J.Animal and Poultry Prod., Mansoura Univ., Vol.4 (7): 395 - 409, 2013

EFFECT OF DIETARY SUNFLOWER OIL ON GROWTH PERFORMANCE OF BROILER CHICKS KEPT AT TWO CAGE DENSITIES DURING SUMMER SEASON

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ABSTRACT

The present experiment was conducted with Hubbard broiler-type chicks in a factorial arrangement of treatments (3×2) to investigate the effects of feeding diets fortified with three levels of sunflower oil on growth performance of broiler chicks kept at two stocking densities during summer season. Three isonitrogenous experimental diets, fortified with sunflower oil (0.00, 1.25 or 2.50% of the diet), were formulated and used. The chicks were kept in battery cages at two stocking densities (9.04 and 11.3 birds/m^2). All chicks were fed their respective experimental diets and had free access to feed and water throughout the experimental period from 2 to 6 weeks of age. The criteria of response were growth performance, nutrient digestibility, carcass traits and some blood parameters.

The obtained results can be summarized as follows: Apart from the effect of cage density, dietary supplementation with sunflower oil level increased significantly the growth performance of broiler chicks (final body weight, body weight gain and feed conversion), nutrient digestibility of diets (dry matter, organic matter, crude protein, ether extract and nitrogen retention), and blood plasma glucose concentration. However, dietary oil supplementation did not affect feed intake, carcass traits, digestibility of crude fiber and nitrogen free extract or ash retention as well as blood plasma concentrations of cholesterol, total protein, albumin, globulin, triglycerides, or activity of AST and ALT. Decreasing stocking density led to significant increases in final body weight, body weight gain, feed conversion, and digestibility of dry matter, organic matter, crude protein, nitrogen free extract and nitrogen retention, and in plasma triglycerides concentration. However, stocking density did not affect feed intake, carcass traits, digestibility of ether extract, crude fiber and ash retention and blood plasma concentrations of glucose, cholesterol, total protein, albumin and globulin or activity of AST and ALT. The effect of interaction between dietary sunflower oil and cage density was not significant for most variables examined in the present study. Based on the results of this study, it can be concluded that reducing stocking density and dietary supplementation with sunflower oil in summer season can be used for obtaining normal growth performance of broiler chicks.

Keywords: Broiler performance, stocking density, dietary oil supplementation.

INTRODUCTION

Heat stress is known to be one of the major problems facing broiler industry in the tropical and subtropical areas (Sabah Elkheir *et al*., 2008). In this regard, Butcher and Miles (2003) demonstrated that broilers subjected to high temperature exhibit many behavioral changes which allow them to reestablish heat balance with their surrounding environment. But the response of broilers at high temperatures differs based on the relative humidity occurred. High environmental temperature accompanied by high humidity is more detrimental to growth of broiler chicks than high temperature with low humidity (Daghir, 2009). At the same time, constant high temperature of 30-

32°C is more deleterious to broilers than cyclic or alternating temperatures of 30-32°C at day and 25°C at night. According to the scientific literature, high ambient temperatures have deleterious effects on feed intake, live weight gain, efficiency of feed and energy utilization, and digestibility of nutrients in different classes of poultry (Mills *et al.,* 1999; Hai *et al*., 2000).

Stocking density of broilers can be defined by the number or the weight of birds in a given area. It is considered an important factor in broiler production because of its impact on health, welfare, and well-being, as well as on growth performance of birds (Estevez, 2007). Current recommendations for stocking density in broilers differ widely by country and husbandry systems (Bessei, 2006; Buijs *et al.*, 2009). Several studies are present in the literature on the effect of stocking density on productive performance of broiler chicks. These studies evaluated a wide range of stocking density, from less than 10 to over 80 kg/m^2 floor space (Bessei, 2006; Manning *et al*., 2007). There is a well documented reduction of feed intake and reduced growth rate when stocking density exceeds 30 kg/m^2 in floor pens (Dozier *et al*. 2005; Bessei, 2006; Onbasilar *et al.*, 2008); but the effect of stocking density was reduced when broilers were kept in cages (Bessei, 2006; Houshmand *et al*., 2012). On the other hand, Bessei (2006) concluded that the influence of stocking density on growth rate of broilers is acting through heat stress rather than physical restriction of the animals' space for movement, since growth depression which has been found with increasing stocking density was closely linked to problems of heat dissipation.

Dietary fat supplementation is a common nutritional means to compensate for the reduction of feed intake of heat-stressed broiler chicks. The beneficial effects of added dietary fat at high temperature are several and well known (Dale and Fuller, 1979; Leeson, 1986; Wiernusz, 1998; Leeson and Summers, 2005; Daghir, 2008). The higher fat content of the diet contributes to reduced heat production, since fat has a lower heat increment than either protein or carbohydrates (Leeson and Summers, 2005; Daghir, 2008). The latter authors also reported that energy intake is increased in both broiler and laying hens in a warm environment by the addition of fat. The addition of fat to the diet appears to increase the energy value of the other feed constituents (Mateos and Sell, 1981). Fat has also been shown to decrease the rate of food passage in the gastrointestinal tract (Mateos *et al*., 1982) and thus increase nutrient utilization. Therefore, the present study was carried out in order to investigate the effects of feeding diets supplemented with sunflower oil on growth performance of broiler chicks kept at two stocking densities during summer season.

MATERIALS AND METHODS

The field work of the present study was performed at the Poultry Farm, belonging to the Kalabsho Center for Agricultural Researches and Experiments, Faculty of Agriculture, Mansoura University, Egypt, during summer season (from July to and August 2011). Prevailing means of maximum and minimum daily temperatures in Dakahliyah Governorate during

the experimental period were 35°C and 23°C, while the relative humidity ranged between 41 and 85%.

Experimental birds and diets

During the first two weeks of age, unsexed Hubbard broiler chicks were kept in brooding batteries, provided with an extra heat and fed a common commercial starter diet. The chicks were also vaccinated against diseases and managed similarly. At two weeks of age, one hundred sixty two chicks were randomly divided into six experimental groups, each with three replications. All the experimental groups of chicks were stocked at battery cages in an open-sided house under two cage densities (9.04 or 11.30 birds/m^2). Three isonitrogenous experimental diets, fortified with three levels of sunflower oil (0.00, 1.25 or 2.50% of the diet), were formulated to meet or exceed the nutrient requirements of broiler chicks (NRC, 1994). Dietary inclusion of sunflower oil was exclusively at the expense of the ground yellow corn content of the basal diet, with no adjustments in metabolizable energy contents of the experimental diets. The high level of stocking density (11.30 birds/m^2), applied herein, was hypothesized to be suitable under normal condition. All chicks were given a free access to feed and water, fed their respective experimental diets and managed similarly throughout the experimental period, from 2 to 6 weeks of age. Composition and chemical analyses of the experimental grower diets are presented in Table 1.

Criteria of response

Criteria of response included growth performance of chicks (live body weight, weight gain, feed intake and feed conversion, mortality rate), nutrient digestibility, carcass traits, and some blood constituents {plasma concentration of glucose, cholesterol, total protein, albumin, triglycerides, and activity of aspartate aminotransferase (AST) and alanine aminotransferase (ALT)}. Records on weekly live body weight (LBW), body weight gain (BWG), and feed intake (FI), and thereby feed conversion (FC; g feed: g gain) of broiler chicks, were maintained on a replicate group basis throughout the experimental period from 2 to 6 weeks of age. But mortality was monitored and recorded daily and its cumulative rate was calculated.

Digestibility trials:

At 5 weeks of age, one replication from each treatment were placed in a separate battery compartment and fed its respective experimental diet for a 3-day adaptation period, followed by a 3-day test period during which daily feed intake and excreta voided were quantitatively determined. Just after collection, the excreta were sprayed with 1% boric acid to eliminate nitrogen loss due to possible ammonia release. Any feather or foreign debris occasionally found in the excreta were removed out. The excreta were then dried in a forced-air oven at 70°C for 48 hours. The procedure described by Jakobsen *et al* (1960) was used for separating the fecal protein fraction in excreta samples. The urinary organic matter was calculated by multiplying the percent of urinary nitrogen by the factor 2.62 (Abou-Raya and Galal, 1971). Chemical analyses of the experimental diets and dried excreta were carried out according to the official methods of analysis (AOAC, 1990). Digestibility of nutrients were calculated for dry matter (DM), organic matter

(OM), crude protein (CP), crude fiber (CF), ether extract (EE) and nitrogen-free extract (NFE). The retention rates (%) of ash (AR) and nitrogen (NR) were also determined.

Table 1: Composition and chemical analyses of the experimental grower diets

Ingredients %	Level of added sunflower oil (%)		
	0.00	**1.25**	**2.50**
Ground yellow corn	71.93	70.68	69.43
Soybean meal (44% CP)	7.09	7.09	7.09
Corn gluten meal (60% CP)	16.50	16.50	16.50
Dicalcium phosphate	1.70	1.70	1.70
Ground limestone	1.60	1.60	1.60
Common salt (NaCl)	0.30	0.30	0.30
Vit. & min. premix**	0.30	0.30	0.30
Lysine- HCL	0.58	0.58	0.58
Sunflower oil	…	1.25	2.50
Total	100	100	100
Calculated analysis (air dry basis; NRC, 1994)			
Metabolizable energy (ME); kcal/kg	3208	3287	3366
Crude protein (CP); %	20.15	20.05	19.95
ME: CP ratio	159.2	163.9	168.7
Ether extract (EE); %	3.20	4.41	5.61
Crude fiber (CF); %	2.29	2.27	2.24
Calcium; %	1.02	1.02	1.02
Total phosphorus; %	0.65	0.64	0.64
Non-phytate phosphorus; %	0.39	0.38	0.38
Lysine; %	1.13	1.12	1.12
Methionine; %	0.42	0.42	0.41
Methionine plus cystine; %	0.78	0.77	0.77
Determined analysis (dry matter basis; AOAC, 1990)			
DM; %	89.32	89.91	89.29
CP; %	22.36	22.18	22.30
Ash; %	4.61	4.80	4.67
EE; %	3.65	4.88	6.29
CF; %	2.59	2.54	2.61
NFE; %	66.79	65.60	64.13

**** Each 3 kg premix contains: Vit. A, 12,000,000 IU; Vit. D_3, 2,500,000 IU; Vit. E, 10 g; Vit. K, 2.5 g; Vit. B_2, 5 g; Vit. B_6, 1.5 g; Vit. B_{12}, 10 mg; Biotin, 50 mg; Folic acid, 1.0 g; Nicotinic acid, 30 mg; Pantothenic acid, 10 g; Antioxidant, 10 g; Mn, 60 g; Cu, 10 g; Zn, 55 g; Fe, 35 g; I, 1.0 g; Co, 250 mg and Se, 150 mg.**

Carcass traits of broiler chicks:

At the conclusion of the feeding trial (6 weeks of age), 3 chicks from each treatment; whose body weight were near the average of their respective treatment, were selected for slaughter test. Prior to slaughter the birds were held 16 hours without feed. Just after slaughter and complete bleeding, their

carcasses were individually weighed, scalded, feather-plucked and eviscerated. Procedures of cleaning out and separating the abdominal fat were performed on hot carcasses. The abdominal fat included the adipose tissues surrounding the gizzard and the bursa of Fabricius and cloaca. Individual weights of eviscerated carcass and giblets (*i.e.* the edible organs including heart, liver and gizzard) were recorded. Total edible parts were calculated as eviscerated carcass plus giblets. All measurements of carcass and its components were determined relative to live body weight at slaughter.

Blood plasma parameters

During slaughtering (6 weeks of age), three blood samples per treatment were taken in heparinized test tubes. They were immediately centrifuged at 3000 r.p.m for 15 minutes in order to separate blood plasma. Plasma samples were frozen at –20°C until later analysis. Concentration of plasma total protein (Henry, 1964), albumin (Doumas *et al.,* 1971), glucose (Trinder, 1969), cholesterol (Allain *et al*., 1974), triglycerides (Tietz, 1995) and the activity of plasma AST and ALT (Reitman and Frankel, 1957) were determined using commercial kits of diagnostic examination. Plasma globulin level was estimated as plasma total protein minus that of albumin, neglecting the fibrinogen content of blood plasma.

Statistical analysis

A completely randomized design with a 3×2 factorial arrangement of treatments (3 levels of added dietary sunflower oil by two levels of stocking density, namely, 9.04 and 11.3 birds/m^2) was used. The statistical processing of data was performed using the Statgraphics Program (Statistical Graphics Corporation, 1991) based on a one-way analysis of variance. The significant differences (P≤0.05) among means of the different variables were identified by LSD-multiple range test of Quattro Program (Borland International, Inc., 1990).

RESULTS AND DISCUSSION

Growth performance of broiler chicks:

Data on the performance of broiler chicks for live body weight (LBW), body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR) as affected by added dietary sunflower oil and stocking density, during summer season, are given in Table 2. Apart from the effect of stocking density, added dietary sunflower oil significantly improved (P≤0.01) final LBW and total BWG of broiler chicks compared with their control counterparts during the whole experimental period, from 2 to 6 weeks of age (Table 2). It was observed that birds fed the oil-supplemented diets consumed slightly more (P>0.05) feed as compared to the control birds, so their total FCR was significantly better (P≤0.05) only for birds given the 2.5% oil-supplemented diets. Dietary supplementation with sunflower oil, applied herein, perhaps exerted some positive effect on feed intake and/or growth rate of heat-stressed broiler chicks. Because energy intake is often the limiting factor to growth of broilers during heat stress, added dietary fat perhaps enhanced the energy intake and reduced the specific dynamic effect of the diet *via* reducing heat

production, since fat has a lower heat increment than either protein or carbohydrates (Leeson and Summers, 2005; Daghir, 2008).. The addition of fat to the diet also increases the energy value of other feed constituents (Mateos and Sell, 1981). The present results are in accordance with those obtained by Miraei-Ashtiani *et al*. (2004), who reported that high-fat diets (6%) have helped in reducing the detrimental effect of heat stress in broilers raised at 30–38°C. In harmony also with the present results, Ghazalah *et al.* (2008) found that growth performance of heat-stressed broiler chicks was significantly improved due to feeding high-energy or high-fat diets.

Table 2: Effects of dietary sunflower oil and cage density on growth performance of broiler chicks during summer season

Treatments	Initial LBW (g)	Final LBW (g)	Total BWG (g)	Total FI (g)	Total FCR (g: g)
Main effects:	**(2 wk-old))**	**(7 wk-old)**	**2-7 wk-old**	**2-7 wk-old**	**2-7 wk-old**
Added oil: A					
0.00% (A1)	411	2217^{b}	1807^{b}	3509	1.95^{b}
1.25% (A2)	411	2289^{a}	1878^{a}	3578	1.91^{b}
2.50% (A3)	411	2322^{a}	1911^{a}	3609	1.89^{a}
SEM¶	0.712	19.0	19.3	33.6	0.014
Significance level	NS	**	**	NS	*
Cage density: B					
9.04 Birds/m^2 (B1)	412	2220^{b}	1808^{b}	3595	1.99^{b}
11.30 Birds/m^2 (B2)	410	2333^{a}	1922^{a}	3536	1.84^{a}
SEM¶	0.581	15.5	15.7	27.4	0.012
Significance level	NS	**	**	NS	**
AB Interaction					
A1×B1	412	2157	1746	3593	2.06
A1×B2	410	2278	1868	3426	1.83
A2×B1	413	2229	1816	3602	1.98
A2×B2	410	2349	1940	3554	1.83
A3×B1	410	2272	1862	3590	1.93
A3×B2	411	2371	1960	3628	1.85
SEM¶	1.007	26.9	27.2	47.5	0.02
Significance level	NS	NS	NS	NS	**

$^{a-b}$: 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 is standard errors of the means.

Regardless of the effect of added dietary sunflower oil, decreasing stocking density of broiler chicks from 11.3 to 9.04 birds/m^2 caused significant improvements (P≤0.01) in final LBW, total BWG and total FCR (Table 2). These results are in agreement with the general viewpoint that performance of growing birds is inversely related to the rate of stocking density (Feddes *et al.*, 2002; El-Deek and Al-Harthi, 2004; Houshmand *et al.*, 2012). The obtained results are also consistent with those reported by Estevez (2007) and Onbasilar *et al.* (2008), who found that increasing stocking density of broiler chickens had negative effects on criteria of growth performance. Similarly, Dozier *et al.* (2005) reported that high stocking density depressed

growth and feed consumption of broiler chicks. Recently, Beloor *et al.* (2010) found that daily feed intake was reduced from 114 g/bird (low density group, 0.116 m^2 /bird) to 103.2 g/bird (high density group, 0.0578 m^2/bird). The effect of interaction between dietary sunflower oil and cage density on the performance of broiler chicks was significant only for FCR during the whole experimental period (Table 2).

Nutrient digestibility:

Effects of dietary sunflower oil and cage density on nutrient digestibility of the experimental diets in broiler chicks are presented in Table 3. Independently from the effect of stocking density, added dietary sunflower oil significantly improved digestibilities of DM, OM, CP and EE, and the percentage of NR compared with those of the control group while CF digestibility and percent ash retention were not affected. Feeding high-fat diets to broiler chicks has been shown to decrease the rate of food passage in their digestive tract and thus increase nutrient utilization (Mateos *et al*., 1982). In agreement with the current results, Ghazalah *et al*. (2007) observed improvements in means of nutrient digestibility due to inclusion of dry fat in diets of broiler chicks. Similarly, Ghazalah *et al.* (2008) found that digestion coefficients of crude protein and ether extract were improved significantly when broiler chicks were fed diets containing high level of either metabolizable energy or poultry fat.

Irrespective of the effect of added dietary sunflower oil, decreasing stocking density of broiler chicks from 11.3 to 9.04 birds/m^2 led to significant improvements in digestibility of DM, OM, CP and NFE as well as the percentage of nitrogen retention while digestibility of CF and EE, and percent ash retention were not affected. In the present study, the positive effects of decreasing cage density on nutrient digestibility could not be explained based on the results obtained, since feed intake of birds was unaffected while their water intake was not estimated. As far as the authors aware, no publications were found in the scientific literature on the effect of stocking density on feed digestibility by animals. But if high stocking density adversely affected feed and/or water intake of broiler chicks, it might negatively affect nutrient digestibility as well, because impacts of stocking density on feed and water intakes are closely related (Dozier *et al.*, 2005). Significant interactions between dietary sunflower oil and cage density were observed on digestibility of CP and NFE, and percent nitrogen retention (Table 3).

Table 3: Effects of dietary sunflower oil and cage density on nutrient digestibility of the experimental diets of broiler chicks during summer season

Treatments	DM[1]	OM[2]	CP[3]	EE[4]	CF[5]	NFE[6]	NR[7]	AR[8]
Main effects:	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**
Added oil: A								
0.00% (A1)	79.9^{b}	83.2^{b}	94.9^{b}	86.8^{b}	16.7	84.0	83.4^{b}	34.9
1.25% (A2)	82.2^{a}	84.8^{a}	95.6^{ab}	91.7^{a}	16.8	84.8	88.1^{a}	44.3
2.50% (A3)	82.7^{a}	85.3^{a}	96.2^{a}	88.9^{b}	17.3	85.3	89.4^{a}	43.4
SEM¶	0.58	0.51	0.23	0.91	1.29	0.63	0.64	2.72
Significance level	*	*	**	**	NS	NS	**	NS
Cage density: B								
9.04 Birds/m^2 (B1)	80.5^{b}	83.4^{b}	95.3^{b}	88.1	15.8	83.7^{b}	84.9^{b}	40.9
11.30 Birds/m^2 (B2)	82.8^{a}	85.5^{a}	95.8^{a}	90.1	18.1	85.7^{a}	88.9^{a}	40.9
SEM¶	0.47	0.42	0.19	0.74	1.05	0.51	0.52	2.22
Significance level	**	**	*	NS	NS	*	**	NS
AB Interaction								
A1×B1	79.2	82.8	94.1	84.0	14.7	84.6	78.8	34.8
A1×B2	80.7	83.7	95.7	89.6	18.8	83.4	88.0	35.0
A2×B1	80.8	83.5	95.8	91.1	15.4	83.0	87.5	43.9
A2×B2	83.5	86.2	95.4	92.4	18.3	86.5	88.7	44.8
A3×B1	81.4	84.0	95.9	89.3	17.3	83.5	88.6	44.0
A3×B2	84.0	86.7	96.4	88.4	17.3	87.2	90.1	42.8
SEM¶	0.81	0.72	0.33	1.29	1.82	0.88	0.90	3.84
Significance level	NS	NS	*	NS	NS	*	**	NS

[a-b]: 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. ¶:Standard errors of means.

[1-8]: Denote to dry matter, organic matter, crude protein, ether extract, crude fiber, nitrogen-free extract, nitrogen retention and ash retention, respectively.

Carcass traits:

Data on relative weights of carcass traits of 6-week-old broiler chicks, as affected by added dietary sunflower oil and stocking density during summer season, are presented in Table 4. Carcass traits of broiler chicks during summer season were not affected by either added dietary sunflower oil or stocking density of birds. The similarity of slaughter weights of birds, selected herein, perhaps contributed in the lack of significant differences among the different treatments in carcass traits of broiler chicks. There were no significant interactions between dietary sunflower oil and cage density on all carcass traits of broiler chicks, measured in the present study (Table 4).

In agreement with the present results, Thomas *et al*. (2004), Dozier *et al.* (2005) and Sekeroglu *et al.* (2011) found that stocking density of broiler chicks had no effect on their carcass characteristics. However, Feddes *et al.* (2002) and Škrbić *et al.* (2011) reported that birds grown at high stocking density had lower carcass yield than those of birds grown at low stocking density. The inconsistent effects of stocking density on carcass traits of broiler chicks in different studies might be due to many factors such as

stocking density level, season and housing type (floor pens of cages) or conditions (open-sided house or environmentally-controlled house).
In harmony also with the present results, Tabeidian *et al.* (2005) found that added dietary soybean oil (up to 7.5%) had no effect on carcass yield of broilers. Similarly, Anitha et al. (2006) reported that increasing rice oil level up to 5% exerted no significant effect on carcass yield of 42-day-old broilers. In addition, Ghazalah *et al.* (2008) found that dressing percentage and giblets of broiler chicks were not affected by feeding diets containing high level of either metabolizable energy or poultry fat. However, Ghazalah *et al.* (2007) reported significantly better carcass measurements of broiler chicks due to inclusion of dry fat in their diets as compared to the control group.

Table 4: Effects of dietary sunflower oil and cage density on relative weights of carcass traits of 6-week-old broiler chicks during summer season

Treatments	LBW[1] (g)	EC[2] (%)	Liver (%)	Gizzard (%)	Heart (%)	Giblets (%)	TEP[3] (%)	AF[4] (%)
Main effects:								
Added oil: A								
0.00% (A1)	2264	73.03	2.29	1.46	0.57	4.31	77.35	1.83
1.25% (A2)	2268	72.55	2.43	1.58	0.53	4.54	77.09	1.95
2.50% (A3)	2233	71.53	2.69	1.65	0.52	4.85	76.39	1.78
SEM¶	40.65	0.50	0.12	0.12	0.03	0.19	0.45	0.17
Significance level	NS	NS	NS	NS	NS	NS	NS	NS
Cage density: B								
9.04 Birds/m^2 (B1)	2238	72.55	2.44	1.54	0.54	4.51	77.07	1.77
11.30 Birds/m^2 (B2)	2272	72.20	2.50	1.59	0.54	4.62	76.82	1.93
SEM¶	33.19	0.41	0.10	0.10	0.02	0.15	0.37	0.14
Significance level	NS	NS	NS	NS	NS	NS	NS	NS
AB Interaction								
A1×B1	2245	72.99	1.97	1.53	0.61	4.11	77.10	1.80
A1×B2	2283	73.09	2.61	1.38	0.53	4.52	77.61	1.85
A2×B1	2235	73.08	2.38	1.51	0.48	4.37	77.44	1.81
A2×B2	2301	72.03	2.47	1.65	0.58	4.70	76.73	2.09
A3×B1	2235	71.58	2.97	1.57	0.52	5.07	76.65	1.70
A3×B2	2230	71.50	2.40	1.72	0.51	4.64	76.13	1.86
SEM¶	57.49	0.71	0.17	0.17	0.04	0.27	0.64	0.24
Significance level	NS	NS	NS	NS	NS	NS	NS	NS

Ns: Not significant

Blood parameters of broiler chicks:

Effects of dietary sunflower oil and cage density on blood plasma parameters of 6-week-old broiler chicks during summer season are summarized in Table 4. Apart from the effect of stocking density, added dietary sunflower oil significantly increased (P≤0.05) blood plasma glucose level but had no significant effect on other blood parameters (levels of total

protein, albumin, globulin, cholesterol and triglycerides, and activity of AST and ALT in blood plasma), examined in the present study. Regardless of the effect of added dietary sunflower oil, decreasing cage density of broiler chicks from 11.3 to 9.04 birds/m^2 led to a significant increase ($P \leq 0.05$) in plasma level of triglycerides but other blood parameters were not affected. Dietary sunflower oil by cage density interactions were not significant for all blood parameters of broilers, estimated in the present study (Table 4).

In accordance with the present results, Zulkifli *et al.* (2007) found that dietary supplementation with soybean oil or palm oil had no significant effect on blood plasma levels of total protein and cholesterol in broilers. However, Mondal *et al.* (2007) found that inclusion of soybean oil in broiler chicks' diet (4%) decreased plasma total cholesterol, high density lipoprotein cholesterol, triglycerides and very low density lipoprotein cholesterol but concentrations of glucose and total protein were unaffected. In addition, Monfaredi *et al.* (2011) found that broiler chicks fed diets supplemented with 2 or 4% soybean oil exhibited comparable levels of serum triglycerides and very low density lipoprotein to those of the control group but levels of cholesterol, high- and low-density lipoproteins were significantly increased while serum glucose level was decreased due to dietary oil supplementation.

Table 5: Effects of dietary sunflower oil and cage density on blood plasma parameters of 6-week-old broiler chicks during summer season

Treatments	GLU[1] mg/dl	CHO[2] mg/dl	TPR[3] g/dl	ALB[4] g/dl	GLO[5] g/dl	TRI[6] mg/dl	AST[7] U/l	ALT[8] U/l
Main effects:								
Added oil: A								
0.00% (A1)	221[b]	148	4.30	1.75	2.55	168	95.7	35.2
1.25% (A2)	236[a]	146	4.32	1.70	2.62	169	97.8	35.5
2.50% (A3)	243[a]	149	4.33	1.62	2.72	166	96.2	36.2
SEM¶	4.85	1.33	0.06	0.18	0.19	2.30	3.33	1.09
Significance level	*	NS	NS	NS	NS	NS	NS	NS
Cage density: B								
9.04 Birds/m^2 (B1)	232	147	4.31	1.67	2.64	164[b]	96.6	35.7
11.30 Birds/m^2 (B2)	234	148	4.32	1.71	2.61	171[a]	96.6	35.6
SEM¶	3.96	1.09	0.05	0.14	0.16	1.87	2.72	0.88
Significance level	NS	NS	NS	NS	NS	*	NS	NS
AB Interaction								
A1×B1	221	149	4.33	1.73	2.60	162	96.0	35.7
A1×B2	220	146	4.27	1.77	2.50	175	95.3	34.7
A2×B1	229	145	4.30	1.73	2.57	164	99.7	35.3
A2×B2	244	147	4.33	1.67	2.67	172	96.0	35.7
A3×B1	246	148	4.30	1.53	2.77	166	94.0	36.0
A3×B2	239	150	4.37	1.70	2.67	166	98.3	36.3
SEM¶	6.86	1.89	0.08	0.25	0.27	3.25	4.71	1.54
Significance level	NS	NS	NS	NS	NS	NS	NS	NS

[a-b]: For each of the main effects, means in the same column bearing different superscripts differ significantly ($P \leq 0.05$). NS: Not significant. *:Significant at $P \leq 0.05$. ¶:Standard errors of means.

[1-8]: Refer to levels of glucose, cholesterol, total protein, albumin, globulin, triglycerides, aspartate aminotransferase and alanine aminotransferase.

The present results are also in line with the findings of El-Deek and Al-Harthi (2004), who observed no significant impact of stocking density on most of blood plasma constituents or liver functions, as evidenced by activity of ALT and AST in blood plasma. Similarly, Dozier *et al*. (2005) and Thaxton *et al.* (2006) indicated that stocking densities, at least from 20 to 55 kg of body weight/m^2, did not cause physiological stress in broilers. In harmony also with the present results, Yakubu *et al.* (2009) reported that stocking density (8.3, 11.1 and 14.3 birds/m^2) exerted no influence on serum biochemical components (total protein, albumin, globulin, glucose, cholesterol, and creatinine) of broiler chicks. In partial agreement with the present results, Tayeb *et al.* (2011) found that stocking density of broiler chicks (8.66, 10.41 and 13.36 birds/m^2) did not affect blood plasma levels of total protein, albumin, triglycerides or low-density lipoprotein while levels of glucose, cholesterol, high-density lipoprotein and very low density lipoprotein were significantly reduced as stocking density increased. However, Onbasilar *et al.* (2008) reported that high stocking density (17.5 *vs*. 11.9 birds/m^2) caused significant elevations in levels of blood serum glucose and cholesterol in broiler chickens.

Based on the results of this study, it can be concluded that reducing stocking density and dietary supplementation with sunflower oil in summer season can be used for obtaining normal growth performance of broiler chicks.

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تأثير إضافة زيت عباد الشمس علي أداء النمو لكتاكيت اللحم تحت مستويين من كثافة الإسكان خلال فصل الصيف

محمود حسن ربيع ، السمرة حسن علي أبو عجلة ، فوزي صديق عبد الفتاح إسماعيل و سارة خليل شريف

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أجريت تجربة عاملية (3×2) علي كتاكيت اللحم (هبرد) لبحث تأثير التغذية علي علائق مدعمة بثلاثة مستويات من زيت عباد الشمس علي أداء النمو لكتاكيت اللحم تحت مستويين من كثافة الإسكان خلال فصل الصيف. تم تكوين ثلاث علائق تجريبية متساوية في محتواها من البروتين الخام وتم تدعيمها بزيت عباد الشمس (صفر، 1.25 ، 2.5% من العليقة). تمت التربية في بطاريات تسمين بمستويين من كثافة الإسكان (9.04 أو 11.30 طائر/م^2) وغذيت الكتاكيت علي العلائق التجريبية الخاصة بها كما أتيح لها الوصول للماء والغذاء بحرية خلال الفترة التجريبية من 2-6 أسابيع من العمر. وتضمنت القياسات المأخوذة أداء النمو ومعاملات هضم العناصر الغذائية، ومواصفات الذبيحة، وبعض مقاييس الدم.

ويمكن تلخيص النتائج المتحصل عليها فيما يلى : بغض النظر عن تأثير كثافة الإسكان، أدت التغذية علي العلائق المدعمة بزيت عباد الشمس إلي زيادة معنوية فى أداء النمو (وزن الجسم النهائي والزيادة الوزنية ومعامل التحويل الغذائي) ومعامل هضم كل من المادة الجافة، والمادة العضوية، والبروتين الخام، والدهون، والنتيروجين المحتجز وتركيز الجلوكوز ببلازما الدم. بينما لم تؤثر إضافة الزيت للعليقة على الغذاء المأكول ، ومواصفات الذبيحة ، ومعامل هضم كل من الألياف الخام، والمستخلص خالي الأزوت، أو الرماد المحتجز وتركيز البلازما من الكوليستيرول والبروتين الكلى والألبيومين والجلوبيولين والجلسريدات الثلاثية أو نشاط إنزيمات الكبد (AST، ALT). وبغض النظر عن تأثير إضافة الزيت للغذاء، أدي خفض كثافة الإسكان إلي تحسن معنوي في وزن الجسم النهائي والزيادة الوزنية ومعامل التحويل الغذائي وكذلك معاملات هضم كل من المادة الجافة، والمادة العضوية، والبروتين الخام، والمستخلص خالى الأزوت، والنتيروجين المحتجز وتركيز الجلسريدات الثلاثية ببلازما الدم. بينما لم تؤثر كثافة الإسكان معنوياً على الغذاء المأكول ، ومواصفات الذبيحة ، ومعاملات هضم كل من الدهون، والألياف الخام، والرماد المحتجز وتركيز البلازما من الجلوكوز الكوليستيرول والبروتين الكلى والألبيومين والجلوبيولين أو نشاط إنزيمات الكبد (AST، ALT). ولم يكن للتفاعل بين إضافة الزيت للغذاء وكثافة الإسكان تأثير معنويا علي معظم القياسات المأخوذة في هذه الدراسة. وبناء علي نتائج هذه الدراسة يمكن أن نستنتج أنه بخفض كثافة الإسكان وتدعيم الغذاء بزيت عباد الشمس يمكن أن يستخدم للحصول علي أداء نمو طبيعي لكتاكيت اللحم خلال فصل الصيف.

قام بتحكيم البحث

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