ISSN 1682-8356
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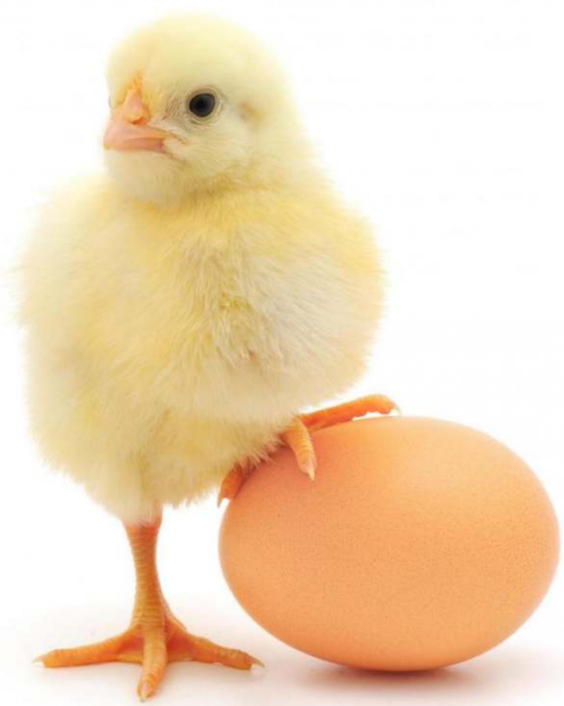

INTERNATIONAL JOURNAL OF POULTRY SCIENCE

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International Journal of Poultry Science 7 (4): 355-359, 2008
ISSN 1682-8356

Influence of Dietary Energy and Poultry Fat on the Response of Broiler Chicks to Heat Therm

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Abstract: Heat stress and the associated production losses and mortality are a challenge to commercial broiler production. A total number of 1000 one day old unsexed Arbor Acres broiler chicks were used in this study. Birds were offered with water and grower diet containing 23% crude protein and 3100 kcal ME/ kg of the diet from 1 to 4 weeks of age. At 29 day of age, 900 birds of nearly similar live body weight (about 850 g) were chosen to study the effect of different levels of metabolizable energy (ME) and poultry fat (PF) on broiler performance, nutrients digestibility and carcass characteristics during the hot summer season (29 - 36°C and 50 - 60% H). The birds were randomly distributed into 9 treatments, each contained 100 birds in 4 replicates of 25 birds each. Three levels of ME and three levels of PF were tested in 3 X 3 factorial designs to alleviate the side effects of heat stress on broiler chick performance. The tested ME levels (kcal/ kg) were 3100 (low level, ME_1), 3200 (recommended level, ME_2) and 3300 (high level, ME_3). The tested three levels of PF were 0 % (PF_1), 2.5% (PF_2) and 5% (PF_3) for each level of ME. Chicks were allocated in a littered floor poultry house in an open system under the same management conditions. Water and feed were offered *ad-libitum* and artificial lighting was provided 24 hours daily for the either experimental period, which lasted for 7 weeks.The overall results showed that the average body weight, body weight gain, feed conversion ratio and performance index were improved significantly with high levels of either metabolizable energy or poultry fat. Data showed that the digestion coefficient of both crude protein and ether extract were improved significantly when broiler chicks were fed diets containing high level of either metabolizable energy or poultry fat. Results indicated that the average values of abdominal fat increased significantly with high levels of either metabolizable energy or poultry fat. While, there were no significant differences for either dressing percentage or giblets due to dietary treatments. Therefore, it is suggested to increase dietary metabolizable energy more than recommended level and adding fat up to 5 % of the diet to alleviate the side effects of heat stress on the performance of broiler chicks.

Key words: Heat stress, broiler, performance, energy and poultry fat

Introduction

In tropical and subtropical regions, hot climate is a major limiting factor for broiler production because broilers have a very poor heat tolerance, especially with rapidly growth. (Arjona *et al.*, 1988; Osman, 2000; Tollba *et al.*, 2004; Abd-Elsamee, 2005). indicated that as environmental temperature exceeds 35°C, morbidity and mortality of broilers increased substantially. Also, increasing ambient temperature above 30°C from 4 weeks of age up to marketing reduced growth performance as a result of decreasing feed intake, growth rate and feed utilization of broilers (Cahaner and Leenstra, 1992; Teeter, 1995; Hussein, 1996; Cooper and Washbrun, 1998; Yalcin *et al.*, 2001; Al-Harthi *et al.*, 2002 and Abd-Elsamee, 2005). Moreover, exposure of chickens to heat stress (32°C) tends to reduce nutrients digestibility as a result of decreasing blood flow to the digestive system. This would reduce proteolytic enzymatic activities (Belay *et al.*, 1993; Zuprizal *et al.*, 1993 and Bonnet *et al.*, 1997). In order to overcome the adverse effect of heat stress on broiler performance, a considerable amount of research has been conducted upon nutritional parameters such as increasing dietary metabolizable energy to improve broiler performance during heat stress (Yalcin *et al.*, 1998; Rosa *et al.*, 2000; Al-Harthi *et al.*, 2002; Lou *et al.*, 2003 and Raju *et al.*, 2004). While, Baghel and Pradhan (1990) and Hoffmann *et al.* (1991) recommended reducing dietary metabolizable energy during hot conditions. On the other hand, the performance of broiler chicks was improved with using fat in broiler chick diets (Smith *et al.*, 2003; Ghazalah *et al.*, 2007). Furthermore, the addition of fat in broiler diets during heat stress is another method to alleviate the side effects of heat stress on broiler performance due to the low in heat increment of fat (Dale and Fuller, 1980 and Deaton *et al.*, 1984). However, Sinurat and Balnave (1985) did not measure the beneficial effect of broiler performance due to adding levels of fat in broiler chick diets under hot conditions.

Table 1: Composition and calculated analysis of experimental diets

	3100 kcal (ME_1) Poultry fat (PF)			3200 kcal (ME_2) Poultry fat (PF)			3300 kcal (ME_3) Poultry fat (PF)		
Ingredients	0 %	2.5 %	5.0 %	0 %	2.5 %	5.0 %	0 %	2.5 %	5.0 %
Yellow corn	69.00	63.00	57.70	71.10	65.50	60.10	72.90	67.40	62.00
Soybean meal (44%)	14.00	23.60	32.00	7.00	16.00	24.50	1.00	9.00	17.50
Corn gluten (60%)	13.00	7.00	1.50	17.80	12.00	6.60	22.00	17.00	11.50
Poultry fat	-	2.50	5.00	-	2.50	5.00	-	2.50	5.00
Di-Ca phos.	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Na Cl	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Vit. AND Min. Premix *	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Dl-methionine	0.05	0.10	0.20	-	0.05	0.10	-	-	0.10
L-lysine HCl	0.30	0.20	-	0.50	0.35	0.10	0.50	0.50	0.30
Total	100	100	100	100	100	100	100	100	100
Calculated analysis**									
CP %	20.03	20.08	20.04	20.07	20.00	20.01	20.06	20.10	20.05
ME kcal/ kg	3107	3100	3105	3203	3202	3208	3300	3300	3305
EE %	3.16	5.42	7.71	3.25	5.53	7.82	3.33	5.62	7.90
CF %	2.80	3.25	3.64	2.43	2.85	3.24	2.12	2.48	2.87
Ca %	0.85	0.88	0.90	0.83	0.86	0.88	0.82	0.84	0.86
Avail. P %	0.49	0.50	0.50	0.48	0.49	0.49	0.48	0.48	0.49
Lys. %	1.02	1.04	1.09	1.03	1.07	1.02	1.00	1.07	1.06
Meth. %	0.52	0.50	0.54	0.52	0.51	0.51	0.57	0.52	0.55
Meth. + Cys. %	0.84	0.81	0.84	0.84	0.82	0.81	0.89	0.84	0.86

* Vitamin and mineral premix at 0.3 % of the diet supplies the following per kg of the diet: Vit. A 12000 IU, Vit. D_3 3500 IU, Vit. E 30 mg, Vit. K_3 3 mg, Vit. B_1 3 mg, Vit. B_2 8 mg, Pantothenic acid 12 mg, Folic acid 1 mg, Biotin 5 mcg, Choline chloride 600 mg, Niacin 66 mg, Vit. B_6 5 mg, Vit. B_{12} 20 mcg, Mn 100 mg, Fe 100 mg, Zn 75 mg, Cu 8 mg, I2 45 mcg and Se 10 mcg. ** According to NRC (1994).

Due to these conflicting results, this work was conducted to define the best combination of metabolizable energy and fat levels required for the optimum growth performance of broiler chicks during hot summer season.

Materials and Methods

This work was conducted at the Department of Animal Production, Faculty of Agriculture, Cairo University, during the summer season (July and August months). The analytical part of study was conducted at the Laboratories of the same Department. A total number of 1000 one day old unsexed Arbor Acres broiler chicks were used in this study. Birds were reared under the same management conditions and offered with water and grower diet containing 23 % crude protein and 3100 kcal ME/ kg of the diet from 1 to 4 weeks of age. At 29 day of age, 900 birds of nearly similar live body weight (about 850 g) were chosen to study the effect of different levels of metabolizable energy (ME) and poultry fat (PF) on broiler performance, nutrients digestibility and carcass characteristics. The birds were randomly distributed into 9 treatments; each contained 100 birds in 4 replicates of 25 birds each. All diets were formulated to contain the tested levels of metabolizable energy and poultry fat. Three levels of ME and three levels of PF were tested in 3 X 3 factorial designs to alleviate the side effects of heat stress on broiler chick's performance. The tested ME levels (kcal/ kg) were 3100 (low level, ME_1), 3200 (recommended level, ME_2) and 3300 (high level, ME_3). The three levels of PF were 0 % (PF_1), 2.5% (PF_2) and 5% (PF_3) for each level of ME as shown in Table 1. All experimental diets were isonitrogenous (23% CP). Chicks were allocated in a littered floor poultry house in an open system under the same management conditions. Water and feed were offered *ad-libitum* and artificial lighting was provided 24 hours daily for the experimental period, which lasted for 7 weeks. The minimum and maximum ambient temperatures were recorded daily at noon (12 p.m). The ambient Temperature ranged between 29 and 36°C and relative humidity was 50-60%. Live body weights and feed intake were recorded at the end of the experimental period, besides; records of daily mortality of birds were obtained. Body weight gain and feed intake values were used to calculate the values of feed conversion ratio. The performance index (live body weight (kg) X 100/ feed conversion ratio) was also calculated according to North (1981). At 49 days of age, 8 birds (4 males and 4 females) of each treatment were randomly taken and housed in individual cages to determine the nutrients digestibility, thereafter; these birds were used to study the carcass characteristics. The assigned birds were individually weighed, slaughtered to complete bleeding, followed by feathers plucking. Weights of dressing, giblets and abdominal fat were expressed relative to live body weight. The analyses of feed and dried excreta were done according to A.O.A.C. (1990). The data obtained were examined statistically by using MSTAT-C (1989) procedures. Differences among treatment means were separated by Duncan's new multiple range test (Duncan, 1995). Significance was defined as $P<0.05$.

Results and Discussion

Broiler performance: The effect of dietary treatments on broiler performance is presented in Table 2. Results showed that the average body weight, body weight gain, feed intake, feed conversion ratio and performance index were improved significantly (P<0.05) when broiler chicks were fed diets containing the high level of metabolizable energy (ME_3) compared to those fed diets containing either the recommended metabolizable energy level (ME_2) or low level of metabolizable energy (ME1). These results were confirmed by Nagra and Sethi (1993) and Al-Harthi *et al.* (2002) who indicated that broiler performance increased significantly with increasing dietary metabolizable energy during heat stress. On the contrary to our findings, Baghel and Pradhan (1990) and Hoffmann *et al.* (1991) found that dietary metabolizable energy must be decreased when broiler chicks were reared under heat stress conditions. They indicated that the total amounts of ME used for maintenance and growth were maximum in the cold season followed by that in hot season. Also, data in Table 2 showed that when broiler chicks were fed diets containing 5 % poultry fat (PF_3), the average values of broiler performance were improved significantly (P<0.05) comparing to other levels of added poultry fat. This could be attributed to improving the diet palatability and increasing the amounts of feed intake due to adding poultry fat to broiler chick diets. The beneficial effect of high fat diets on heat stressed chick's results largely from the associative dynamic effect of such diets. There is now sufficient evidence to show that the associative dynamic effect, originally attributed simply to a decrease in heat increment when dietary mixtures contained fat. The same results were obtained by Dale and Fuller (1980) and Deaton *et al.* (1984) who found that broiler chicks which received high dietary fat gained more weight than those fed low dietary fat level, when they fed broiler chicks the diets containing different levels of fat ranged between 2.5 and 10 % under heat stress conditions (22 - 35^{o}C). In contrast to these results, Sinurat and Balnave (1985) fed broiler chicks diets containing different levels of fat under heat stress conditions and did not find any improvement in broiler performance. Table 2 results also showed the interaction of dietary metabolizable energy X poultry fat on broiler performance. Data showed that the best results were recorded when broiler chicks were fed a diet containing highest level of ME (ME_3) through the addition of highest level of poultry fat (PF_3). While, the worst performance was recorded when broiler chicks were fed the diet which contained the lowest level of ME (ME_1) without poultry fat supplementation (PF_1).

Nutrients digestibility: The effects of dietary ME and PF and their interaction on nutrients digestibility of the experimental diets are presented in Table 3. Results showed that the average digestion coefficients of crude

Table 2: Effect of dietary treatments on broiler performance

Treatments			Broiler performance				
No.	ME	PF	BW (g)	BWG(g)	FI (g)	FCR	PI
	ME_1	-	1680^c	830^c	2019^b	2.43^a	69.1^c
	ME_2	-	1781^b	931^b	2121^a	2.28^b	78.1^b
	ME_3	-	1824^a	974^a	2118^a	2.17^c	84.1^a
	-	PF_1	1720^c	870^c	2061^b	2.34^a	73.5^c
	-	PF_2	1753^b	903^b	2079^b	2.30^a	76.2^b
	-	PF_3	1812^a	962^a	2116^a	2.19^b	82.7^a
1	ME_1	PF_1	1650^e	800^e	2000^e	2.50^a	66.0^h
2	ME_1	PF_2	1683^d	833^d	2033^{de}	2.44^b	68.9^g
3	ME_1	PF_3	1705^d	855^d	2023^{de}	2.36^c	72.2^f
4	ME_2	PF_1	1753^c	903^c	2115^{bc}	2.34^{cd}	74.9^e
5	ME_2	PF_2	1760^c	910^c	2098^{bc}	2.30^d	76.5^d
6	ME_2	PF_3	1830^b	980^b	2150^{ab}	2.19^e	83.5^b
7	ME_3	PF_1	1758^c	908^c	2069^{cd}	2.28^d	77.1^c
8	ME_3	PF_2	1815^b	965^b	2108^{bc}	2.18^e	83.3^b
9	ME_3	PF_3	1900^a	1050^a	2176^a	2.07^f	91.8^a
L.S.D			26	22	57	0.05	0.6

$^{a, b, c, ...}$ Means in each column, within each item, bearing the same superscripts are not significant different (P<0.05). BW = Body weight BWG = Body weight gain FI = Feed intake. FCR = feed conversion ratio PI = Performance index.

Table 3: Effect of dietary treatments on nutrients digestibility

Treatments			Nutrients digestibility (%)				
No.	ME	PF	OM	CP	EE	CF	NFE
	ME_1	-	70.6^b	82.5^b	78.2^b	22.3^a	72.1^a
	ME_2	-	71.2^a	82.4^b	77.6^b	22.7^a	71.8^a
	ME_3	-	71.4^a	83.1^a	80.4^a	22.8^a	71.7^a
	-	PF_1	69.6^b	81.9^b	69.2^c	22.4^a	71.7^a
	-	PF_2	71.5^a	82.8^b	80.9^b	22.3^a	71.9^a
	-	PF_3	72.1^a	83.2^a	86.2^a	23.1^a	71.9^a
1	ME_1	PF_1	68.6^e	81.8^{ef}	67.9^f	21.9^a	71.7^a
2	ME_1	PF_2	71.1^c	82.5^{cd}	80.8^{cd}	21.7^a	72.6^a
3	ME_1	PF_3	72.0^{ab}	83.1^{ab}	85.9^b	23.3^a	72.1^a
4	ME_2	PF_1	70.2^d	81.6^f	68.1^f	22.8^a	71.8^a
5	ME_2	PF_2	71.5^{bc}	82.8^{bc}	79.9^d	22.3^a	71.2^a
6	ME_2	PF_3	71.9^{ab}	82.9^{bc}	84.9^b	22.9^a	72.3^a
7	ME_3	PF_1	69.9^d	82.3^{de}	71.6^e	22.6^a	71.6^a
8	ME_3	PF_2	71.9^{ab}	83.3^{ab}	81.9^c	22.9^a	72.0^a
9	ME_3	PF_3	72.5^a	83.7^a	87.8^a	23.0^a	71.5^a
		L.S.D	0.6	0.5	1.2	1.8	1.5

$^{a, b, c, ...}$ Means in each column, within each item, bearing the same superscripts are not significant different (P<0.05).

Table 4: Effect of dietary treatments on carcass characteristics

Treatments			Carcass characteristics (%)		
No.	ME	PF	Dressing	Giblets	Abdom-inal fat
	ME_1	-	62.1^a	5.97^a	3.44^b
	ME_2	-	62.0^a	5.95^a	3.52^b
	ME_3	-	62.1^a	5.96^a	3.86^a
	-	PF_1	62.0^a	5.95^a	2.67^c
	-	PF_2	62.3^a	5.94^a	3.59^b
	-	PF_3	61.9^a	6.00^a	4.56^a
1	ME_1	PF_1	62.1^a	5.93^a	2.34^e
2	ME_1	PF_2	62.3^a	5.95^a	3.54^c
3	ME_1	PF_3	61.9^a	6.04^a	4.44^b
4	ME_2	PF_1	62.3^a	5.95^a	2.57^e
5	ME_2	PF_2	62.1^a	5.84^a	3.58^c
6	ME_2	PF_3	61.8^a	6.06^a	4.42^b
7	ME_3	PF_1	61.7^a	5.96^a	3.10^d
8	ME_3	PF_2	62.4^a	6.02^a	3.63^c
9	ME_3	PF_3	62.2^a	5.91^a	4.82^a
		L.S.D	1.1	0.20	0.30

$^{a, b, c, ...}$ Means in each column, within each item, bearing the same superscripts are not significant different (P<0.05).

protein (CP) and ether extract (EE) were significantly ($P<0.05$) increased using the high level of ME (ME_3) compared with either the low (ME_1) or recommended level (ME_2). Moreover, the average value of ether extract digestibility was significantly ($P<0.05$) increased with the high level of poultry fat (PF_3) compared to either the low level (PF_2) or no poultry fat supplementation (PF_1). On the other hand, data showed that the average values of nutrients digestibility were nearly similar and there was no clear trend due to the interaction between dietary levels of metabolizable energy and poultry fat. In this respect, Mateos and Sell (1981) and Mateos *et al.* (1982) suggested that supplementing broiler diets with fat decreased the rate of food passage, thereby, permitting better digestion and intestinal absorption of nutrients. In agreement with our results, Ghazalah *et al.* (2007) showed improvement in the average values of nutrients digestibility due to using poultry fat in broiler chick diets.

Carcass characteristics: The effects of dietary treatments on carcass characteristics (carcass yield, giblets and abdominal fat %) are shown in Table 4. There were no significant differences ($P<0.05$) carcass yield and giblets due different levels of either metabolizable energy or poultry fat. While, when broiler chicks were fed diets containing high level of metabolizable energy (ME_3) or poultry fat (PF),$_3$ the average values of abdominal fat were increased significantly ($P<0.05$) compared to other treatment. Similar results were obtained by Al-Harthi *et al.* (2002) who found that the average values of abdominal fat were increased significantly with increasing metabolizable energy in broiler chick diets under heat stress conditions. Also, Ghazalah *et al.* (2007) showed an increase in abdominal fat for broiler chicks which received diets supplemented with dry fat. However, El-Metnawy (2005) found that there were no significant effects among dietary fat sources on all carcass characteristics of broiler chicks.

The results of this study indicated that the best performance of broiler chicks during hot summer season could be obtained by raising ME level of broiler chick diets up to 3300 kcal ME/ kg diet during the finishing period (5-7 weeks of age). In addition, poultry fat supplementation up to 5 % under such conditions could be useful to achieve performance the objects

Acknowledgement

The author acknowledges the help of Poul H. Patterson and Ralph M. Hulet Dep. Poultry Sci . Pennsylvania State University).

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