Alleviating the Harmful Effects of New Valley Summer on Growth Performance and Health Status of Japanese Quail by 1. Feeding time

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Abstract

A total number of one hundred and fifty unsexed one-day old chicks of Japanese quail were used to study the effect of feeding time on the growth performance of birds under subtropical prevailing environmental conditions in New Valley. All chicks were housed in batteries in five equal groups (3 replicates of 10 birds each). The birds of first group were full-fed *ad libitum* and were considered the control (C). While the second group (T1) was fed 75% of diet at morning and 25% of diet at afternoon; the third group (T2) was fed 50% of diet at morning and 50% of diet at afternoon; the fourth group (T3) was fed 25% of diet at morning and 75% of diet at afternoon; the fifth group (T4) was fed 0% of diet at morning and 100% of diet at afternoon. All experimental birds were supplied with clean water all the time. The obtained results indicated that change of feeding time affected body weight, feed conversion, most blood parameters, body temperature, viability rate and tonic immobility in Japanese quail. However, insignificant differences of plumage conditions and some carcass traits were observed among all experimental groups. Therefore, it could be recommended that feeding time (25% of diet at morning and 75% of diet at afternoon) during summer season could be applied successfully by the farm managers to have a better growth performance without any significant negative effects on production process.

Key Words: feeding time, summer, growth performance, Japanese quail

Introduction

In hot climates as Upper Egypt, poultry producers face the challenge of avoiding heat stress during summer season. Management and feeding systems are among the most important factors, which can relatively reduce the heat load (Diarra and Tabuaciri, 2014). Quail birds are very susceptible to high ambient temperature and consequently they face difficulty in eliminating excess of body heat especially when temperature exceeds the appropriate thermo neutral zone (Farghly 2017&2018). This effect leads to a remarkable depression in feed conversion for growth. Also, there are disturbances in metabolism of energy, protein and mineral balances, enzymatic, hormonal secretion and blood metabolism (Aengwanich, 2007; Farghly 2010&2011&2012; Farghly *et al.*, 2017; 2018abcd; 2019ac).

Many researchers reported that most of the bird's heat load comes from the feed metabolism (digestion, absorption and nutrient assimilation). Therefore, birds would be facing problematic conditions when the feeding time is at around 1000– 1100 h, as the heat of feed utilization coincides with the hottest part of the day especially in the summer season (Saiful *et al.*, 2002; Yahav *et al.*, 2004; Farghly and Makled 2015 and Farghly and Mahmoud 2018).

Many strategies to avoid the harmful effects of ambient high temperature can be applied on specific feed manipulations as feeding time (Aengwanich, 2007; Farghly *et al*., 2018a&2019bc). Whether feeding late during temperate time of the day can be used as a means to improve the feed conversion and health status. Therefore, the main objective of this study is choice of suitable feed time and quantity to improve growth performance of Japanese quail during summer season under New Valley conditions.

Materials and Methods

The present study was carried out at the research poultry unit of Poultry Production Department, Faculty of Agriculture, New Valley University, New Valley, Egypt. The experiment lasted during summer season (2017-2018), where the environmental temperature ranged between 21.6 °C at night to 36.9 °C at midday while, humidity was from 39.2 to 58.6% . A total number of one hundred and fifty, one-day old Japanese quail chicks (Coturnix coturnix japonica) were used in this study. All chicks were housed in batteries in five equal groups (3 replicates of 10 birds each). The birds of first group were full-fed *ad libitum* and were considered the control (C). While the second group (T1) was fed 75% of diet at morning and 25% of diet at afternoon; the third group (T2) was fed 50% of diet at morning and 50% of diet at afternoon; the fourth group (T3) was fed 25% of diet at morning and 75% of diet at afternoon; the fifth group (T4) was fed 0% of diet at morning and 100% of diet at afternoon. All experimental birds were supplied with clean water all the time. All experimental chicks were fed a starter diet (24% crude protein and 2600 Kcal/kg of diet) from 0 to 6 weeks of age.

The newly hatched chicks were exposed to continuous lighting for 24 hrs/day during the first 3 days of age. Thereafter, the photoperiod was decreased gradually (one hr/wk) to be adjusted to 12 and 16 hrs lighting regimens during the growing and laying periods, with light intensities of 10 and 20 Luxes, respectively. Three estimates for the indoor temperature and the relative humidity (%) were recorded for both the control and the treatment groups throughout the experimental period using a thermo hygrograph.

All experimented chicks were weighed individually from 0 to 6 weeks of age. The average body weight gain (BWG), feed consumption (FC) and feed conversion values (g feed/g gain, FCR) were calculated from 0 to 6 weeks of age. The following carcass parameters (dressing percentage , liver, heart and gizzard) were recorded. The body feathering area was using a scale from 1(completely feathered) to 5 (featherless). Body temperature (ºC) was measured by using a thermometer inserted into the rectum for 2 minutes at depth of 2 cm during feeding time. Leg problems and dead birds were recorded daily and expressed as percentages during the experimented period. Dead birds were recorded daily and expressed as percentage during the experimental period.

The blood samples were centrifuged at 3000 rpm for 15 min and the plasma obtained was stored at -20 ◦C until analysis. The total protein (TP), albumin (A), globulin (G), glucose and cholesterol levels of the plasma, as well as the transaminase enzymes activities (aspartate transferase, AST and alanine transferase, ALT), were determined colorimetrically, using diagnostic kits from Spectrum (Cairo, Egypt).

Statistical analysis: Data collected were subjected to ANOVA by applying the General Linear Models Procedure of SAS software (SAS Institute, 2009). Duncan methods (1955) were used to detect significant of differences among means of different groups. The percentages of HDP, fertility and hatchability were transformed to Arcsin values before statistical analysis.

Results and Discussion

1- Growth performance:

The results presented in Table (1), feeding time statistically (P<0.05) affected the BW, BWG and FCR of Japanese quail. The feeding time enhanced the BWG and considerably improved the final BW. Significant effects of the treatment were not observed on the FC at all groups. The remarkable increase of BW of Japanese quail fed at afternoon (T3 and T4) than those of birds fed at midday, could be attributed to feeding of birds during afternoon, which more adequate ambient climatic temperature (C°), consequently avoid the harmful effect of the high temperature in the summer season. Similar results were found by Farghly (2010&2011) who, found that a change in feeding time resulted in a significantly higher (P≤0.05) BWG in birds fed at 2200 to 0400 h (T1), 1000 to 1600 h (T2) and 2200 to 0400 h (T3) than those of C by about 6.4, 9.7 and 6.4 %, respectively. The timing of feed restriction is important for the expression of genes necessary for muscle satellite cell proliferation and the morphological development of the pectoralis major muscle in birds (Velleman *et al.*, 2014). Farghly and Makled (2015) found that broiler chicks that were intermittently fed were able to compensate the partial depression in body weight till the age of 3 weeks due to restricted feeding time. This fact may be a result of the gradual physiological adaptation of the birds to the feeding system mainly due to the improvement of efficiency of feed. Heat load can be decreased by improving the dissipation of heat production by managing the thermal production pattern (Farghly, 2011&2012). Exposure of birds to high temperature more than 35°C causes different detrimental changes in their biological functions, which lead to disturbances in metabolizable energy for growth. However, Bouvarel *et al.* (2004) found that hens did not utilize the energy of the feed as efficiently when birds fed at 0600 h as they did when fed at 1800h.

These obtained results are also coincided with the results of Bouvarel *et al.* (2004) and Farghly *et al.*, (2018ab), who stated that birds fed at afternoon had significantly (P≤0.05) higher body weight than those of birds fed at midday. Moreover, Avila *et al.* (2003) showed that time of feeding 6:30 AM had significantly (P≤0.05) higher body weight than those of birds fed at 3:30 PM due to the greater efficiency of feed utilization. On the other hand, Harms (1991) found a decrease in body weight when the time of feeding was changed from the morning to the afternoon.

Table 1. Growth performance affected by feeding time.

Traits		Treatments					SEM	P value
		C	T1	T2	T3	T4		
Body weight (g)	Initial	8.12	7.90	8.10	7.92	7.96	0.69	0.5462
	Final	215.62 ^{b}	219.42 ^{b}	235.94^{ab}	241.12^{a}	238.15 ^{a}	6.82	0.0413
Body weight gain (g/bird/day)		4.95 ^{b}	5.04 ^{b}	5.42 ^{ab}	5.55 ^{a}	5.48 ^{a}	0.229	0.0344
Feed consumption (g/bird/day)		14.97	15.11	13.99	14.00	14.98	0.692	0.6582
Feed conversion (g feed/g gain)		3.03^{a}	3.00^{a}	2.57 ^{b}	2.52 ^{b}	2.74 ^{ab}	0.384	0.0452

$^{a-----b}$ Means within row followed by different superscripts are significantly different (P<0.05).

The deleterious effect of the high temperature on appetite of birds and consequently on their feed consumption is logic and expected, since most of the bird's heat load comes from the feed, as consequences of digestion, absorption and nutrient assimilation or excretion. These obtained results are in agreement with the obtained findings by Keshavarz, (1998) who, found that the feed conversion for broilers fed during the period from 1300 to 2100 h, was superior to the other treatments. In the same trend, Abd El-Hakim and Abd-Elsamee (2003) and Farghly (2010) showed that feeding time significantly improved the feed conversion. In summer, high temperature evokes different detrimental changes in biological functions of bird, which lead to remarkable depression in appetite, feed consumption, metabolizable energy for growth and decreased efficiency of feed utilization (Farghly 2019b).

2. Carcass traits: Effect of feeding time on carcass traits was presented in table (2). Insignificant differences (P>0.05) in the liver, heart, and gizzard percentages were found among all groups except dressed carcass percentages. The dressed carcass of third and fourth groups (T3 and T4) significantly (P≤0.05) exceeded those of second and third groups (T1 and T3). While, the dressed carcass of first group (C) had an intermediate values. Farghly *et al.,* (2018abcd) found that ambient high temperature is related with reduction in dressed carcass and meat quality of chickens. Also in broilers, Zhang, *et al.,* (2012) reported that heat stress as chronic case reduced the percentage of breast muscle. Afsharmanesh *et al.,* (2016) found that high temperature had superior carcass percentage compared with birds fed dry feed.

Similar to our results, El-Fiky *et al.,* (2008) and Farghly and Hassanien (2012) demonstrated that liver weight as a percent of pre-slaughter weight was affected by the feeding frequencies. Camacho *et al.,* (2004) claimed that feed restriction had no significant impact on abdominal fat weight. Petek (2000) showed that broiler chickens of the 6-hours feed removal group had heavier weights of liver, gizzard, heart and carcass than that of the *ad libitum* fed and the 3- hours feed removal groups. Farghly (2012) reported no significant influence (P>0.05) in the proportions of giblets, liver, gizzard and heart after feed manipulation during summer season. Velleman *et al.,* (2014) found that feed timing of feed restrictions in chicks is critical in fat deposition, expression of adipogenic genes and development pectoralis major muscle. Farghly and Makled (2015) found that intermittent feed did not have a significant effect on the majority of carcass, liver and abdominal fat percentages.

Table 2. Carcass traits as affected by feed time.

Traits	Treatments					SEM	P value
	C	T1	T2	T3	T4		
Dressed carcass, %	75.36 ^{ab}	73.20 ^{b}	73.41 ^{b}	76.01 ^{a}	75.95 ^{a}	1.632	0.0448
Heart, %	0.86	0.85	0.86	0.90	0.87	0.054	0.8236
Liver, %	2.62	2.60	2.71	2.74	2.69	0.328	0.3726
Gizzard, %	2.21	2.19	2.30	2.33	2.31	0.230	0.5728

a-----b Means within row followed by different superscripts are significantly different (P≤ 0.05).

3. Blood constitutes:

Blood traits affected by wet feed were presented in table, (3). Significant differences (P≤0.05) in glucose observed among all treatments groups. However, no significant differences (P>0.05) were existed in all other blood parameters. Many studies found that blood metabolite levels consistently affected by heat stress (Mack *et al.,* 2013). Previous studies show an immune suppressing effect of ambient high temperature (Niu, *et al.,* 2009). Afsharmanesh *et al.,* (2016) reported that broiler chicks fed wet feed form had significant high levels of total cholesterol.

Farghly and Makled (2015), Farghly, and Enas Ahmad (2017) and Farghly *et al.,* (2018d) observed insignificant (P>0.05) differences were existed for studied plasma blood parameters (T protein, globulin, albumin, glucose, cholesterol, aspartate transferase, AST and alanine transferase, ALT concentrations) between the wet feed fed broilers and Muscovy ducklings.

Table 3. Blood traits affected by feed time.

Traits	Treatments					SEM	P value
	C	T1	T2	T3	T4		
Total protein (g/dl)	4.30	4.21	4.32	4.41	4.36	0.265	0.5864
Albumin (g/dl)	2.71	2.63	2.68	2.72	2.69	0.244	0.9384
Globulin (g/dl)	1.59	1.58	1.64	1.69	1.67	0.188	0.2856
A:G ratio	1.69	1.66	1.63	1.62	1.62	0.242	0.3425
Glucose (mg/dl)	15.04 ^{b}	14.81 ^{b}	16.82 ^{ab}	17.67 ^{a}	17.28 ^{a}	1.412	0.6352
Cholesterol (mg/dl)	155.42	157.36	151.82	152.69	158.51	7.39	0.2628
AST (u/ml)	178.81	182.50	173.64	171.32	172.41	6.53	0.8271
ALT (u/ml)	11.92	12.11	10.89	9.86	9.94	1.302	0.5324

a-----b Means within row followed by different superscripts are significantly different (P≤ 0.05).

4- Physiological and healthy traits:

Data presented in Table (4), show no significant differences (P≤0.05) in plumage conditions and leg problems among the studied treatments groups except body temperature (°C) and tonic immobility values. The average body temperature of T3 and T4 groups significantly (P≤0.05) decreased than those of C and T1 groups. The average tonic immobility of T2, T3 and T4 groups significantly (P≤0.05) decreased than those of C group. In same table, the mortality rates of the four experimented groups were 3.33, 0.00, 1.67, 0.00 and 1.67 % for C, T1, T2, T3 and T4 groups, respectively. It is well known that, most of the bird's heat load comes from digestion, absorption, assimilation of feed. Heat production peaks occur at 3 to 5 hrs after feeding cause almost 100% increase in heat production as compared to unfed birds. The increase in heat production associated with about +1°C rise in body temperature (Avila *et al.,* 2003). The findings of many researchers as Koh *et al.* (2000) found that heat production in fasted birds was much lower than that in fed birds at 26°C, changed little until 20°C and then increased steeply.

Wiernusz and Teeter (1993) observed that heat production and body temperature increased with feed intake at 24°C. They also showed that there were no differences in body temperature between feeding systems at 35°C, even though heat production increased with feed intake in broilers. They found that amount of feed intake did not consistently affect body temperature post feeding at 24°C or 35°C in broilers.

Birds can regulate or adjust their body temperatures in a narrow range of ambient temperatures from 16 to 26 °C (Diarra and Tabuaciri 2014). High temperature is enough to cause increased body temperature (Altan *et al.,* 2000 and Farghly 2018abc). Farghly and Makled (2015) and Farghly *et al.,* (2018d) reported that feed manipulations insignificantly (P>0.05) affected body temperature. However, they found that feeding practices insignificantly (P>0.05) affected conformations, foot pad burns, plumage conditions and leg problems. Beg *et al.,* (2011) found insignificant differences in mortality for feed form. Exposing birds to high temperature during midnight (more than three hours/day for 8 weeks during the summer) increased the mortality rate (Lin *et al.,* 2006). Farghly and Makled (2015) and Farghly *et al.,* (2018d) reported that feed practices insignificantly affected mortality rate.

Table 4. Physiological and healthy traits affected by feed time.

Traits	Treatments					SEM	P value
	C	T1	T2	T3	T4		
Body temp. (C°)	41.80 [a]	41.74 [a]	41.39 [ab]	41.11[b]	41.15[b]	0.202	0.0481
Plumage conditions	1.66	1.78	1.66	1.44	1.44	0.115	0.8532
Leg problems	1.52	1.42	1.42	1.38	1.42	0.162	0.4265
Tonic immobility test	83.10[a]	80.22 [ab]	72.40 [b]	52.26 [c]	58.52 [bc]	4.342	0.0362
Mortality rate, %	3.33	0.00	1.67	0.00	1.67	--	--

a-----b Means within row followed by different superscripts are significantly different (P≤ 0.05).

Conclusions

It could be concluded that the birds were fed 25% of diet at morning and 75% of diet at afternoon (T3) and birds were fed 0% of diet at morning and 100% of diet at afternoon (T4) were the best performance than other groups. This could be attributed to the superiority of T3 and T4 in growth performance and viability, as well as having adequate body temperature, which positively reflected on the health condition of the birds, while the T2 had an intermediate value. The feeding by 25% of diet at morning and 75% of diet at afternoon and birds were fed 0% of diet at morning and 100% of diet at afternoon for growing Japanese quail is highly recommended.

References

Abd El-Hakim, A.S. and Abd-Elsamee, M.O. (2003): Effect of feeding systems and phytase supplementation on the performance of broiler chicks during summer season. Egypt. Poult. Sci. J., 24: 297-310.

Aengwanich, W. (2007). Effects of High Environmental Temperature on Blood Indices of Thai Indigenous Chickens, Thai Indigenous Chickens Crossbred and Broilers. International J. of Poult. Sci., 6: 427-430.

Afsharmanesh M.; M. Lotfi and Z. Mehdipour (2016). Effects of wet feeding and early feed restriction on blood parameters and growth performance of broiler chickens. Anim. Nutr. 2:168–172.

Altan, O.; A. Altan; M. Çabuk and H. Bayraktar (2000). Effects of heat stress on some blood parameters in broilers. Turkish J. Vet. Anim. Sci., 24:145–148.

Avila, V., Penz, J.A., Brum, P.; Rosa P., Guidoni, A. and E. Figueiredo, (2003): Performance of female broiler breeders submitted to different feeding schedules. Rev. Bras. Cienc. Avic., 6:5.

Beg M.A.H.; M.A. Baqui; N.R. Sarker and M.M. Hossain (2011). Effect of stocking density and feeding regime on performance of broiler chicken in summer season. Inter. J. of Poult. Sci., 10: 365-375.

Bouvarel, I., B., Guillot, P.Larroude, B., Boutten, C., Leterrier, F., Merlet, M.Vilarino, L.Roffidal, S., Tesseraud, J.Castaing, and M. Picard, (2004). Sequential feeding programs for broiler chickens twenty-four- and forty-eight-hour cycles. Poult. Sci., 83: 49–60.

Camacho, M. A., M. E. Suarez, J. G. Herrera, J. M. Cuca and Carcia-Bojalil C. M. (2004). Effect of age of feed restriction and microelement supplementation to control ascites on production and carcass characteristics of broilers. Poult. Sci. 83:526–532.

Diarra S.S. and P. Tabuaciri, (2014). Feeding Management of Poultry in High Environmental Temperatures. Inter. J. of Poult. Sci., 13 (11): 657-661.

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

El-fiky, A., M. Soltan, F.H. Abdou, S. El- Samra and B. El- Neney (2008). Effect of light regime and feeding frequency on some productive, physiological traits and hormonal profiles in broiler chicks. Egypt. Poult. Sci., 28:711-743.

Farghly M.F.A., (2010). Productive and reproductive performance of Japanese quail as affected by time of feed in hot climate. Assiut Vet. Med. J. 56:202-224.

Farghly, M.F.A. (2011). Changing lighting and feeding time to alleviate the deleterious effect of hot summer of Assiut governorate on performance of Japanese quail. Egyptian J. Anim. Prod. 48, Suppl. Issue:315-330.

Farghly, M.F.A. (2012). Effect of mash, pellets, crumbles and wet feed on performance of Japanese quail during the summer. Egypt. J. Nutr. and Feeds 15:161-172.

Farghly, M.F.A. and H.H.M. Hassanien (2012). Effect of feed frequencies and durations on performance of broiler chicks. Egypt. Poult. Sci., 32: 273-288.

Farghly M. F. A. and M. N. Makled (2015). Application of intermittent feeding and flash lighting regimens in broiler chickens management. Egypt. J. Nutr. and Feeds, 18:261-276.

Farghly, M. F. A., (2017). Using different cage floor and litter types for raising Japanese quail during summer season. The 16th Scientific Conference of Animal Nutrition, 28 November to 1 December 2017, Luxor, Egypt.

Farghly, M. F. A. and Enas A. M. Ahmad (2017). Effect of intermittent feed and light programs on performance of broiler chicks. The 16th Scientific Conference of Animal Nutrition, 28 November to 1 December 2017, Luxor, Egypt (Abstract).

Farghly M. F. A.; Kh. M. Mahrose.; Z. Ullah; Z. Rehman and C. Ding (2017). Influence of swimming time in alleviating the deleterious effects of hot summer on growing Muscovy duck performance. Poult. Sci., (96): 3912 – 3919. http://dx.doi.org/10.3382/ps/pex207

Farghly M.F.A. (2018). Alleviating the deleterious effect of hot summer on performance of Japanese quail by cold water. The 18th conference of the Egyptian society of animal production, Hurghada, Egypt November 7- 10.

Farghly, M.F.A. and Usama T. Mahmoud (2018). Access to outdoor swimming pond during summer season improved Muscovy ducks performance and health status. Live sto. Sci., 211: 98-103

Farghly M. F. A.; Abd El-Hack M. E. and M. Alagawany (2018a). Feeding time can alleviate negative effects of heat stress on performance, meat quality and health status of turkey. Br. Poult. Sci., 59: 205-210. https://doi.org/10.1080/00071668.2017.1413233

Farghly M. F. A.; Kh. M. Mahrose; Ross G. Cooper; Z. Ullah; Z. Rehman and C. Ding (2018b). Sustainable floor type for managing turkey production in a hot climate. Poult. Sci., 97:3884-3890.

Farghly M. F. A.; Kh. M. Mahrose; A. E. Galal; Reham M. Ali; Enas A. M. Ahmad; Z. Rehman and C. Ding (2018c). Implementation of different feed withdrawal times and water temperatures in managing turkeys during heat stress. Poult. Sci., 97: 3076–3084.

Farghly, M.F.A., Abd El-Hack M. E., M. Alagawany, I M. Saadeldin and A. A. Swelum (2018d). Wet feed and cold water as heat stress modulators in growing Muscovy ducklings. Poultry Science, 97 (5), 1588-1594.

Farghly M. F. A., Kh. M. Mahrose, Enas A. M. Ahmad, Z. Rehman and Yu, Shengqing (2019a). Implementation of different feeding regimes and flashing light in broiler chicks. Poultry Science, (98): 2034-2042. https://doi.org/10.3382/ps/pey577.

Farghly M. F. A., A. Galal and E.A.M. Ahmad (2019b). Using wet feed in feeding Japanese quail under summer conditions. Egyptian Poultry Science Journal, 39 (2), 391-403.

Farghly, M.F.A.; Abd El-Hack M. E.; M. Alagawany; I M. Saadeldin and A. A. Swelum (2019c). Ameliorating deleterious effects of heat stress on growing Muscovy ducklings using feed withdrawal and cold water. Poult. Sci., (0): 1-8.

Harms, RH. (1991): The influence of changing time of feeding on performance of broiler breeder hens. Poult. Sci., 70: 1695-1698.

Keshavarz, K. (1998): Investigation on the possibility of reducing protein, phosphorus, and calcium requirements of laying hens by manipulation of time of access to these nutrients. Poult. Sci., 77: 1320–1332.

Koh, K.; Y.Karasawa and K. Sekigawa (2000). Effects of feeding on body temperature, heart rate and shivering threshold in growing broilers acutely exposed to the cold. Faculty of Agric., Shinshu

Univ., Minamiminowa, Nagano 399- 4598, Japan. Poult. Sci., 37: 12-18.

Lin, H.; Jiao, H.C.; Buyse J. and E. Decuypere (2006). Strategies for preventing heat stress in poultry. World's Poult. Sci., J. 62: 71-86.

Mack L.A.; Felver-Gant; J.N. Dennis; R.L.and H.W Cheng, (2013). Genetic variation alter production and behavioral responses following heat stress in 2 strains of laying hens. Poult. Sci., 92, 285–294.

Niu, Z.Y.; Liu, F.Z.; Yan, Q.L. and W.C. Li (2009). Effects of different levels of vitamin E on growth performance and immune responses of broilers under heat stress. Poult. Sci., 88: 2101–2107.

Petek, M. (2000). The effect of feed withdrawal during the day on some production traits and blood parameters of broilers. Turkish Journal of Veterinary and Anim. Sci., 24: 447-452

Saiful, I.M.; Fujita, M. and Ito, T. (2002): Effect of feeding levels and physical activities on heat production in laying hens under different ambient temperatures. Poul. Sci. 39: 118-125.

SAS (2009): SAS User's Guide, statistics (9.2th ed.) Cary NC: SAS Institute Inc.

Velleman S. G., C. S. Coy and D. A. Emmerson (2014). Effect of the timing of posthatch feed restrictions on the deposition of fat during broiler breast muscle development. Poult. Sci., 93:2622-2627.

Wiernusz, V.J. and Teeter, R.G. (1993): Feeding effects on broiler thermobalance during thermoneutral and high ambient temperature exposure. Poult. Sci., 72: 1917-1924.

Yahav, S.; Rath, R.S. and Shinder, D. (2004): The effect of thermal manipulations during embryogenesis of broiler chicks (Gallus domesticus) on hatchability, body weight and thermoregulation after hatch. J. of Thermal Biology. 29 (4-5):

Zhang Z.Y.; Jia G.Q.; Zuo, J.J.; Zhang Y.; Lei J.; Ren L. and D.Y. Feng (2012). Effects of constant and cyclic heat stress on muscle metabolism and meat quality of broiler breast fillet and thigh meat. Poult. Sci. 91:2931–2937.