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Effects of age, rearing system and their interaction on phenotypic characteristics in hisex brown laying hens

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ABSTRACT

The study was conducted in a commercial poultry farm in Quaish under Chittagong district to observe the effects of age and rearing system on phenotypic characteristics Hisex brown layer strains. Several phenotypic characteristics along with egg quality traits Hisex brown were studied. Three hundred cage and Three hundred litter reared hens were randomly selected. Feed and water were available ad libitum. Eggs were sampled in three age periods, from 20 to 26 weeks, 37 to 43 weeks and 54 to 60 weeks of age. No observable difference was found in plumage color, beak color, shank color, comb color, comb type and egg color in both rearing system. Significant ($P<0.05$) difference was found in shank length, egg weight and body weight and in cage rearing system it was 3.32±0.16, 59.44±0.42 and 1851.60±11.93, respectively where in case of litter system it was 3.19±0.01, 61.14±0.45 and 1849.10±33.90, respectively. Egg quality characteristics were affected by rearing system and age. Egg weight, yolk weight and percentage increased with the hens' age in both systems, but Egg shape Index decreased with age. The highest egg weight (61.14±0.45g) was found in litter rearing whereas highest yolk percentage (28.12±0.17%) was found in cage system at the final observation. It can be concluded that rearing system and age has effect on egg quality and any commercial layer strain improvement program should incorporate production objectives and trait performance of the society.

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1. Introduction

Bangladesh is an agricultural based densely populated country. About 71% of the population lives in rural areas (BBS, 2010a). The average per capita income is only US$ 1,314 (Bangladesh Bureau of Statistics, 2015). The majority of people are engaged in agricultural operations, particularly crops, fish and livestock, of which both native and exotic poultry are now mainstream. Approximately 20% of the protein consumed in developing countries comes from poultry meat and eggs (Alders and Pym, 2009). As an important sub-sector of livestock production, the poultry industry in Bangladesh plays a crucial role in economic growth and simultaneously creates numerous employment opportunities. The poultry industry, as a fundamental part of animal production, is committed to supplying the nation with a cheap source of good quality nutritious animal protein in terms of meat and eggs. Two main systems of poultry production are common in Bangladesh nowadays: commercial poultry production – where birds are kept in total confinement and traditional scavenging or semi-scavenging poultry production (Das et al., 2008).

Commercial broiler farming, nowadays, has become a promising and dynamic industry with enormous potential and serves as a tool for poverty reduction through self-employment and income generation of unemployed family members (Raha, 2007). Due to short life cycle, low capital investment and quick return it may be a good source of income to rural farmers throughout the year (Bhende, 2006). It plays a significant role in improving the livelihood of the farmers that is reflected in improved socio-economic conditions and increased empowerment of women among rural people of Bangladesh (Rahaman et al., 2006). Approximately 70% of people are suffering from malnutrition and about 81% of families do not have their caloric requirements met in Bangladesh. In addition, about 60% of families in Bangladesh are not able to meet their protein requirements from their diets. Consumption of protein of animal origin is much lower in the country than in some other countries of the world. This was also echoed recently by (Das et al., 2008). According to a recent report, the average per capita availability of meat is 23.6 g/ head/day compared against the standard human requirement of 120 g/head/day (Rahman et al., 2014).

Approximately 20% of the protein consumed in Bangladesh originates from poultry. With the exception the dip in production due to the recent Avian Influenza outbreak, the growth of this industry in terms of standards of commercialization, is very rapid. A gap still exists between the requirement and supply of poultry meat and eggs within the recent frame-work of the informal marketing system that is currently used. Among poultry species, the chicken population is dominant over others, at almost 90%, followed by ducks (8%) and a small number of quail, pigeons and geese. Free range 'backyard' and scavenging poultry, that are traditionally reared by rural women and children, still play an important role in generating family income, in addition to improving the family's diet with eggs and meat. Productive and reproductive performance of indigenous birds is relatively very low (35-40 eggs and 1-1.5 kg meat per bird per year), but genetic improvements by selective breeding, along with adequate nutrition and proper management, looks promising and quite possible. Commercial poultry production in Bangladesh, is conducted on an industrial scale and is growing tremendously in spite of recent difficulties but is expected to make a significant contribution to the economic development of the country (Das et al., 2008). Out of which, poultry plays an important role to fulfill the animal-source food (FAO, 2000; Permin and Pedersen, 2000). In Bangladesh, around 9% of total protein for human being consumption comes from livestock (Directorate of Livestock Services (DLS), 2012) and Poultry contribute 30% of animal protein and will increase to 40% within 2015 (Anonymous, 2000).

In Bangladesh about 150 hatcheries are producing around 4.56 millions of day old chicks (DOC) per week, about 70,000 commercial layer farms supplying 4,056 millions of table eggs per year (Directorate of Livestock Services (DLS), 2012). In year of 2007-2008 was Tk. 98253 million in which share of broiler farms was 36.97%, layer farms, 42.69%; hatchery, 9.83%; duck, 2.24%; and mixed farm, 8.28 % (Federal Parent Locator Service (FPLS), 2010). Different types of poultry farm in 2006-2008 in total were: Broiler farm 33225, layer farm 10099, hatchery 227, duck farm 5524, mixed 750 and total 49825. Percentage of existing poultry farms in 2006-2008: Broiler 28 %, Layer 23 %, hatchery 2 %, Duck 14 %, Mixed 6 %. The annual growth rate of all farms in 1995-2008 was 22%, during that time the annual growth rates for different types of farms were as broiler 28% (Federal Parent Locator Service (FPLS), 2010).

The genotype affects mainly egg weight and eggshell characteristics. Several studies have shown heavier eggs in brown hens than in white ones (Halaj and Grofík, 1994; Ledvinka et al., 2000; Leyendecker et al., 2001; Vits et al., 2005). (Baumgartner et al., 2007) reported a significant effect of age on egg weight in the Leghorn type hens. Egg weight influences the weight of its components as well. The correlations between the egg weight and the albumen weight, yolk weight, eggshell weight are high and range from 0.67 to 0.97 (Zhang et al., 2005). (Harms et al., 1990) reported the range of correlation between egg size and eggshell thickness as 0.92– 0.97. The egg shape index can also be affected by the genotype (Tůmová et al., 2007). Egg shape index in the white hens Shaver Starcross 288 was higher than in the brown Moravia SSL (Halaj and Grofík, 1994).

Heritability of the yolk weight is 0.45 (Zhang et al., 2005), 0.22 (Hartmann et al., 2000). The eggshell quality is given through its weight and percentage of the eggshell, thickness and strength. The main differences in eggshell quality depend on the way of breeding, strain or pure lines. Egg weight directly affects the egg size and shell thickness. For instance brown hens D 102 had a higher shell weight in comparison with lines of White Leghorn (Ledvinka et al., 2000).

The age of hens is another of the factors influencing egg weight. (Peebles et al., 2000; Silversides and Scott, 2001; Oloyo, 2003; Van Den Brand et al., 2004; Johnston and Gous, 2007) showed that the egg weight increased with the hens' age. On the other hand, (Zemková et al., 2007) demonstrated that the egg weight was not influenced significantly by age. The age of hens also increased yolk weight (Rossi and Pompei, 1995; Suk and Park, 2001; Van Den Brand et al., 2004), albumen weight (Rossi and Pompei, 1995; Suk and Park, 2001) and yolk proportion (Rossi and Pompei, 1995; Rizzi and Chiericato, 2010), but decreased albumen percentage (Van Den Brand et al., 2004; Rizzi and Chiericato, 2010). The age of hens influenced the eggshell quality (Silversides and Scott, 2001; Campo et al., 2007) which deteriorated with advancing age of hens. On the other hand, (Yannakopoulos and Tserveni-Gousi, 1987) observed that the eggshell was thicker with hens' age, while (Yannakopoulos et al., 1994) found no significant effect of the age of hens on eggshell characteristics. No effect of age on eggshell thickness was found by (Van Den Brand et al., 2004) and the shape index of the eggs decreased with age. The eggshell traits may be affected by interactions of age and breed (Campo et al., 2007).

Egg quality is influenced by many internal and external factors, of which genotype, housing system and time of oviposition are of major importance. Egg weight is one of the most important characteristics because each of the components of the egg depends on egg weight (Hartmann et al., 2000). The proportion of yolk is negatively related to egg size but positively associated with hen's age (Hartmann et al., 2000; Johnston and Gous, 2007).

In recent years in Europe there has been a significant trend to develop and use alternative housing systems rather than cages. Data from a number of studies revealed differences in egg quality depending on the housing system. In many cases, results are contradictory. (Moorthy et al., 2000; Leyendecker et al., 2001; Jenderal et al., 2004) reported higher egg weights in cages, while (Tůmová and Ebeid, 2005; Pištěková et al., 2006; Zemková et al., 2007) recorded heavier eggs on litter. Quality traits such as eggshell thickness, Haugh unit score and yolk index were reported to be higher in cages than on deep litter (Moorthy et al., 2000; Tůmová and Ebeid, 2005; Lichovníková and Zeman, 2008). Egg quality in different housing systems is also influenced by genotype. (Leyendecker et al., 2001) reported genotype and housing system interactions between Lohmann LSL and Lohmann Brown housed in conventional cages, aviaries or intensive free-range housing. (Vits et al., 2005) pointed out that eggshell quality characteristics were lower in enriched cages than in conventional cages, and that Lohmann brown hens showed better results compared to Lohmann LSL.

The monitoring of egg quality characteristics is important mainly in terms of production economy. The attention is devoted especially to eggshell quality, because cracked eggshell presents higher losses for market-egg producers. Therefore, it is very important to evaluate the egg quality characteristics and factors affecting them. The genotype and age are the most important factors, influencing not only egg weight but also other egg characteristics. The objective of this study was to determine the effect of age and rearing system on phenotypic characteristics of Hisex Brown strain and measure any possible interaction between these effects.

2. Materials and methods

The study was conducted on commercial layer farm at Quaish under Chittagong district. They reared about 27000 layers of Hisex brown in ten shed where five shed birds are reared in cage system and another five shed birds in deep litter system. In brooding shed, feed is provided adlibbed which contains 21% CP and 2900 kcal ME/kg up to 8 weeks and 16% CP and 2650 kcal ME/kg up to 18 weeks and in layer 18.73% CP and 2830.22 kcal ME/kg up to 72 weeks. The birds were vaccinated against Mareks, Newcastle, Fowl cholera, chicken pox and Gumboro diseases. The present study was conducted on layer strains of Hisex brown reared in a commercial poultry farm. A total of 600 birds (300 from each rearing system) were examined. Birds were observed in three time periods such as 20-26, 36-42 and 54-60weeks. The study was carried out from January 10, 2015 to November 4, 2015.

2.1. Housing and management

Brooding system, Lighting management system, Floor Space, Feeder and waterer, Feeding and Nutrition, Medication were observed and information's were collected from the farm by standard questionnaire. Each chick guard contains 1200 chicks where space was 720 square feet, contains electric brooder or gas brooder. It will be increased according to age and up to 16 weeks of age.

Clean water were supplied to bird and each 75 birds need one round drinker and after 3 days later used nipple drinker (one nipple drinker for 8 to 10 birds) with round drinker. The experimental farm supplied feed to Day old chick (DOC) on especial flat feeder for 2 days. Then provide linear feeder @ 2.5 cm/bird. Lighting schedule followed in this farm is given below in Table 2.

2.2. Data collection

The farm was visited every day and used to look after the birds and collected the data by observation and interviewing with the manager of the farm. Data of Amount of Feed intake (gm /bird/day), Body weight gain (gm /bird), Shank length (cm), Beak length (cm), Egg weight (g), Egg shape index ($SI = \frac{W}{L} \times 100$), Yolk weight (g), Yolk Percentage (%) were collected.

Here, W= Egg Weight (g); L= Egg Width (mm)

2.3. Data analysis

Collected data was edited and stored in Microsoft Excel. Mean with standard error of different traits were estimated by PROC GLM and PROC MIXED of SAS (SAS, 2008) by using the following design according to (Stell et al., 1980).

$$Y_{ijk} = \mu + T_i + S_j + e_{ijk}$$

Where,

Y_{ijk} = the observed value of a given individual;

μ = the overall mean for trait;

T_i= effect of weeks;

S_j= effect of rearing system; and

e_{ijk} = the random error associated with the measurement of each individual distributed as N (0, σ^2).

Mean differences were obtained by least significant differences (LSD) at 5% level of significance (Stell et al., 1980).

3. Results and discussion

The parameters which are related to this study about cage and litter reared commercial layer strains of three age groups are presented in Table 3. Several interactions between the rearing system and hen's age were found. In this study, the average body weight of cage type layers was found significantly (P<0.05) higher than litter in the later observation but it was vice-versa in initial observation. In cage type layers, body weight was found 1851 ± 11.93g. The cage type had a significantly (P ≤ 0.001) higher egg weight (55.44 g) than the litter (53.82g) at the beginning of the experiment, but at the end of the experiment litter system produced the heaviest eggs (61.14 g). The quality of yolk is given by yolk weight and its percentage. Both of these variables increased with age in both rearing system. The highest (P > 0.05) yolk percentage was at the age 54 to 60 weeks in cage rearing system (28.12%) in comparison with eggs of litter system (27.76%). Shank length of cage reared layers is significantly (P<0.05) higher than litter type for all age group. In cage type, it was found 3.32 ± 0.16 but in litter type, it was found 3.19 ± 0.01. Cage and litter type layers are not similar in beak length. The beak length of both types bird was 2.09 ± 0.01 and 2.07±0.00, respectively.

In this study, the mean egg shape index (SI) values were 78.52±0.99 and 78.94± 69 for the eggs of cage and litter type layers, respectively in initial observation. In final observation it was 75.09±0.77 and 75.34±0.81, respectively. Table 4 indicates the model parameters for cage and litter reared hens, were positive and cage reared hens showed higher values than the litter in terms of body weight. In case of egg weight the model parameter for litter reared hens was higher than that of cage. The model parameters for cage and litter reared hens, were negative and cage reared hens showed lower values than the litter in terms of SI. However, the higher R^2 values indicated the close agreement between two rearing systems in terms of different traits (For example- Body weight, egg weight and egg shape index) (Figure 1-3). If a model achieves R-squared above 90%, it indicates close agreement (Karmakar and Ray, 2011).

The egg weight increased with the layer's age in both rearing systems. These results are in agreement with (Peebles et al., 2000; Silversides and Scott, 2001; Oloyo, 2003; Van Den Brand et al., 2004; Baumgartner et al., 2007; Rizzi and Chiericato, 2010) who showed that egg weight increases with the age of hens. (Rossi and Pompei, 1995; Suk and Park, 2001; Van Den Brand et al., 2004; Tůmová and Ledvinka, 2009) confirmed that the yolk weight and yolk percentage (Rossi and Pompei, 1995; Rizzi and Chiericato, 2010) significantly increased with the hens' age, which is in agreement with our result. (Moorthy et al., 2000; Leyendecker et al., 2001; Jenderal et al., 2004) reported higher egg weights in cages, while (Tůmová and Ebeid, 2005; Pištěková et al., 2006; Zemková et al., 2007) recorded heavier eggs on litter. Shank length of cage reared layers is significantly higher than litter type for all age group. In cage type, it was found 3.32 ± 0.16 which is nearly similar to (Olawunmi et al., 2008), but in litter type, it was found 3.19 ± 0.01, which is also nearly similar to (Olawunmi et al., 2008). In both rearing system SI was decreased with age. (Rossi and Pompei, 1995; Suk and Park, 2001; Van Den Brand et al., 2004; Tůmová and Ledvinka, 2009) confirmed that the yolk weight and yolk percentage (Rossi and Pompei, 1995; Rizzi and Chiericato, 2005) significantly decreased with the hens' age, which is in agreement with our result. Average age at first laying of cage type is insignificantly (P>0.05) dissimilar with litter type. The average age of first lying of cage type was found 143 ± 0.51 days which is agreed by others (Kabir and HAQUE, 2010); but it was higher than recommended level of Hendrix Genetic Company limited (Anonymous, 2015). In litter type, it was 141±0.58 day which is also nearly agreed by (Kabir and HAQUE, 2010); but it is higher than than recommended level of Hendrix Genetic Company limited (Anonymous, 2015). Variation with company level might be due to managemental causes. In cage type layers, body weight was found 1851 ± 11.93g, which is nearly agreed (1854. 9g) by (Anonymous, 2014) and it is nearly similar to recommended level of Hendrix Genetic Company limited (Anonymous, 2015) at 50 weeks of age and in case of litter type layers, it was 1849.10 ± 33.90g which is also nearly similar (1854.9g) to (Anonymous, 2014) and it is nearly similar to recommended level of Hendrix Genetic Company limited (Anonymous, 2015) at 50weeks of age.

4. Conclusion

Population of commercial layer strain in Bangladesh is increasing. Chicken is only species that is expected to be found in village that serves as a source of income and nutrition. Therefore emphasis should be given from stakeholders (policy makers, research and development bodies) to keep chicken population. Bangladesh has diversified agro-ecologies that may be attributing for the presence of diversified phenotypic appearance of commercial layer strain. Thus any breeding and improved production program of the commercial layer should therefore, incorporate the production objectives and trait performances of the society. By improving the approaches and traditional management of commercial layer, better performance always been achieved from these birds. Hence, these huge gene pool should be protected from genetic erosion and apply for improvement through scientific selection together along with technologies of genomics.

Table 1
Composition of ration supplied to layer birds.

Ingredients	Amount	Calculated nutrients	Percentage (%)
Maize	64kg	CP	18.73
Rice Polish	6kg	ME (Kcal/Kg)	2830.22
Soyabean meal	18kg	Crude Fiber	4.22
Oil Cake	2kg	Ether Extract	5.18
Propack/PL-68	6kg	Ca	3.965
Limestone	4kg	P	0.97
DCP plus	300gm	Methionine	0.47
Cevit GS	250gm	Cystine	0.79
Methionine	100gm	Lysine	0.91
Lysine	75gm		
Choline	50gm		
Salstop	200gm		
Allitox	200gm		
Zymax	50gm		
Gut Care	50gm		
Tocomin Plus	50gm		
Biogold P	100gm		
Diconil	50gm		

Table 2
Lighting schedule.

Age/day/week	Light/day (in hour)	Intensity (Watt/sq.ft)
1-3day	24hours	0.56 watt
4-6day	23 hours	0.50 watt
7-8day	23 hours	0.37 watt
1-2weeks	23 hours	0.25 watt
2-3weekas	22 hours	0.19 watt
3-4weeks	18 hours	0.19 watt
4-5	16 hours	0.19 watt
5-6	14 hours	0.19 watt
6-10	13 hours	0.19 watt
11-18	12 hours	0.095 watt
18-20	11.30 hours	0.019 watt
20-21	12 hours	0.25 watt
21-22	12.30 hours	0.25 watt
22-23	13 hours	0.25 watt
23-24	13.30 hours	0.25 watt
24-25	14 hours	0.25 watt
25-26	14.30 hours	0.25 watt
26-27+ weeks	16 hours	0.25 watt

Table 3
Different phenotypic variables' parameters in different age and rearing systems.

		Week of Laying			
Variable	**Rearing system**	**20-26 Mean ± SE**	**36-42 Mean ± SE**	**54-60 Mean ± SE**	**P-value**
Body weight (g)	Cage	1781.60±11.18	1826.47±12.1	1851.62±11.93	0.036
	Litter	1786.10±27.93	1826.17±31.09	1849.81±33.90	
Shank length (cm)	Cage	2.91±0.01	3.17±0.11	3.32±0.16	0.00
	Litter	2.93±0.00	3.11±0.03	3.19±0.01	
Beak length (cm)	Cage	1.99±0.01	2.02±0.01	2.09±0.05	0.533
	Litter	1.98±0.05	2.02±0.01	2.07±0.00	
Egg weight (g)	Cage	55.44±0.34	57.53±0.47	59.44±0.42	0.00
	Litter	53.82±0.45	59.44±0.54	61.14±0.45	
Egg Shape Index (%)	Cage	78.52±0.99	76.64±0.87	75.09±0.77	0.067
	Litter	78.94±0.69	76.88±0.74	75.34±0.81	
Yolk Weight (g)	Cage	12.46±0.33	16.86±0.56	17.19±0.76	0.782
	Litter	12.94±0.17	16.71±0.34	17.98±0.75	
Yolk (%)	Cage	23.12±0.19	26.94±0.31	28.12±0.17	0.312
	Litter	23.53±0.12	26.93±0.17	27.76±0.21	
Age at first lay	Cage	143±0.51			0.834
	Litter	141±0.58			

Table 4
Regression and R^2 of different traits in both rearing systems at three different age groups.

Rearing System		Cage			Litter		
	Regression value & R^2	**Intercept**	**Slope**	**R^2**	**Intercept**	**Slope**	**R^2**
Traits	Body wt.	1749	35.09	0.974	1757	31.85	0.978
	Egg wt.	53.47	2	0.999	50.81	3.66	0.912
	Egg shape index	80.65	-1.8	0.993	80.22	-1.75	0.998

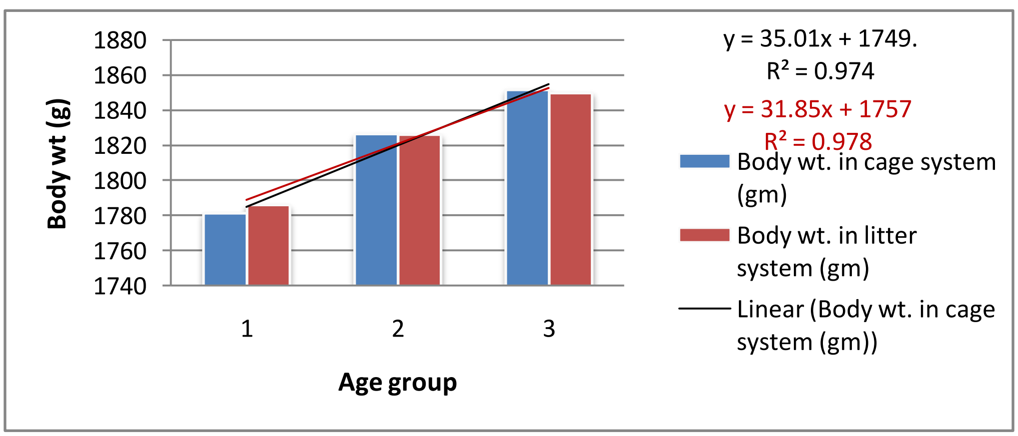

Fig. 1. Differences of body weight for cage and litter reared hens in 3 different age groups.

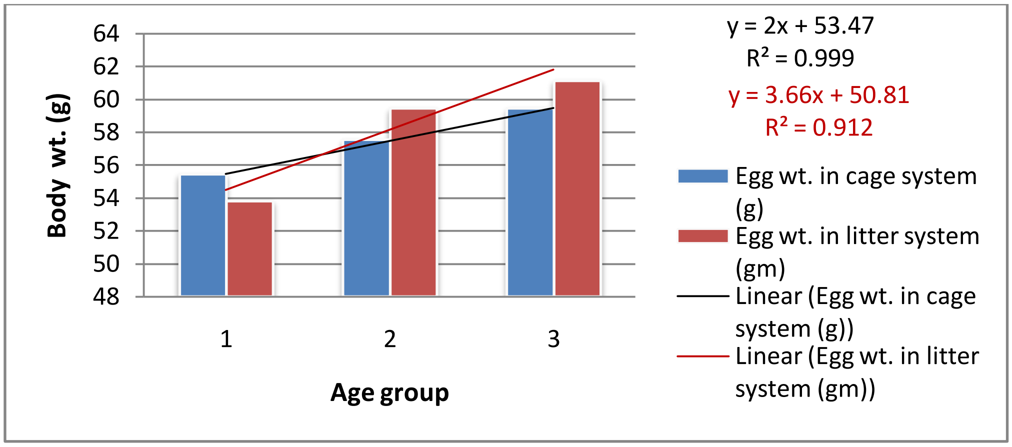

Fig. 2. Differences of egg weight for cage and litter reared hens in 3 different age groups.

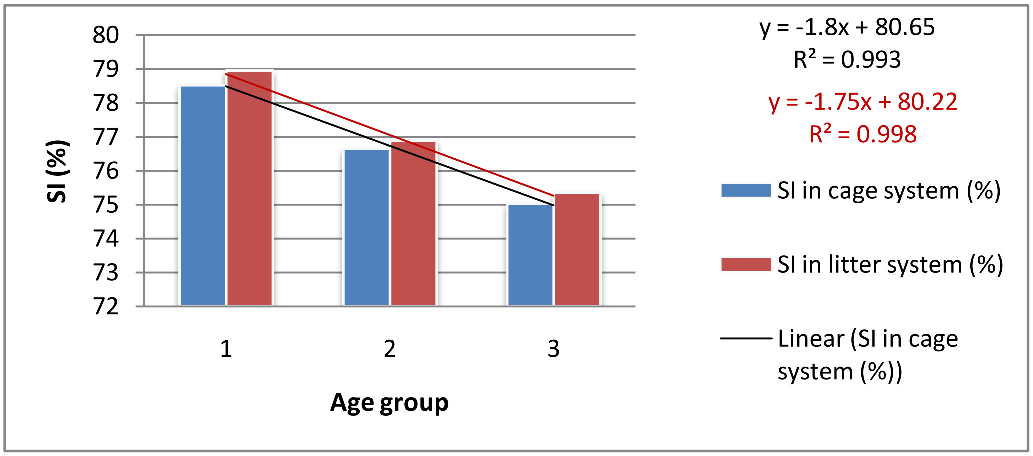

Fig. 3. Differences of egg shape index (SI) for cage and litter reared hens in 3 different age groups.

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References

Alders, R., Pym, R., 2009. Village poultry: still important to millions, eight thousand years after domestication. World. Poult. Sci. J., 65, 181-190.

Anonymous, 2000. International Food Policy Research Institute (IFPRI), Washington, D.C., USA.

Anonymous, 2014. 23rd Annual Australian poultry science symposium, The Poultry Research Foundation (University of Sydney) and The World's Poultry Science Association, New South Wales. Sydney.

Anonymous, 2015. ISA Brown Management Guide, In: Company, A.H.G. (Ed.), Netherlands.

Bangladesh Bureau of Statistics, 2015. Statistical Pocket Book of Bangladesh. Bureau of Statistics, In: Ministry of Planning (Ed.), Government of the People's Republic of Bangladesh, Dhaka.

Baumgartner, J., Benková, J., Peškovicová, D., 2007. Effect of line, age and individuality on yolk cholesterol content and some other egg quality traits in Leghorn type yolk cholesterol selected hens, XVIII European Symposium on the quality of poultry meat and XII European Symposium on the quality of eggs and egg products, September, 2-5.

Bhende, M., 2006. Production and cost of broiler meat: A case study. Karnataka Agricultural Development and Rural Transformation Center, Research Report 9/ADRT 118.

Campo, J., Gil, M., Dávila, S., 2007. Differences among white-, tinted-, and brown-egg laying hens for in-cidence of eggs laid on the floor and for oviposition time.

Das, S., Chowdhury, S., Khatun, M., Nishibori, M., Isobe, N., Yoshimura, Y., 2008. Poultry production profile and expected future projection in Bangladesh. World. Poult. Sci. J., 64, 99-118.

Directorate of Livestock Services (DLS), 2012. Annual report on livestock, Division of Livestock Statistics, In: Livestock, M.O.F.A. (Ed.), Government of the people's Republic of Bangladesh, Farmgate, Dhaka, Bangladesh.

FAO, 2000. Statistical Database, Food and Agriculture Organization of the United Nations, Rome, Italy.

Federal Parent Locator Service (FPLS), 2010. Office of Child Support Enforcement, FPLS.

Halaj, M., Grofík, R., 1994. The relationship between egg shell strength and hens features. Živočišná výroba, 39, 927-934.

Harms, R., Rossi, A., Sloan, D., Miles, R., Christmas, R., 1990. A method for estimating shell weight and correcting specific gravity for egg weight in eggshell quality studies. Poult. Sci., 69, 48-52.

Hartmann, C., Johansson, K., Strandberg, E., Wilhelmson, M., 2000. One-generation divergent selection on large and small yolk proportions in a White Leghorn line. Br. Poult. Sci., 41, 280-286.

Jenderal, M., Church, J., Feddes, J., 2004. Assessing the welfare of layers hens housed in conventional, modified and commercially-available furnished battery cages, Proceedings of 22nd World Poultry Congress, Istanbul, Turkey.

Johnston, S., Gous, R., 2007. Modelling the changes in the proportions of the egg components during a laying cycle. Br. Poult. Sci., 48, 347-353.

Kabir, F., HAQUE, T., 2010. Study on the production performance of Isa-Brown strain at Krishibid firm LTD. Trishal, Mymensingh. Bangladesh. Res. Pub. J., 3, 1039-1044.

Karmakar, M., Ray, R., 2011. Current trends in research and application of microbial cellulases. Res. J. Microbiol., 6, 41-53.

Ledvinka, Z., Tumova, E., Arent, E., Holoubek, J., Klesalova, L., 2000. Egg shell quality in some white-egg and brown-egg cross combinations of dominant hens. Czech. J. Anim. Sci., 45, 285-288.

Leyendecker, M., Hamann, H., Hartung, J., Kamphues, J., Ring, C., Glunder, G., Ahlers, C., Sander, I., Neumann, U., Distl, O., 2001. Analysis of genotype-environment interactions between layer lines and housing systems for performance traits, egg quality and bone breaking strength-1st communication: Performance traits. Zuchtungskunde, 73, 290-307.

Lichovníková, M., Zeman, L., 2008. Effect of housing system on the calcium requirement of laying hens and on eggshell quality. Czech. J. Anim. Sci., 53, 162.

Moorthy, M., Sundaresan, K., Viswanathan, K., 2000. Effect of feed and system of management on egg quality parameters of commercial white leghorn layers. India. Vet. J., 77, 233-236.

Olawunmi, O., Salako, A., Afuwape, A., 2008. Morphometric differentiation and assessment of function of the Fulani and Yoruba ecotype indigenous chickens of Nigeria. Int. J. Morphol., 26, 975-980.

Oloyo, R., 2003. Effect of age on total lipid and cholesterol of hen eggs. India. J. Anim. Sci., 73, 94-96.

Peebles, E., Zumwalt, C., Doyle, S., Gerard, P., Latour, M., Boyle, C., Smith, T., 2000. Effects of breeder age and dietary fat source and level on broiler hatching egg characteristics. Poult. Sci., 79, 698-704.

Permin, A., Pedersen, G., 2000. Problems related to poultry production at village level, possibilities for smallholder poultry projects in Eastern and Southern Africa, Morogoro (Tanzania), 22-25 May 2000, KVL.

Pištěková, V., Hovorka, M., Večerek, V., Strakova, E., Suchý, P., 2006. The quality comparison of eggs laid by laying hens kept in battery cages and in a deep litter system. Czech. J. Anim. Sci., 51, 318-325.

Raha, S., 2007. Broiler industry in Bangladesh: Some issues, International Poultry Show & Seminar.

Rahaman, S., Sayeed, M., Sarkar, N., Alam, J., 2006. Impact of improved poultry management technique on socio-economic condition of broiler beneficiaries. J. Bangladesh. Agr. Univ., 4, 401-411.

Rahman, M.N., Rahman, A., Kamal, G.M., Chowdhury, A.B., 2014. Statistical pocketbook of Bangladesh-2013, In: Statistics, B.B.o. (Ed.), Government of the People's Republic of Bangladesh, Dhaka.

Rizzi, C., Chiericato, G., 2005. Effect of genotype and storage on some egg quality parameters of laying hens reared according to organic farming production, Proceedings of the XVII European Sympoisum on the Quality of Poulty Meat and XI European Symposium on the Quality of Eggs and Egg Products, Golden Tulip Parkhotel Doorwerth, Doorwerth, Netherlands, 23–26 May 2005, 37-43.

Rizzi, C., Chiericato, G.M., 2010. Organic farming production. Effect of age on the productive yield and egg quality of hens of two commercial hybrid lines and two local breeds. Italia. J. Anim. Sci., 4, 160-162.

Rossi, M., Pompei, C., 1995. Changes in some egg components and analytical values due to hen age. Poult. Sci., 74, 152-160.

Silversides, F., Scott, T., 2001. Effect of storage and layer age on quality of eggs from two lines of hens. Poult. Sci., 80, 1240-1245.

Stell, R., Torrie, J., Dickey, D., 1980. Principles and procedures of statistics: a biometrical approach. New York: MacGraw-Hill.

Suk, Y., Park, C., 2001. Effect of breed and age of hens on the yolk to albumen ratio in two different genetic stocks. Poult. Sci., 80, 855-858.

Tůmová, E., Ebeid, T., 2005. Effect of time of oviposition on egg quality characteristics in cages and in a litter housing system. Czech. J. Anim. Sci., 50, 129-134.

Tůmová, E., Ledvinka, Z., 2009. The effect of time of oviposition and age on egg weight, egg components weight and eggshell quality. Archiv für Geflügelkunde, 73, 110-115.

Tůmová, E., Zita, L., Hubený, M., Skřivan, M., Ledvinka, Z., 2007. The effect of oviposition time and genotype on egg quality characteristics in egg type hens. Czech. J. Anim. Sci., 52, 26-30.

Van Den Brand, H., Parmentier, H., Kemp, B., 2004. Effects of housing system (outdoor vs cages) and age of laying hens on egg characteristics. Br. Poult. Sci., 45, 745-752.

Vits, A., Weitzenbürger, D., Hamann, H., Distl, O., 2005. Production, egg quality, bone strength, claw length, and keel bone deformities of laying hens housed in furnished cages with different group sizes. Poult. Sci., 84, 1511-1519.

Yannakopoulos, A., Tserveni-Gousi, A., 1987. Effect of egg weight and shell quality on day-old duckling weight. Archiv fuer Gefluegelkunde (Germany, FR).

Yannakopoulos, A., Tserveni-Gousi, A., Nikokyris, P., 1994. Egg composition influenced by time of oviposition, egg weight, and age of hens. Archiv fuer Gefluegelkunde (Germany).

Zemková, Ľ., Simeonovová, J., Lichovníková, M., Somerlíková, K., 2007. The effects of housing systems and age of hens on the weight and cholesterol concentration of the egg. Magnesium (g/kg) 1, 1.54.

Zhang, L.-C., Ning, Z.-H., Xu, G.-Y., Hou, Z.-C., Yang, N., 2005. Heritabilities and genetic and phenotypic correlations of egg quality traits in brown-egg dwarf layers. Poult. Sci., 84, 1209-1213.

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