



Asian Journal of **Poultry Science**

ISSN 1819-3609



Academic
Journals Inc.

www.academicjournals.com

Growth Performance and Carcass Yield of Broilers as Affected by Stocking Density and Enzymatic Growth Promoters

H.H.M. Hassanein

Department of Animal and Poultry Production, Faculty of Agriculture, South Valley University, 83523 Qena, Egypt

ABSTRACT

Present experiment was performed to study the effects of stocking densities and feed additive on broiler performance carcass traits. Total of 144 unsexed one-day old Hubbard broilers were reared at three Stocking Densities (SD), feeding on diet with or without enzymatic growth promoters (A) as growth promoter in an environmental controlled (windowless house). Birds were kept until 42 days old with 7, 8 and 9 birds in a cage of 97×50×45 cm. Birds were distributed into sex treatments in each three replicates. Mortality and carcass yield was calculated for each treatment. The highest ($p<0.05$) Body Weight (BW) and Body Weight Gain (BWG) were recorded in low densities of birds fed on diet supplemented with enzymes (SD7+A and SD8+A) compared to other treatments during the experimental period. Also, Feed Intake (FI) and Feed Conversion Ratio (FCR) were improved ($p<0.05$) in SD7+A and SD8+A compared to other treatments. Relatively carcass yields were increased ($p<0.05$) in low densities with enzyme supplementation without any adverse effect on digestive organs.

Key words: Feed additives, stoking, feed intake, carcass, enzymes, broilers

INTRODUCTION

Relatively great number of studies are focused on the effect of stocking density in broiler production and were primarily motivated by its great economical importance, also factor of carcass quality (Edriss *et al.*, 2003; Yadgari *et al.*, 2006) and in recent period, as factor of poultry welfare (Weeks *et al.*, 2000; Thomas *et al.*, 2004; Skrbic *et al.*, 2009).

Numerous studies have demonstrated that increasing placement density (of broiler chickens approximating 2.4 to 2.7 kg) adversely affects growth performance, carcass yield, and skin scratches and tears (Feddes *et al.*, 2002). The higher stocking densities caused stress on the birds compared with the lower stocking densities. Moreover, high stocking density has been reported to increase ammonia production, footpad lesions, litter moisture, locomotion, heat stress, and preening (Ritz *et al.*, 2005; Bennett *et al.*, 2003). 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 increased stocking density (Puron *et al.*, 1995). The effects of group size and density on social behavior and move within available space have received much attention (Estevez, 2007; Leone *et al.*, 2010) few studies investigate their impact on broiler performance under feed additive feeding.

An alternative to intensify poultry production is the use of enzymes or probiotics as feed additives to improve broilers performance in environmentally controlled houses. According to European legislation, using of all Antibiotic Growth Promoters (AGP) are forbidden in feed. During

the past few years numerous trials have been conducted to compare the incorporation of mannan-oligosaccharides and direct feed microbials in the diets, versus conventional AGP (Markovic *et al.*, 2009). The addition of commercial enzyme products to broiler diets generally results in a significant improvement in performance and a reduction in intestinal viscosity by breakdown of soluble or nonstarch polysaccharides (Khan *et al.*, 2006). Moreover, the use of appropriate feed enzymes offers an opportunity to overcome some of the potential limitations imposed by exclusive vegetable protein-based diets including lower digestibility of protein and starches (Mushtaq *et al.*, 2009). The effect of feed multi enzyme has been reported to improve *in vitro* digestibility of starch and acid soluble nitrogen fraction of autoclaved high fibre (Kocher *et al.*, 2000). Broiler feed formulation based on ideal protein concept may be a better option than based on CP or total Amino Acid (AA). Most non-soy vegetable protein sources used in poultry diet formulations are moderate to low in lysine contents; hence supplementation with lysine is inevitable in growing broilers to ensure rapid growth and optimum efficiency of feed utilization (Corzo *et al.*, 2006; Ahmad *et al.*, 2007).

It was necessary to throw some more light on these enzymes supplemented to plant diet with different densities concerning their effects on broiler performance and carcass yield. So, this study examined the effects of various stocking densities on birds fed on diet supplemented with enzymatic growth promoters or without to evaluate growth performance and carcass yields of broilers.

MATERIALS AND METHODS

Experimental birds and housing: This study was carried out in South Valley University, Qena, Egypt in 2009. The aim of this research was to determine feed intake, growth performance, and carcass traits of broiler chicks fed on plant diet supplemented with Enzymes as feed additive within different stocking densities.

One hundred forty four unsexed one-day old Hubbard broiler chicks were used in this study. The chicks were randomly divided equally 18 groups (6 treatments $\times$ 3 replicates). Treatments were included three stocking densities (SD 7, 8 or 9 birds) fed on dietary supplemented with enzymatic growth promoters (500 g ton^{-1}) and three of them fed on the same diet without with 3 replicates in each. Chicks were brooded in two-tier wire floor a cage of $97 \times 50 \times 45 \text{ cm}$ in battery located in windowless house. Chicks of each replicate were housed individually in metabolic cages, made up of metabolic wire mesh according to the following treatments:

Treatment (1): SD with 7 birds / 0.485 m^2 fed on diet with A (SD7+A)

Treatment (2): SD with 8 birds / 0.485 m^2 fed on diet with A (SD8+A)

Treatment (3): SD with 9 birds / 0.485 m^2 fed on diet with A (SD9+A)

Treatment (4): SD with 7 birds / 0.485 m^2 fed on diet without A (SD7)

Treatment (5): SD with 8 birds / 0.485 m^2 fed on diet without A (SD8)

Treatment (6): SD with 9 birds / 0.485 m^2 fed on diet without A (SD9)

Diet and management: The starter and grower diets were formulated from plant origin Table 1. The starter and grower diets were formulated to meet the nutrient requirements of broiler chicks according to NRC (1994). All diets were formulated to have similar levels of lysine and sulphur amino acids as recommended by NRC (1994). Both starter and grower diets were supplemented with or without enzymatic growth promoter (Amecozyme 2 $\times$ A) as a multi enzymes product containing; Amylase 5,500,000 units: Protease 2,000,000 units: B-Glucanase 30,000 units:

Table 1: Composition and calculated analysis of the experimental diets

	Starter diets		Grower diets	
Items	------(0-3 weeks)-----		------(4-6 weeks)-----	
Ingredients (g kg⁻¹)				
Yellow corn, ground	531.70	531.20	565.20	564.70
Soybean meal (44% CP)	320.00	320.00	300.00	300.00
Corn gluten meal (60% CP)	90.00	90.00	60.00	60.00
Vit and Min. Premix*	3.00	3.00	3.00	3.00
Sunflower oil	20.00	20.00	40.00	40.00
Dicalcium phosphate	20.00	20.00	18.00	18.00
Limestone	10.00	10.00	10.00	10.00
Salt	3.80	3.80	3.80	3.80
DL-methionine	0.50	0.50	---	---
L-lysine	1.00	1.00	---	---
Amecozyme	-	0.50	-	0.50
Total	1000.00	1000.00	1000.00	1000.00
Calculated analysis				
ME (kcal kg ⁻¹)	3017.00	3017.00	3145.00	3145.00
Crude protein (%)	24.19	24.19	21.65	21.65
Crude fiber (%)	3.16	3.16	3.05	3.05
Crude fat (%)	4.62	4.62	6.65	6.65
Ca (%)	0.93	0.93	0.88	0.88
P (Available %)	0.52	0.52	0.48	0.48
Lysine (%)	1.27	1.27	1.04	1.04
Methionine (%)	0.62	0.62	0.41	0.41
Price of ton diet (LE) 2010	2600.00	2600.00	2400.00	2400.00

*Each diet was supplied with 2.5 kg ton⁻¹ Vit. And Min. Mix (commercial source B. p. Max) Each 2.5 kg contains, Vit. A 10,000,000 MIU, Vit. D 2,000,000 MIU, Vit. E 10000 mg, Vit. K3 1000 mg, Vit. B1 1000 mg, Vit. B2 5000 mg, Vit. B6 1500 mg, Biotin 50 mg, BHT 10000 mg, Pantothenic 10000 mg, folic acid 1000 mg, Nicotinic acid 30000 mg, Mn 60 g, Zinc 50 g, Fe 30 g, Cu 4 g, I 3 g, Selenium 0.1 g, Co 0.1 g

Lipase 50,000 units: Xylanase 500,000 units: Cellulase 15,000 units. Management was similar for all treatments. The environmental temperature was about 32°C during the first week old and gradually reduced by about 2°C weekly until about 24°C at the fourth week up to the end of experiment (at 6 weeks of age). Artificial light was provided continuously during night without interruption. Birds in each replicate were weekly weighted and the feed consumed was recorded. Feed conversion (gram feed /gram gain) was calculated for different experimental periods. Mortality was recorded daily and calculated for the entire experimental period.

Carcass yields: At 6 weeks of age (end of the experiment) four birds from each treatment representing the average body weight of such treatment was slaughtered (6 treatments×4 birds = 24 birds). After slaughtering and bleeding, the birds were scalded and feathers were plucked. Carcasses were eviscerated, heads and shanks were separated, then the carcasses were chilled in a tap water for about 10 min. Eviscerated carcasses were individually weighted and dressing percentage was calculated (weight of carcass+giblet+abdominal fat/pre-slaughter weight×100). Weight of breasts, thighs, giblets (liver+gizzard+heart), spleen and abdominal fat were measured.

Statistical analysis: Data was subjected to analysis of variance using general linear model described in SAS User's Guide SAS Institute (2009) using the following model:

$$Y_{ik} = U + T_i + E_{ik}$$

Where:

Y_{ik} = Observed value of the concerned trait

U = Observed mean for the concerned trait

T_i = The fixed effect due to densities with or without Amecozyme 2×

E_{ik} = Random error

The differences among the means of individual treatments were tested with Duncan multiple range test (Duncan, 1955). $p < 0.001$ was considered as significance level.

RESULTS AND DISCUSSION

Body Weight (BW) and Body Weight Gain (BWG): Data in Table 2 shows that T2 and T1 increased significantly ($p < 0.05$) BW and cumulative BWG compared to other treatments at 21, 42 days of age. The present results indicated that the low stocking densities of the birds fed on diet with enzymatic growth promoters (T2 and T1) increased significantly ($p < 0.01$) BW and BWG compared with high stocking densities (T3, T5 and T6) during the experimental period. Moreover, low densities without enzymatic growth promoters (T4) increased significantly ($p < 0.05$) BW and BWG compared to high densities with or without enzymes (T3, T5 and T6).

Table 2: Effects of stocking densities and enzymes on Body Weight (BW) and Body Weight Gain (BWG) of broilers at 21, 42 days and whole period of age

Treatment	Body weight (g)			Body weight gain (g)		
	Initial	21 days	42 days	21 days	42 days	Cumulative
T1	46.0	778 ^{ab}	2165 ^a	732 ^{ab}	1387 ^a	2120 ^a
T2	44.7	802 ^a	2227 ^a	758 ^a	1425 ^a	2182 ^a
T3	45.6	715 ^{bcd}	1868 ^b	669 ^{bcd}	1154 ^b	1823 ^b
T4	45.0	767 ^{abc}	2120 ^a	722 ^{abc}	1353 ^a	2075 ^a
T5	45.0	684 ^{cd}	1802 ^b	639 ^d	1117 ^b	1757 ^b
T6	45.0	668 ^d	1697 ^b	623 ^d	1028 ^b	1651 ^b
SEM	0.693	18.73	43.58	18.81	36.89	43.47
p-value	0.754	0.001	<0.001	0.001	<0.001	<0.001 ^{abc}

Means in the same column with different superscripts are significantly different ($p < 0.05$)

Table 3: Effects of stocking densities and enzymes on Feed Intake (FI) and Feed Conversion Ratio (FCR) of broilers at 21, 42 days and whole period of age

Treatment	Feed intake (g)			Feed conversion ration		
	21 days	42 days	Cumulative	21 days	42 days	Cumulative
T1	1010	2310 ^{ab}	3320 ^a	1.380 ^{ab}	1.667 ^a	1.566 ^a
T2	1000	2409 ^a	3410 ^a	1.322 ^a	1.697 ^a	1.565 ^a
T3	997	2346 ^{ab}	3344 ^a	1.492 ^{ab}	2.033 ^b	1.834 ^b
T4	1027	2271 ^{abc}	3299 ^{ab}	1.424 ^{ab}	1.667 ^a	1.591 ^a
T5	972	2048 ^{bc}	3020 ^{bc}	1.524 ^{ab}	1.833 ^{ab}	1.719 ^{ab}
T6	984	1992 ^c	2977 ^c	1.580 ^b	1.937 ^{ab}	1.802 ^a
SEM	29.46	64.68	64.99	0.044	0.064	0.035
p-value	0.818	0.003	0.002	0.015	0.007	<0.001 ^{abc}

Means in the same column with different superscripts are significantly different ($p < 0.05$)

The superior increased in BW and BWG in low stocking densities with or without enzymatic growth promoters may be due to the improvements in FI and FCR (Table 3). Moreover, these improvements in live performance in low densities may be due to decrease stress on the birds which may have given the birds more opportunity to obtain more feed and more space for activity. The reduction in cumulative BW gain due to placement density can be partially explained by less feed consumption as evidenced by 95.4% of the sum of squares of BW gain being attributable to feed consumption (Dozier *et al.*, 2005).

Moreover, these improvements may be due to that enzyme supplementation led to increase nutrient digestibility. According to Ritz *et al.* (1995) enzyme supplementation increased the length of villi within the jejunal and ileal sections of 3 weeks old turkey pullets fed corn soybean meal diets. The increase in surface area suggested by the increased villus length may enhance nutrients absorption and improve nutrient digestibility (Caspary, 1992). Broiler chicks fed on the diets supplemented with enzymatic growth promoters (Ronozyme) achieved the highest ($p<0.05$) body weight and body weight gain at 6 week old (Osman *et al.*, 2007). Live weights and feed consumption showed a linear reduction as the space per bird decreased (Puron *et al.*, 1995).

Feed Intake (FI) and Feed Conversion Ratio (FCR): Data in Table 3 shows that T2 and T1 improved significantly ($p<0.05$) FI and cumulative FCR compared to other treatments at 21, 42 days of age. Generally the low stocking densities of the birds fed on diet with enzymatic growth promoters (T2 and T1) improved significantly ($p<0.01$) FI and FCR compared with high stocking densities (T3, T5 and T6) during the experimental period. Moreover, low densities without enzymatic growth promoters (T4) improved significantly ($p<0.05$) FI and FCR compared to high densities with or without enzymes (T3, T5 and T6).

These improvements FI and FCR with low densities may be due to increase feed digestibility. Osman *et al.* (2007) mentioned that enzymatic growth promoters decreased wet litter syndrome, ammonia production in broiler houses and reduced the residence time of nutrients in the gastrointestinal tract by improving feed digestibility which gives less opportunity for growth of pathogenic bacteria. In addition Puron *et al.* (1995) found that, reductions in feed consumption at the highest stocking densities compared with the lowest were 3.7 and 3.9% for males and females, respectively. The reduction of seven week live weight and feed consumption at the highest stocking density agrees with the findings of other researchers e.g., Shanawany (1988) and Soares *et al.* (1991).

Carcass yields: Average of carcass yields in broiler chicks as affected by stocking densities and dietary supplemented with enzymatic growth promoters are illustrated in Table 4. Stocking densities and dietary enzymes had significant effect ($p<0.05$) on fasting body weight, carcass

Table 4: Effects of stocking densities and enzymes on carcass yields of broilers at 42 days of age

Treatment	Live BW (g)	Carcass weight (g)	Dressing (%)	Breast weight (g)	Thigh weight (g)	Abdominal fat weight (g)
T1	2053 ^{ab}	1653 ^{ab}	80.52	791 ^a	638 ^{ab}	32.0 ^a
T2	2163 ^a	1725 ^a	79.77	812 ^a	669 ^a	23.5 ^{ab}
T3	1912 ^{cd}	1536 ^{bc}	80.32	749 ^{abc}	577 ^b	29.5 ^{ab}
T4	2010 ^{bcd}	1595 ^{ab}	79.46	767 ^{ab}	622 ^{ab}	19.5 ^b
T5	1821 ^d	1435 ^c	78.73	696 ^{bc}	572 ^b	19.5 ^b
T6	1860 ^{cd}	1457 ^c	78.42	682 ^c	572 ^b	21.0 ^{ab}
SEM	29.00	24.30	0.361	12.06	10.56	1.429
p-value	<0.001	<0.001	0.511	<0.001	0.009	0.016 ^{abc}

Means in the same column with different superscripts are significantly different ($p<0.05$)

Table 5: Effects of stocking densities and enzymes on digestive organs of broilers at 42 days of age

Treatment	Weight (g)				
	Giblet	Liver	Heart	Gizzard	Spleen
T1	101.50	44.50	11.00	46.00	3.00
T2	96.50	43.50	8.50	44.50	2.00
T3	92.50	37.50	9.50	45.00	3.00
T4	93.50	40.50	9.50	43.50	2.00
T5	87.00	35.00	9.50	42.50	2.00
T6	92.50	38.50	9.50	44.50	3.00
SEM	1.676	1.073	0.380	1.202	0.181
p-value	0.521	0.063	0.637	0.981	0.163 ^{abc}

Means in the same column with different superscripts are significantly different ($p < 0.05$)

weight, breast weight, thigh weight and abdominal fat at 6 weeks of age. As previously mentioned body weight was significantly ($p < 0.05$) higher in broiler chicks fed the lowest Stocking densities with dietary enzymes (T2 and T1) compared to those fed the highest Stocking densities without enzymes diets at 6 weeks of age. Similar trend was observed in carcass weight. It is well known that, there was a strong relationship (from $r = 0.92$ to 0.98) between fasting body weight and carcass weight (Saleh, 1992).

The present results are coincided with the findings reported by Dozier *et al.* (2005) who indicated that weight of carcass, breast and thigh decreased in a linear manner as stocking density increased. Increasing stocking density from 10 to 13 birds/m² has been shown to reduce breast fillet yield relative to BW but breast tender and total white meat yields are not affected by stocking density (Bilgili and Hess, 1995). Broiler chicks fed on the diets supplemented with enzymatic growth promoters (Ronozyme) had higher ($p < 0.05$) fasting body weight and carcass weight compared to the unsupplemented control diet (Osman *et al.*, 2007).

Digestive organs: Average of digestive organs in broiler chicks as affected by stocking densities and dietary supplemented with enzymatic growth promoters are illustrated in Table 5. Liver, gizzard, heart, spleen and giblet weights were not significantly affected by dietary treatments. Thus the enzymes feed within different densities seem to be have positive effects on growth performance and carcass weight without significant effects on digestive organs. Broiler chicks fed on the diets supplemented with enzymatic growth promoters (Ronozyme) had no effects ($p > 0.05$) on digestive organs among treatments (Osman *et al.*, 2007).

CONCLUSION

The best stocking densities for broilers in an environmentally controlled (windowless house) under the conditions described are 7 and 8 birds/0.485 m² fed on enzymes, respectively. Body weight, body weight gain, feed intake and feed conversion ratio increased as stocking density decreased. Also, birds fed on dietary enzyme in low densities can be used to improve carcass yields of broiler.

REFERENCES

- Ahmad, G., T. Mushtaq, M.A. Mirza and Z. Ahmed, 2007. Comparative bioefficacy of lysine from L-Lysine hydrochloride or L-Lysine sulfate in basal diets containing graded levels of canola meal for female broiler chickens. Poult. Sci., 86: 525-530.

- Bennett, D.D., S.E. Higgins, R.W. Moore, R. Beltran, D.J. Caldwell, J.A. Byrd and B.M. Hargis, 2003. Effects of lime on *Salmonella enteritidis* survival *in vitro*. *Applied Polt. Res.*, 12: 65-68.
- Bilgili, S.F. and J.B. Hess, 1995. Placement density influences broiler carcass grade and meat yields. *J. Applied Poult. Res.*, 4: 384-389.
- Caspary, W.T., 1992. Physiology and pathophysiology of intestinal absorption. *Am. J. Clin. Nutr.*, 55: 2998-3000.
- Corzo, A., W.A. Dozier III and M.T. Kidd, 2006. Dietary lysine needs of late-developing heavy broilers. *Poult. Sci.*, 85: 457-461.
- Dozier III, W.A., J.P. Thaxton, S.L. Branton, G.W. Morgan and D.M. Miles *et al.*, 2005. Stocking density effects on growth performance and processing yields of heavy broilers. *Poult. Sci.*, 84: 1332-1338.
- Duncan, D.B., 1955. Multiple range and multiple F-tests. *Biometrics*, 11: 1-42.
- Edriss, M.A., S. Davoodv Andi and J. Pourreza, 2003. The effect of stock density on the reduction of performance and carcass traits in broiler chickens. *Proceedings of the 16th European Symposium on the Quality of Poultry Meat*, September 2003, Saint-Brienc, France, pp: 695-700.
- Estevez, I., 2007. Density allowances for broilers: Where to set the limits. *Poult. Sci.*, 86: 1265-1272.
- Feddes, J.J., E.J. Emmanuel and M.J. Zuidhofs, 2002. Broiler performance, body weight variance, feed and water intake and carcass quality at different stocking densities. *Poult. Sci.*, 81: 774-779.
- Khan, S.H., R. Sardar and B. Siddique, 2006. Influence of enzymes on performance of broilers fed sunflower-corn based diets. *Pak. Vet. J.*, 26: 109-114.
- Kocher, A., M. Choct, M.D. Porter and J. Broz, 2000. The effects of enzyme addition to broiler diets containing high concentrations of canola or sunflower meal. *Poult. Sci.*, 70: 1767-1774.
- Leone, E.H., M.C. Christman, L. Douglass and I. Estevez, 2010. Separating the impact of group size, density and enclosure size on broiler movement and space use at a decreasing perimeter to area ratio. *Behav. Processes*, 83: 16-22.
- Markovic, R., D. Sefera, M. Krstic and B. Petrujkic, 2009. Effect of different growth promoters on broiler performance and gut morphology. *Arch. Med. Vet.*, 41: 163-169.
- Mushtaq, T.S., M. Ahmad, G. Mirza, M.A. Ahmad and T. Noreen *et al.*, 2009. Influence of sunflower meal based diets supplemented with exogenous enzyme and digestible lysine on performance, digestibility and carcass response of broiler chickens. *Anim. Feed Sci. Technol.*, 149: 275-286.
- NRC, 1994. *Nutrient Requirements of Poultry*. 9th Edn., National Academy Press, Washington, DC. USA, ISBN-13: 978-0-309-04892-7.
- Osman, A.M.A., M.A.H. Soliman, H.H. Hassanein and A.A.A. Abd El-Warth, 2007. Evaluation of the growth performance of Broiler chicks fed on plant diets supplemented with some feed additives. *J. Agric. Sci. Mansoura Univ.*, 32: 133-150.
- Puron, D., R. Santamaria, J.C. Segura and J.L. Alamilla, 1995. Broiler performance at different stocking densities. *Applied Poult. Sci. Res.*, 4: 55-60.
- Ritz, C.W., R.M. Hulet, B.B. Self and D.M. Denbow, 1995. Growth and intestinal morphology of male turkeys as influenced by dietary supplementation of amylase and xylanase. *Poult. Sci.*, 74: 1329-1334.
- Ritz, C.W., B.D. Fairchild and M.P. Lacy, 2005. Litter quality and broiler performance. Cooperative Extension Service, The University of Georgia College of Agricultural and Environmental Sciences. Bulletin, 1267. <http://www.thepoultresite.com/articles/388/litter-quality-and-broiler-performance>.

- SAS, 2009. User's Guide: Statistics. Version 9.2, SAS Institute Inc., Cary, NC. USA.
- Saleh, K., 1992. Comparative studies on the performance of some broiler hybrids under certain feeding systems. Ph.D. Thesis, Faculty of Agriculture Minia University, Egypt.
- Shanawany, M.M., 1988. Broiler performance under high stocking densities. Br. Poult. Sci., 29: 43-52.
- Skrbic, Z., Z. Pavlovski, M. Lukic, L. Peric and N. Milosevic, 2009. The Effect of stocking density on certain broiler welfare parameters. Biotechnol. Anim. Husbandry, 25: 11-21.
- Soares, P.R., J.B. Fonseca, A.M. Silva, A.S. Graeas, H.S. Rostagno and A.C.A. Silva, 1991. Performance of broilers of four commercial strains, housed at different densities. Revista da Sociedade Brasileira de Zmtecnia, 20: 74-79.
- 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. N. Z. Vet. J., 52: 76-81.
- Weeks, C.A., T.D. Danbury, H.C. Davies, P. Hunt and S.C. Kestin, 2000. The behaviour of broiler chickens and its modification by lameness. Applied Anim. Behav. Sci., 67: 111-125.
- Yadgari, L., R. Kinreich, S. Druyan and A. Cahaner, 2006. The effects stocking density in hot conditions on growth, meat yield and meat quality of fetherless and feathered broilers. Proc. 12th Eur. Conf. World's Poultry Sci. J., 62: 603-603.