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Effects of Cold and Heat Stress on Egg Quality Traits of a Newly Developed Native Hybrid Layer

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A B S T R A C T

ATAK-S is a newly developed native hybrid layer. Although the laying performance of this hybrid has been studied and determined, the performance response of the hybrid to different environmental temperature conditions is not known. This study was therefore undertaken to determine the effect of cold and heat stress on egg quality traits. Hens were divided into three different groups; control (20°C), low (12°C) and high (32°C). A total of 360 hens, with 120 in each of the groups, were used in the study. Hens were held in three tier battery cages in an environmentally controlled poultry house. The study lasted for 3 weeks. No differences were found among different groups in terms of shape index, albumen height and Haugh unit of the egg quality traits. It was found that the differences among the heat groups in terms of egg shell breaking strength, egg weight, shell thickness and yolk colour were significant and the value of these traits decreased under the heat stress conditions, whereas they were not affected from the cold stress.

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Yeni Geliştirilen Yerli Yumurtacı Tavuklarda Soğuk ve Sıcaklık Stresinin Yumurta Kalite Özellikleri Üzerine Etkisi

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Ö Z E T

ATAK-S yeni geliştirilen yerli ticari yumurtacı tavuktur. Bu tavukların verim özellikleri üzerinde araştırmalar yapılmış olmasına rağmen farklı çevre sıcaklıklarına karşı direnci konusunda bilgi bulunmamaktadır. Araştırma, soğuk ve sıcaklık stresinin bu tavuklarda yumurta kalite özellikleri üzerine etkisini belirlemek amacıyla yürütülmüştür. Tavuklar, kontrol (20°C), düşük (12°C) ve yüksek (32°C) sıcaklık olmak üzere üç farklı deneme grubuna ayrılmışlardır. Araştırmada her bir grupta 120 adet olmak üzere 360 adet tavuk kullanılmıştır. Tavuklar çevre kontrollü kümeste batarya tipi üç katlı bireysel kafeslerde barındırılmıştır. Stres uygulaması 3 hafta sürdürülmüştür. Araştırmada üzerinde durulan yumurta kalite özelliklerinden şekil indeksi, ak yüksekliği ve haugh birimi bakımından gruplar arasında farklılık bulunmamıştır. Yumurta kabuk kırılma mukavemeti, ağırlık, kabuk kalınlığı ve sarı rengi bakımından sıcaklık grupları arasındaki farklılığın önemli olduğu ve yüksek sıcaklık stresinde bu özelliklerin düştüğü tespit edilmiştir. Sonuç olarak, tavuklarda bazı yumurta kalite özellikleri sıcaklık stresi ile düşerken, soğuk stresinden etkilenmemiştir.

Introduction

Since mammals and bird species are warm-blooded animals, they have the ability to sustain their body temperature through heat loss or generation. Normally, the body temperature of hens is around 39.4-40°C. They will not be able to continue their normal performance during changes when there is an increase in body temperature. The thermo neutral zone, which is around 18-23.9°C for adult laying hens and 26-27°C adult broilers, is crucial for the metabolic and productive activity of hens. Energy is efficiently used for growth, immune system and reproduction activities within thermo neutral zone. On the other hand, hens use a large part of the energy for heat production or loss to control body temperature outside the thermo neutral zone. In such cases, efficiency of feed utilization decreases (Czarick III and Fairchild, 2008).

Heat stress in laying hens has a negative effect on egg efficiency, egg weight and egg quality traits (Daniel and Bolnave, 1979; Ahvar et al., 1982; Deaton, 1983; Gill and Ganwar, 1984; Moshaly et al., 2004; Rozenboim et al., 2007; Feizi et al., 2012). It is reported that there is a difference among lines in terms of tolerating the effect of heat stress and that it is necessary to evaluate the genetic differences with regard to the response against heat stress (Felver et al., 2012).

Many studies have been carried out in order to decrease the effect of heat stress and to prevent the decrease in production traits. Dai et al. (2009) reported that egg production and feed consumption gradually decreased when the drinking water of hens in heat stress was added with NaCl by 0.2 or 0.4% during the study. However the production traits returned to normal after the stress period and that the egg production rate decreased in the control group with no supplementation. In another study, it was found that feed efficiency, egg production and Haugh unit values increased by adding vitamin E to the feeds of hens under stress (Ehran and Bolukbasi, 2011). On the other hand, Yardibi and Turkay (2008) pointed out that adding vitamin E in different dosages to the diet has no positive effect on egg production.

The addition of y-aminobutyric acid (Hui et al., 2010), aspirin (XiaoTing and YouMing, 2002) and betain (Ryu et al., 2002) has been reported to increase or improve albumen height, Haugh unit, egg production, feed efficiency, shell weight and shell thickness or egg shell breaking strength during heat stress period.

ATAK-S is a newly developed commercial layer. It has been developed by crossbreeding of Rhode Island Red and Barred Rock (Durmus et al., 2009). Comparative studies have been undertaken to determine the laying performance of this layer hybrid. Hens of this hybrid reach sexual maturity at an age of 138 days with 1.83 kg of weight on average. Total egg production for 72 weeks has been determined as 312.8 with an average egg weight of 64.1 g. ATAK-S have a high viability rate, which is about 95.9%. On the other hand, the production response of this hybrid under different temperature and humidity conditions (heat or cold stress) has not been studied. The aim of this study was to investigate the production response of ATAK-S hybrid to heat or cold stress conditions.

Materials and Methods

Animal material of this study was 360 ATAK-S commercial laying hens located at the Poultry Research Station. Feeds fed to the hens throughout the study were presented with chemical composition in Table 1.

The study was conducted in 3 environmentally controlled poultry houses, each of which is a three tier poultry house that has battery type cage systems with a capacity of 120 hens. The temperature was set automatically to 20±2°C in control group, 12±2°C in low temperature group and 32±2°C in high temperature group. The relative humidity was set at 40% and ventilation was in a manner to provide 6.5 m^3/hour air circulations per kg live weight. Chicks were transferred to the poultry house after raising 16 weeks of age in rearing houses to which a 10h of environmentally controlled illumination was provided daily. Chicks were randomly distributed to the cage tiers. One pullet was placed to every cage with 29x43x51 cm dimensions. Illumination period was kept at 10h per day until the pullet reached 18 weeks of age; afterwards it was raised by one hour a week and fixed at 16h. Compact fluorescent lamps for illumination were placed with a distance of 120 cm from the cage on the middle tier in the manner to provide 4watt/m^2 of light intensity. Feeds were given as *ad libitum* to hens. Hens were subjected to heat stress for a period of 3 weeks after they reached 27 weeks of age. In the last two days of heat stress application, quality traits given below were determined on a total of 540 eggs, with 180 eggs from each group.

Egg weight: Weight of each egg was weighed by a scale with a sensitivity of 0.01g,

Shape Index: By means of shape index measurement instrument developed by Rauch,

Egg shell breaking strength: By means of shell measurement shell breaking strength instrument (Newton/cm^2),

Yolk Colour: In Roche scale value determined by digital yolk colour measurement instrument,

Shell Thickness: In mm, by means of micrometre,

Albumen height: Determined by tripod micrometre,

Haugh Unit: Calculated by the use of egg weight and albumen height,

Haugh Unit=100 Log(H+7.57–1.7 $G^{0,37}$)

H: Albumen height (mm)

G: Egg weight (g)

Statistical Analysis: The data obtained from the study were evaluated by using Minitab 16 Package Statistics Program. Analysis of variance was conducted with the intention of determining whether the differences between groups are essential, Tukey multiple comparison method was used in determining the differences between group means.

Result and Discussion

Egg quality traits in cold and heat stress conditions of the present study are presented in Table 2. No differences were found among different groups in terms of shape index, albumen height and Haugh unit of the egg quality traits in the study (P>0.05). However, shell breaking strength, egg weight, shell thickness and yolk colour differed among the temperature groups (P<0.05).

Egg shape index, Haugh unit and albumen height of the eggs did not change 3 weeks of heat or cold stress period in the present study (Table 2). These findings are not consistent with the results of Ahvar et al. (1982), Deaton (1983), Gill and Gangwar (1984), who found that albumen height and Haugh unit decrease when hens are kept under heat stress conditions. The difference between this study and other studies can be explained by the length of the stress period, which might not be long enough to observe the negative effects of the temperature stress especially high temperature (32°C).

Table 1 Feed materials with chemical compositions fed to hens in the study

Ingredients	0-3 weeks	4-10 weeks	11-16 weeks	17-30 weeks
	Diet composition, % of the diet			
Maize	56.3	50.7	53.3	56.9
Soybean meal	19.6	14.1	13.0	16.7
Sunflower meal	10.0	10.0	5.1	8.0
Wheat middlings	9.7	20.0	-	-
Full fat soybean	-	-	16.0	4.0
Vegetable oil	0.56	1.3	1.4	1.3
Other ingredients and additives	3.8	3.9	11.2	13.1
Nutrients	Chemical composition			
Dry matter, min (%)	88	88	88	88
Crude ash, max (%)	8	8	8	8
Crude protein, min (%)	19	18	16	18
Metabolic energy, min (kcal/kg)	2900	2800	2700	2800
Calcium, min-max (%)	1-1.2	1-1.1	0.9-1	3.5-4
Available phosphorus min (%)	0.45	0.42	0.40	0.40
Lysine, min (%)	1.15	0.98	0.72	0.75
Methionin, min (%)	0.55	0.47	0.35	0.47
Methonin+cystein min (%)	0.85	0.76	0.58	0.78
Triptophan, min (%)	0.20	0.19	0.17	0.20
NaCl, min-max (%)	0.35-0.50	0.35-0.50	0.35-0.50	0.35-0.50
Crude cellulose, max (%)	4.5	5	6	6
Linoleic acid, min (%)	1.5	1.25	1.0	1.7
A vitamin (IU/kg)	13 000	13 000	10 000	12 000
D_3 vitamin (IU/kg)	3 000	3 000	2 000	2 500
E vitamin (mg/kg)	20	20	20	20
K_3 vitamin (mg/kg)	2	2	2	2
B_2 vitamin (mg/kg)	5	5	5	5
B_{12} vitamin (mg/kg)	0.02	0.02	0.01	0.01
Niacin (mg/kg)	60	60	30	25
Mangan (mg/kg)	100	100	100	60
Zinc (mg/kg)	70	70	70	40
Iron (mg/kg)	40	40	40	40
Cupper (mg/kg)	7	7	7	7
Selenium (mg/kg)	0.2	0.2	0.2	0.2
Cobalt (mg/kg)	0.5	0.5	0.5	0.5

Table 2 Egg quality traits

Egg Quality Traits	Groups		
	Control (20±2°C)	Low (12±2°C)	High (32±2°C)
Shape index	78.244±0.181	77.900±0.214	77.278±0.850
Haugh Unit	79.326±0.616	80.852±0.590	80.999±0.735
Albumen height (mm)	6.343±0.081	6.508±0.079	6.446±0.094
Shell breaking strength (N/cm^2)	43.372±0.596[a]	44.856±0.497[a]	41.584±0.534[b]
Shell Thickness (mm)	0.337±0.002[a]	0.335±0.002[a]	0.323±0.002[b]
Egg Weight (g)	59.990±0.330[a]	59.874±0.307[a]	58.226±0.311[b]
Yolk colour (Roche scale 12)	11.278±0.050[a]	11.400±0.069[a]	10.804±0.078[b]

Within columns, means followed by different letters are significantly different at P = 0.05; n=180; ± expresses the standard error

Shell breaking strength, shell thickness, egg weight and yolk colour did not differ in hens under cold stress condition but substantially decreased under heat stress condition. Lack of difference between hens in control group and hens in cold stress can be explained by the ability of hens to balance their body temperature by obtaining additional feed during cold environmental conditions. This probably does not cause a serious problem for the metabolic and productive activities of birds (Czaric and Fairchild, 2008). However a limitation in the provision of feed to the hens under cold environments may likely result in effects, which are similar to those observed in heat stress conditions. The findings of hens under heat stress are consisted with those of Ahvar et al. (1982), Deaton (1983), Gill and Ganwar (1984), Patterson (2004), Rozenboim et al. (2007), and Daniel and Bolnave (1979), but are in contradiction with the findings of Dai et al. (2009) that heat stress does not affect egg weight, shell thickness, shell breaking strength and yolk colour.

Conclusion

In conclusion, heat stress decreases egg quality traits in ATAK-S layers and this situation will have a negative effect on both producers and consumers. In order to prevent such losses, the construction and management of poultry houses for ATAK-S, especially in regions with warm climate should carefully be planned and anti-stress measures should be taken.

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