiler chickens decreased by increasing stocking density. When stocking density exceeded 30 birds/m^2, Shanawany (1988) birds had significantly lighter body weights as compared to lower stocking densities.

At 21 days old, birds given probiotic-supplemented drinking water (1.0 or 2.0 ml/liter) were significantly ($P \leq 0.05$) heavier by 8.90 and 4.53%, compared with the control group. Similar trend was observed in final live body weight of birds at the end of study, where body weight of birds given probiotic-supplemented drinking water at a level 2.0 ml/liter was significantly ($P<0.05$) higher by 9.65% than the control group, followed by those given the probiotic at a level of 1.0 ml/liter, being 4.10%. The improved LBW of broiler chicks, observed herein, may be due to increased absorption and utilization of nutrients. Added probiotic can also improve the balance between the useful and pathogenic bacteria in the gastrointestinal tract in favor of the host animal, non-pathogenic bacteria may depress FCR and growth in chickens due to competition with the host for the nutrients in the intestinal tract or via reducing the absorptive surface area (Bedford, 2000). Contrary to the present results, Zulkifli *et al.* (2000) observed no improvements in growth of chickens fed on diets supplemented with probiotic. Inconsistent responses of chickens to added probiotic in various studies may be attributed to the differences in the strains of bacteria or types of probiotic used and in their levels of addition in diets or drinking water.

At the end of starter period, added probiotic positively affected body weight gain of birds. Similar trend was observed in LBW of birds at the end of finisher period and at the whole experimental period. Our results harmonize with the findings of Ernest (1996) and Alwan *et al.* (1997), who found that added dietary yeast culture significantly improved BWG of broiler chickens compared with the control group. On the other hand, Mohan *et al.* (1996) reported that the differences in body weight gain of broilers were not significant due to adding probiotic at 3.0 g/kg diet. The effects of interaction between stocking density and probiotic supplementation were significant on live body weight and bodyweight gain of broiler (Tables 2 and 3). The highest LBW and BWG were observed when birds were kept at 10 birds/m^2 with adding probiotic at 2.0 ml/liter of water for the starter, finisher and the whole experimental periods.

Feed intake and feed conversion ratio:

The effects of stocking density, added probiotic and their interaction on feed intake and feed conversion ratio of broiler chicks are given in Table 3. During the whole experimental period, broiler chicks reared under stocking density of 10 birds/m^2 consumed less feed and had better feed conversion ratio as compared to those kept at 12 or 14 birds/m^2. At the whole experimental periods, feed conversion ratio were significantly ($P \leq 0.05$) depressed but feed intake responded with no clear-cut trend by increasing stocking density from 10 to 14 birds/m^2. Conversely, Dozier *et al.* (2006) found that increasing the stocking density improved feed conversion ratio in broiler chicks. However, Proudfoot and Hulan (1985) and Dozier *et al*. (2006) observed no significant differences in feed intake when broilers were kept under many stocking densities. But Bolton *et al*. (1972) found a significant decrease in feed intake as the space per bird decreased.

During the whole experimental period, feed consumption of broiler chicks that were given probiotic-supplemented water was significantly lower than that of the control birds. Probiotic addition in drinking water positively affected feed conversion ratio of birds in comparison with the control group during the entire experimental period (Table 3). The present results agree also with those of Kahraman *et al.* (1997) and Jin *et al.* (1998), who reported that FCR of broilers fed probiotic-supplemented diets was significantly better than the control group. In disagreement with our results, El-Ghamry *et al*. (2002) and Kumar *et al*. (2002) observed no improvements in feed conversion ratio in probiotic-supplemented groups compared with the control group. There were significant interactions between stocking density and added probiotic on feed conversion ratio of broiler chicks. The best mean of feed conversion ratio was achieved by birds kept at 10 birds/m^2 and given 2.0 ml probiotic per liter of water compared with other treatments during the whole experimental periods.

Mortality rate:

The effects of stocking density, added probiotic and their interaction on mortality rate of broilers are presented in Table 4. At the end of study, mortality rate was significantly ($P<0.05$) increased due to increasing stocking density from 10 to 14 birds/m^2. But these results disagree with the findings of Thomas *et al.* (2004), Dozier *et al*. (2006) and Meluzzi *et al*.(2008), who observed no relationship between stocking density and mortality rate in broiler chicks.

Probiotic supplementation led to significant reductions in mortality rate of broiler chicks comparing to the control group during all the examined phases of growth (Table 4). The present results disagree with those of Senani *et al*. (1997), Cavazzoni *et al*. (1998) and Ali (1999), who observed that mortality rate of the chicks was not significantly affected by addition of probiotic to the diets. The discrepancies in the response of chickens to added probiotic might be related to a variety of factors such as diet composition, dose and type of probiotic, experimental protocol, duration of study, housing system and strain and age of bird.

Significant interactions were observed between stocking density and added probiotic on mortality rate of broilers during the starter, finisher and whole experimental periods. During the entire experimental period, the least mortality rates were achieved by birds kept at 10 or 12 birds/m^2 and given 2.0 ml probiotic per liter of drinking water.

Table 4. Effect of stocking density and drinking water supplemented with probiotic on mortality rate. Of broiler chicks from one to 42 days of age

Treatments	Starter Period From 0 – 21 days of age		Finisher Period From 21– 42 days of age		Total Period From 0 – 42 days of age	
Main effects	**N**	**Mo%**	**N**	**Mo%**	**N**	**Mo%**
Stocking density (A)						
10 birds/m^2 A1	5	2.78^{b}	0	0.00^{a}	5	2.78^{a}
12 birds/m^2 A2	3	1.67^{a}	4	2.22^{b}	7	3.89^{b}
14 birds/m^2 A3	6	3.33^{c}	4	2.22^{b}	10	5.55^{c}
SEM						
Significance		*		*		*
Added probiotic (B						
Without probiotic B1	6	3.33^{c}	3	1.67^{b}	9	5.00^{c}
1.0 ml/L water liter B2	5	2.78^{b}	2	1.67^{b}	8	4.44^{b}
2.0 ml/L water liter B3	3	1.67^{a}	2	1.11^{a}	4	2.78^{a}
SEM						
Significance		*		*		*
AB Interactions						
A1 B1	2	3.33	0	0.00	2	3.33
A1 B2	2	3.33	0	0.00	2	3.33
A1 B3	1	1.67	0	0.00	0	1.67
A2 B1	1	1.67	2	3.33	3	5.00
A2 B2	1	1.67	2	3.33	3	5.00
A2 B3	1	1.67	0	1.67	1	1.67
A3 B1	3	5.0	1	1.67	4	6.67
A3 B2	2	3.33	1	1.67	3	5.00
A3 B3	1	1.67	2	3.33	3	5.00
(%)Significance		*		*		*

a-c : For each of the main effects, means in the same column bearing different superscripts differ significantly (P<0.05)
NS : Not significant, * :Significant at P<(0.05, ** : Significant at P<0.01, SEM : Standard error. L : Liter.

Carcass traits and lymphoid organs:

The response of carcass traits of broiler chicks to stocking density, added probiotic and their interaction are presented in Table 5. Relative weights of carcass traits were significantly decreased but abdominal fat increased in response to rising stocking density from 10 to 14 birds/m^2. These results agree with the findings of Cravener *et al*. (1992), Feddes *et al*. (2002) and Dozier *et al*. (2005), who reported that carcass weight of chicks decreased as the level of stocking density increased, but other parameters were not affected.

The results showed also that relative weights of carcass traits were not significantly affected by adding probiotic in drinking water (Table 5). These results disagree with the findings of Tawfeek *et al*. (1993), who reported that feeding Fermacto-supplemented diets caused significantly higher carcass and dressing percentages of broilers in comparison with feeding the control diet. The results of Abd-Elsame (2001), El-Ghamry *et al*. (2002) and Kalavathy *et al*. (2003) confirmed the present results. They found no significant effect of probiotic supplementation on carcass quality of broilers. The carcass traits of broiler chicks as influenced by the interaction between stocking density and added probiotic are given in Table 5. The best means of carcass traits were achieved by birds kept at 10 birds/m^2 and given 2.0 ml probiotic per liter of drinking water as compared to other treatments.

The effects of stocking density, probiotic supplementation and their interaction on lymphoid organs are presented in Table 6. Relative weight of bursa slightly increased while percentages of thymus and spleen slightly decreased in response to increasing stocking density from 10 to 14 birds/m^2. No significant interactions were observed between stocking density and added probiotic on absolute weights of lymphoid organs. The Stocking density by added probiotic interactions were significant on relative weights or bursa and thymus but were not significant on percent spleen.

Table 5. Effect of stocking density and drinking water supplemented with probiotic on relative weight of some carcass traits of 42-days-old broiler chicks.

Treatments	% Carcass	% Liver	%Heart	%Gizzard	%Giblets	AF
Main effects	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**
Stocking density (A)						
10 birds/m^2 A1	63.65	2.54	0.71	2.82	6.07	2.83
12 birds/m^2 A2	62.54	2.48	0.64	2.75	5.87	2.92
14 birds/m^2 A3	61.51	2.39	0.62	2.73	5.73	3.27
SEM	1.37	0.007	0.009	0.069	0.055	0.04
Significance	NS	NS	NS	NS	NS	NS
Added probiotic (B)						
Without probiotic B1	62.00	2.41	0.61	2.72	5.75	3.24
1.0 ml/L water liter B2	62.44	2.49	0.67	2.79	5.96	3.09
2.0 ml/L water liter B3	63.26	2.51	0.68	2.78	5.98	2.68
SEM	1.37	0.004	0.009	0.025	0.062	0.04
Significance	NS	NS	NS	NS	NS	NS
AB Interactions						
A1 B1	63.01	2.45	0.63	2.72	5.80	2.98
A1 B2	63.51	2.55	0.73	2.81	6.09	2.95
A1 B3	64.42	2.62	0.77	2.94	6.33	2.56
A2 B1	62.12	2.43	0.60	2.74	5.78	3.16
A2 B2	62.35	2.47	0.66	2.83	5.96	2.95
A2 B3	63.16	2.53	0.65	2.69	5.87	2.67
A3 B1	60.88	2.35	0.61	2.71	5.66	3.62
A3 B2	61.45	2.44	0.62	2.75	5.81	3.39
A3 B3	62.21	2.37	0.62	2.72	5.71	2.83
SEM	1.98	0.062	0.099	0.097	0.92	0.22
Significant	NS	NS	NS	NS	NS	NS

a-c : For each of the main effects, means in the same column bearing different superscripts differ significantly (P<0.05 NS : Not significant, * :Significant at P<(0.05, ** : Significant at P<0.01, SEM : Standard error
L : Liter. AF: Abdominal fat.

Table 6. Effect of stocking density and drinking water supplemented with probiotic absolute and relative weights of lymphoid organs of 42-days-old broiler chicks.

Treatments	Bursa		Thymus		Spleen	
Main effects	**(g)**	**%**	**(g)**	**%**	**(g)**	**%**
Stocking density (A)						
10 birds/m² A1	4.210^{b}	0.213^{c}	11.143^{a}	0.565^{a}	3.048^{a}	0.155
12 birds/m² A2	4.395^{a}	0.227^{a}	10.320^{b}	0.534^{b}	2.801^{b}	0.145
14 birds/m² A3	3.872^{c}	0.225^{b}	09.011^{c}	$0.524c^{b}$	2.355^{c}	0.137
SEM	0.102	0.005	0.388	0.087	0.061	0.011
Significance	*	*	*	*	*	NS
Added probiotic (B)						
Without probiotic B1	3.357^{c}	0.184^{c}	9.191^{c}	0.503^{c}	2.469^{c}	0.136
1.0 ml/L water liter B2	4.187^{b}	0.227^{b}	9.926^{b}	0.539^{b}	2.689^{b}	0.146
2.0 ml/L water liter B3	4.933^{a}	0.253^{a}	11.357^{a}	0.581^{a}	3.046^{a}	0.156
SEM	0.102	0.003	0.387	0.087	0.066	0.011
Significance	*	*	*	*	*	NS
AB Interactions						
A1 B1	3.52	0.180	10.175	0.520	2.673	0.138
A1 B2	4.12	0.214	10.642	0.554	2.999	0.156
A1 B3	4.99	0.245	12.611	0.620	3.473	0.171
A2 B1	3.450	0.184	9.200	0.492	2.614	0.140
A2 B2	4.442	0.234	10.152	0.534	2.713	0.143
A2 B3	5.294	0.262	11.607	0.575	3.075	0.152
A3 B1	3.102	0.188	8.197	0.497	2.121	0.129
A3 B2	4.000	0.235	8.984	0.528	2.354	0.138
A3 B3	4.514	0.251	9.852	0.547	2.590	0.144
SEM	0.133	0.043	0.402	0.099	0.122	0.018
Significant	*	*	*	*	*	NS

a-c : For each of the main effects, means in the same column bearing different superscripts differ significantly(P<0.05) : Not significant, * :Significant at P<(0.05, ** : Significant at P<0.01, SEM : Standard error. L : Liter

Blood parameters:

There were significant increases (P≤ 0.05) in plasma levels of total lipids, triglycerides and cholesterol as stocking density increased from 10 to 14 birds/m² (Table 7). But plasma total protein was significantly reduced due to increasing the stocking density from 10 to 14 birds/m². In this respect, Pesti and Howarth (1983) and Thaxton et al. (2006) reported no significant effect of stocking density on plasma cholesterol of broiler chickens.

Results presented in Table 7 showed that plasma concentrations of total lipids, triglycerides and cholesterol significantly decreased while those of total protein, albumin and globulin increased due to adding probiotic to drinking water of broiler chicks compared with their control counterparts. Similarly, Tawfeek et al. (1993) and El-Ghamry et al. (2002) reported that levels of plasma albumin and globulin were not affected by experimental diets supplemented with yeast culture in comparison with the control group. The present results agree with the results of Salim (2004) and Tolba et al. (2004), who found significant increases in plasma concentrations of total protein, albumin and globulin fractions when birds were fed on probiotic-supplemented diet compared with the control group. Stocking density by added probiotic interactions were significant on blood plasma constituents examined here (Table 7).

Economic efficiency:

The effects of stocking density and probiotic supplementation and their interaction on economic efficiency of broiler chicks throughout this experiment are illustrated in Table 8. The obtained results revealed that keeping broiler chicks at 10 birds/m² resulted in the highest means of economic efficiency and relative economic efficiency. Probiotic supplementation in drinking water had a positive effect on economic efficiency and relative economic efficiency of broiler chicks.

Table 7. Effect of stocking density anddrinking water supplemented withprobioticon some blood constituents of 42-day-old broiler chicks.

Treatments	Total lipids	Triglycerides	Cholesterol	Total protein	Albumin	Globulin
Main effects	**mg/dl**	**mg/dl**	**mg/dl**	**g/dl**	**g/dl**	**g/dl**
Stocking density (A)						
10 birds/m² A1	339.2^{c}	64.2^{c}	126.11^{c}	4.92^{a}	3.45^{a}	1.47^{a}
12 birds/m² A2	369.1^{b}	78.3^{ab}	138.20^{ab}	4.54^{b}	3.46^{a}	1.08^{b}
14 birds/m² A3	408.8^{a}	80.2^{a}	142.41^{a}	4.03^{c}	2.59^{b}	1.44^{a}
SEM	3.21	2.45	2.44	0.066	0.07	0.075
Significance	*	*	*	*	*	*
Added probiotic (B)						
Without probiotic B1	427.9^{a}	84.3^{a}	147.48^{a}	4.12^{c}	2.86^{b}	1.26^{c}
1.0 ml/L water liter B2	366.8^{b}	73.9^{b}	135.17^{b}	4.57^{b}	3.27^{ab}	1.30^{ab}
2.0 ml/L water liter B3	322.5^{c}	64.5^{b}	124.08^{c}	4.80^{a}	3.37^{a}	1.40^{a}
SEM	3.22	2.49	2.44	0.066	0.09	0.075
Significance	*	*	*	*	*	*
AB Interactions						
A1 B1	409.3	451.2	141.33	4.41	3.01	1.40
A1 B2	326.2	409.1	129.00	4.85	3.42	1.43
A1 B3	282.1	366.1	108.00	5.50	3.93	1.57
A2 B1	423.1	86.8	148.11	4.16	3.12	1.04
A2 B2	365.0	75.1	137.49	4.44	3.39	1.05
A2 B3	319.2	73.0	129.01	5.01	3.86	1.15
A3 B1	451.2	91.0	153.00	3.78	2.45	1.33
A3 B2	409.1	82.4	139.01	4.41	2.99	1.42
A3 B3	366.1	67.2	135.22	3.89	2.33	1.56
SEM	4.02	3.51	3.05	0.12	0.77	0.13
Significant	*	*	*	*	*	*

a-c : For each of the main effects, means in the same column bearing different superscripts differ significantly (P<0.05) NS : Not significant, * :Significant at P<(0.05, ** : Significant at P<0.01,SEM: Standard error. L: Liter.

Table 8. Effect of stocking density and drinking water supplemented with on economic efficiency of broilers chicks from 1 – 42 days old.

Treatments Main effects	Total FI g/chick	Price/kg (L.E)	Probiotic Cost (L.E)	Total feed cost (L.E)	Weight gain	Price/kg (L.E)	Total Revenu (L.E)	Net Revenue (L.E)	Economic efficiency	Relative economic efficiency (%)
Stocking density (A)										
10 birds/m^2 A1	3497.76	3.2	0.2	11.39	2031.1	15.2	30.87	19.48	171.03	100
12 birds/m^2 A2	3516.47	3.2	0.2	11.45	1914.3	15.2	29.10	17.65	154.15	90.13
14 birds/m^2 A3	3504.49	3.2	0.2	11.41	1724.7	15.2	26.22	14.81	129.80	75.89
Added probiotic (B)										
Without probiotic B1	3650.17	3.2	0.0	11.68	1805.4	15.2	27.44	15.76	134.87	100
1.0 ml/L water liter B2	3523.03	3.2	0.2	11.47	1881.1	15.2	28.59	17.12	149.22	110.62
2.0 ml/L water liter B3	3345.53	3.2	0.4	11.13	1983.6	15.2	30.15	19.04	171.84	127.01

Net revenue = Price of weight gain/chick – feed costplus probiotic.
Economic efficiency = net revenue / feed cost plus probiotic× 100
Relative economic efficiency (%) assuming the control treatments = 100 %

CONCLUSION

When growth performance broiler chicks and economic aspect are taken into account, it can be concluded that the best stocking density is suggested to be 10 birds/m^2. Further improvement in growth and economic efficiency can be achieved due to probiotic addition.

REFERENCES

Abd-Elsamee, M. O. (2001). Broiler performance as affected by crud protein, lysine and probiotic. Egypt. Poult. Sci., 21: 943-962.

Allain, C.A.; L.S. Poon; C.S.G. Chan; W. Richmond and P.C. Fu (1974). Enzymatic determination of total serum cholesterol. Clin. Chem., 20:470–475.

Ali, Mervat. A. (1999). Effect of probiotics addition to broiler rations on performance and some blood constituents. Egypt. Poult. Sci., 19: 161-177.

Alwan, D.; E. Swierczewska and J. Riede (1997). Effect of probiotic (Cerbiogalli) or antibiotic on performance variation of three broilers strains. Annals of Warsaw Agricultural Univ., Anim. Sci., 33: 37-46.

Bedford, M. (2000). Removal of antibiotic growth promoters from poultry diets: implications and strategies to minimize subsequent problems. World s Poult. Sci. J., 56(4): 347-365.

Bolton, W.; R. Thompson; R.M. Jones and W.A. Dewar (1972). Effect of stocking density on performance of broiler chicks. Br. Poult. Sci., 13: 157-162.

Cravener, T.L.; W.B. Roush and M.M. Mashaly (1992). Broiler production under varying population densities. Poultry Science, 71: 427-433.

Doumas, B.T.; D.D. Bayse; R.J. Carter; T. Peters and R. Schaffer (1981). A candidate reference method for determination of total protein in serum. 1. Development and validation. Clin. Chem., 27(10): 1642-1650.

Doumas, B.T.; W.A. Watson and H.G. Biggs (1971). Albumin standards and the measurement of serum albumin with bromocresolgreen. Clin. Chim. Acta, 31: 87-96.

Dozier, W.A.; J.P. Thaxton; J.L. Purswell; H.A. Olanrewaju; S.L. Branton and W.B. Roush (2006). Stocking density effects on male broilers grown to 1.8 kilograms of body weight. Poultry Sci., 85: 344-351.

Dozier, W.A.; J.P. Thaxton; S.L. Branton; G.W. Morgan; D.M. Miles; W.B. Roush; B.D. Lott and Y. Vizzier-Thaxton (2005). Stocking density effects on growth performance and processing yields of heavy broilers. Poultry Science, 84: 1332-1338.

Duncan, D.B. (1955). Multiple range and multiple F tests. Biometrics, 11:1- 42.

El-Ghamry, A.A.; G.M. EL-Mallah and A.T. El-Yamny (2002). The effect of incorporating yeast culture, *Nigella sativa* seeds and fresh garlic in broiler diets on their performance. Egypt. Poult. Sci., 22: 445-459.

Erenst, T. (1996). The effect of viable yeast cultures on performance of broiler chicks. Roczniki-Naukowe-Zootechniki, 23: 211-222.

Esteves, I. (2007). Density allowances for broilers: Where to set the limits? Poultry Sci., 86: 1265-1272.

Esteves, I.; R.C. Newberry and L. Arias de Regna (1997). Broiler chickens: A tolerant social system? Etologia, 5: 19-29.

Fossati, P. and L. Prencipe (1982). Serum triglycerides determined colorimetrically with an enzyme that produce hydrogen peroxide. Clin. Chem., 28: 2077-2080.

Feddes, J.J.R.; E.J. Emmanuel and M.J. Zuidhof (2002). Broiler performance, body weight variance, feed and water intake and carcass quality at different stocking densities. Poultry Science, 81: 774-779.

Frings, C.S. and R.T. Dunn (1970). A colorimetric method for determination of total serum lipids based on the sulfophosphovanillin reaction. Amer. J. Clin. Pathol., 53: 89-91.

Fuller, R. (1992). Probiotics: The Scientific Basis. Edited by Fuller, R., Published by Chapman and Hall, London, UK.

Heckert, R.A.; I. Estevez; E. Russek-Cohen and R. Pettit-Riley (2002). Effects of density and perch availability on the immune statue of broilers. Poultry Science, 81: 451-457.

Imaeda, N. (2000). Influence of the stocking density and rearing season on incidence of sudden death syndrome in broiler chickens. Poult. Sci., 79: 201-204.

Jin, L.Z.; Y.W. Ho; N. Abdullah and S. Jalaludin (1998). Growth performance, intestinal microbial populations, and serum cholesterol of broilers fed diets containing Lactobacillus cultures. Poultry Sci., 77: 1259-1265.

Kahraman, R.; I. Abas; K. Bostan; A. Tanor; N. Kocabagli and M. Alp (1997). Effects of organic acids and yeast culture on performance, ileum pH, and Enterobacteriaceae population of broilers. Pendik, Veteriner Mikrobiyoloji Dergisi., 28: 171-180.

Kalavathy, R.; N. Abdullah; S. Jalaludin and Y.W. Ho (2003). Effect of Lactobacillus cultures on growth performance, abdominal fat deposition, serum lipids and weight of organs of broiler chickens. Br. Poult. Sci., 44: 139-144.

Kumar, B.; K.L. Pandey and N. Kumar (2002). Effect of different dose levels of microbial feed supplement EY Micromix on broiler performance and plasma protein profiles under midhill conditions, Ind. Vet. J., 79 : 932 – 934.

Meluzzi, A; C. Fabbri; E. Folegatti and F. Sirri (2008). Effect of less intensive rearing conditions on litter characteristics, growth performance, carcass injuries and meat quality of broiler. Br. Poult. Sci., 49(5): 509-515.

Mohan, B.; R. Kadirvel; A. Natarajan and M. Bhaskaran (1996). Effect of probiotic supplementation on growth, nitrogen utilization and serum cholesterol in broiler. Br. Poult. Sci., 37: 395-401.

Pesti, G.M. and B. Howarth (1983). Effects of population density on the growth, organ weight, and plasma corticosterone of young broiler chicks. Poultry Science, 62: 1080- 1083.

Proudfoot, F.G. and H.W. Hulan (1985). Effects of stocking density on the incidence of scabby hip syndrome among broiler chickens. Poultry Science, 64: 2001-2003.

Proudfoot, F.G. and H.W. Hulan and D.R. Ramey (1979). The effect of four stocking densities on broiler carcass grade, the incidence of breast blisters, and other performance traits. Poult. Sci., 58: 791-793.

Salim, I.H. (2004). Effect of dietary protein and some feed additives on broiler performance. M.Sc. Thesis, Department of Animal production, Faculty of Agriculture, Cairo University, Giza, Egypt.

SAS Institute (1999). SAS/STAT. User's Guide: Statistics, 8 ed. SAS Institute Inc., Gary NC., USA.

Senani, S.; R.B. Rai; M.K. Padhi and S.K. Saha (1997). Effects of feeding different levels of Lactobacilli on the performance of broilers. Indian Vet. J., 74: 808-810.

Shanawany, M.M. (1988). Broiler performance under high stocking densities. British Poultry Science, 29: 43-52.

Sarkar S.; L. Mandal and G.C. Banerjee (1996). Comparative efficiency of different types of yeast on the performance of broiler. Indian Vet. J., 73: 224-226.

Tawfeek, M.L.; K.A.O. Yamani; A.A. Rashwan and S.S. Ahmed (1993). Growth performance, carcass triats and blood constituents in broiler chicks as affected by genotype, dietary protein source and feed additives. J. Agric. Sci,. Mansoura Univ., 18 : 2279-2289.

Thaxton, J.P.; W.A. Dozier; S.L. Branton; G.W. Morgan; D.W. Miles; W.B. Roush; B.D. Lott and Y. Vizzier-Thaxton (2006). Stocking density and physiological adaptive responses of broilers. Poultry Sci., 85: 819-824.

Thomas, D.G.; V. Ravindran; D.V. Thomas; B.J. Camden; Y.H. Cottam; P.C.H. Morel and C.J. Cook (2004). Influence of stocking density on the performance, carcass characteristics and selected welfare indicators of broiler chickens. New Zealand Vet. J., 52(2): 76-81.

Tolba, A.A.H.; M.M. Sabry and S.M.M. Abuzead (2004). Effect of microbial probiotics on performance of broiler chicks under normal or heat stress conditions: 1- Lactobacillus or pediococcus. Egypt. Poult. Sci., 24: 351-367.

Yeo, J. and K..Kim (1997).Effect of feeding diets containing an antibiotic, a probiotic or Yucca extract on growth and intestinal urease activity in broiler chicks. Poultry Sci., 76 : 381 – 385.

Zulkifli, L.; N. Abdullah; N.M. Azrin and Y.W. Ho (2000). Growth performance and immune response of two commercial broiler strains fed diets containing Lactobacillus cultures and oxytetracycline under heat stress condition. Br. Poult. Sci., 41: 593-597.

تأثير الكثافة العددية وإضافة المنشط الحيوي في ماء الشرب على الأداء الإنتاجي لدجاج التسمين

رمضان مغاوري محمود [1] و طلعت خضر الريس [2]

[1] معهد بحوث الإنتاج الحيواني، مركز البحوث الزراعية، وزارة الزراعة، مصر

[2] قسم الإنتاج الحيواني، كلية الزراعة، جامعة المنصورة، مصر

أجريت هذه التجربة لدراسة التأثيرات النافعة لإضافة منشط حيوي (بروبيوتك) إلى ماء الشرب تحت مستويات مختلفة من الكثافة العددية للطيور علي الأداءالإنتاجي والحالة الفسيولوجية والكفاءة الاقتصادية لدجاج التسمين عند عمر ٦ أسابيع. استخدم في هذه الدراسة ٥٤٠ كتكوت غير مجنس عمر يوم واحد من سلالة الروس وقسمت إلي ٩ مجموعات ناتجة من تجربة عاملية ٣*٣ بكل معاملة ٦٠ كتكوت. وزعت الطيور علي ٣ مجموعات طبقا لمستوي الكثافة العددية (١٠ ، ١٢ ، ١٤ طائر/م٢). كل مجموعه من المجموعات الثلاثة السابقة قسمت داخليا إلي ٣ مجموعات فرعية طبقا لمعدلات إضافة المنشط الحيوي إلى الماء بمستويات مختلفة (صفر : ١.٠ ، ٢.٠ مل/لتر). تم تسجيل ودراسة وزن الجسم، معدل الزيادة في وزن الجسم، معدل استهلاك العلف، الكفاءة التحويلية للغذاء، نسبة النفوق، قياسات الذبيحة، بعض قياس الكيمو حيوية للدم بالإضافةإلي الكفاءة الاقتصادية علي مدار فترة التجربة. بينت النتائج أن جميع القياسات التي تم تقديرها كانت أفضل معنويا ($P \leq 0.05$) عند مستوي كثافة ١٠ طيور/م٢ مقارنة بباقي الكثافات العددية، تم ملاحظة نفس الاتجاه مع الطيور التي أعطيت الماء المدعم بالمنشط الحيوي بمعدل ٢.٠ مل/لتر. كذلك لوحظ تحسنا معنويا في معدل الأداء ومقاييس الحالة الفسيولوجية والكفاءة الاقتصادية نتيجة للتداخل بين الكثافة العددية (١٠ طيور/م٢) ومعدل إضافةالمنشط الحيوي في الماءبنسبة (٢.٠ مل/لتر). وعلي ذلك فان إضافةالمنشط الحيوي عند مستوى ٢.٠ مل/لتر تحت كثافة عددية ١٠ طيور/م٢ تعتبر أمنة جدا ولها تأثيرات إيجابية علي كل من الكفاءة الإنتاجية والحالة الفسيولوجية والكفاءة الاقتصادية لدجاج التسمين.