WFL Publisher
Science and Technology
Meri-Rastilantie 3 B, FI-00980
Helsinki, Finland
e-mail: info@world-food.net

Journal of Food, Agriculture & Environment Vol.7 (2) : 432-434. 2009

www.world-food.net

Egg weight affects some quality traits of chicken eggs

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Received 16 January 2009, accepted 14 April 2009.

Abstract

Experiments were conducted to evaluate the effect of egg weight on egg quality traits. One hundred and fifty eggs of three grade sizes (small 48.937 g, medium 54.885 g and large 60.385 g) with 50 eggs for each size group were collected from the brown-egg layer strain of Nike and used to determine the egg quality traits. Egg weight (EW) significantly affected the shape index, shell thickness, yolk weight percentage, albumen weight percentage, albumen height and Haugh unit ($P < 0.05$). Shape index, shell thickness and albumen weight percentage increased with EW increasing, while yolk weight percentage decreased with egg weight increasing. Albumen height changed from low to high in the order of medium, small and large eggs, respectively, while Haugh unit was highest in small, intermediate in large and lowest in medium size eggs. There were no significant correlations between EW and other egg quality traits in small, medium and large eggs ($P > 0.05$). In overall, although there were significant positive correlations between EW and shape index, EW and shell thickness and EW and albumen weight percentage, there were significant negative correlations between EW and shell weight percentage and EW and yolk weight percentage. It was concluded that it was feasible to assess some egg quality traits through the egg weight.

Key words: Egg weight, egg quality traits, correlation between quality traits.

Introduction

The egg of chicken is a biological structure intended by nature for reproduction and it also provides a complete diet for the developing embryo. However, in the developing countries, egg is more affordable by the common man than other sources of animal protein and as such this gives poultry more advantage over other livestock[1, 2].

As a natural product, all avian eggs are not equal and need to be routinely checked for quality to meet the specifications being increasingly demanded by today's quality conscious retailers. The egg size and internal quality of eggs are important for both table and hatching eggs. Among them, egg weight (EW) is an important trait that influences egg quality as well as grading [3]. It is a parameter that can be determined without breaking the egg [4]. Egg weight is a direct proportion of albumen, yolk and shell. Significant differences in egg size were reported among lines of White Leghorns by Marion *et al.* [5]. However, there is little studies reported about the relationship between egg weight and other egg quality traits, such as shell index, shell color, shell strength, shell thickness, shell percentage, yolk percentage, albumen percentage, albumen height, Haugh unit, yolk color, etc.

Egg weights are classified according to Canadian egg size standards: small (42.0–48.9 g), medium (49.0–55.9 g), large (56.0–63.9 g), extra-large (64.0–69.9 g) and jumbo (70.0 g or higher). These egg size grades are very similar to those used in the USA: jumbo (≥70 g), extra-large (65–70 g), large (56–65 g), medium (49–56 g) and small (42–49 g). Small, medium and large classifications are the most commonly available [6, 7]. Therefore, the objectives of current study were to estimate the effect of egg weight on shape index, shell colour, shell strength, shell thickness, shell percentage, yolk percentage, albumen percentage, albumen height, Haugh unit and yolk colour, and investigate the relationships between egg weight and each of these egg quality traits.

Materials and Methods

Materials: In this experiment, 150 eggs of three grade sizes (small 48.937 g, medium 54.885 g and large 60.385 g) with 50 eggs for each size group were collected from the chicken breeding farm of Poultry Institute, Chinese Academy of Agricultural Sciences (Yangzhou), China (latitude 32°24'N, longitude 119°26'E). The average air temperature and relative humidity were 4°C and 60% during the egg collection period. Evaluated eggs were collected from the brown-egg layer strain of Nike, reared in a cage system. The layers were at about 28 weeks of age and each of them was kept in a layer cage (48 cm × 42 cm × 45 cm). The nutrient levels of the corn-soybean based diet used to feed the hens were: 2800 kcal /kg metabolizable energy, 18% crude protein, 3.4% calcium, 0.38% available phosphorus, 0.37% methionine, 0.65% methionine + cystine and 0.78% lysine.

Methods: Shell colour, shell strength, shell thickness, albumen height and Haugh unit were determined and recorded with a TSS QCM+ system (Technical Services and Supplies, Dunnington, York, UK) [8]. Shell colour reflectometer works by taking a percentage reading between black and white with 0 and 81.8%, respectively. The micrometer electronically measures the thickness of the shell in mm with the results being entered into the test. Electronic height

Table 1. Effect of egg weight on egg quality traits of chicken egg.

Egg quality properties	Small (48.937 g)	Medium (54.885 g)	Large (60.385g)	SEM	*P* values
Shape index (%)	76.270	76.870	79.511	0.525	<0.000
Shell color (%)	54.244	50.959	51.940	1.052	0.084
Shell strength (kg/cm^2)	4.831	5.333	5.032	0.163	0.097
Shell thickness (mm)	0.341	0.362	0.373	0.005	<0.000
Shell weight (%)	14.526	14.165	13.966	0.240	0.253
Yolk weight (%)	24.006	23.329	21.391	0.311	<0.000
Albumen weight (%)	61.468	62.506	64.643	0.365	<0.000
Albumen height (mm)	10.274	9.785	10.519	0.206	0.042
Haugh unit	102.644	99.152	101.189	0.894	0.025
Yolk color (DSM)	9.000	9.222	9.000	0.158	0.521

gauge measures albumen height. Haugh unit is automatically calculated within the system on the input of egg weight and albumen height (TSS, Dunnington, York, UK). The unit mass weights of egg, shell, albumen and yolk of each egg were weighed with an electronic balance to the nearest 0.001 g. The percentages of weights of shell, albumen and yolk were calculated relative to egg weight. Length (L) and width (W) of eggs were measured with a digital calliper to the nearest 0.01 mm. Shape index (SI) was determined using the following equation [9]: Shape index = W/L×100. Yolk colour was measured using a yolk color fan (DSM, Basel, Switzerland) [10].

Statistical analysis: Data were analyzed using SPSS 13.0 Packet Program according to General Linear Model [11]. Differences in the correlation coefficients of properties were determined and significance tests were applied, using Correlate of SPSS 13.0.

Results

Effect of egg weight on quality traits of chicken eggs is shown in Table 1. Egg weight (EW) significantly affected the shape index, shell thickness, yolk weight percentage, albumen weight percentage, albumen height and Haugh unit ($P < 0.05$). Shape index, shell thickness and albumen weight percentage increased with increasing EW, while yolk weight percentage decreased with egg weight increase. Although EW significantly affected shell thickness ($P < 0.05$), the effect of EW on shell strength and shell weight percentage was not statistically significant ($P > 0.05$). Albumen height changed from low to high in the order of medium (9.785 mm), small (10.274 mm) and large (10.519 mm) eggs, respectively, while Haugh unit was highest in small (102.644), intermediate in large (101.189) and lowest in medium (99.152) eggs. Any significant effect of EW on the colour, including shell colour and yolk colour, was not observed ($P > 0.05$).

Correlation coefficients between egg weight and egg quality traits are shown in Table 2. There were no significant correlations between EW and other egg quality traits in small, medium and large eggs ($P > 0.05$). In overall, although there were significant positive correlations between EW and shape index (0.390), EW and shell thickness (0.428), EW and albumen weight percentage (0.603), there were significant negative correlations between EW and shell weight percentage (-0.261) and EW and yolk weight percentage (-0.534).

Discussion

The reported estimates of EW effect on shell quality traits were inconsistent, ranging from negative to positive [12-15]. Abanikannda *et al.* reported that there was a negative correlation between EW and shape index[16]. However, in the present study, correlation between EW and shape index confirmed the findings of Sekeroglu *et al.* [14] and Farooq *et al.*[3]. Positive correlation between egg weight and shell thickness has also been reported [3]. The association between EW and shell thickness in this study remained constant. However, it has been reported that EW increased significantly while shell thickness decreased [15, 17-20]. In a corresponding study, smaller eggs had stronger shells than larger ones, as hens have a finite capacity to deposit calcium in the shell and, as a result, the same amount of calcium is spread over a larger area [21]. The differences found between results may be partially attributable to differences in lines, nutrition, age and environment, which are also related to shell quality [22]. Especially, the age of the birds (28 wk of age) and the average air temperature (4°C) in this experiment would contribute to differences from forenamed studies[15, 17, 19, 20].

In present study, shell colour was not significantly affected by egg weight. There was a negative correlation between EW and shell colour. These results are also confirmed by other studies [23, 24]. According to Schwaegele, shell color was related to hen health, genetic structure and age [25]. There was a significant relationship between shell color and feed content [26].

Although there was no difference of shell strength among three weight groups (P>0.05), shell strength was higher in medium eggs than in other two weight groups, which was consistent with Sekeroglu and Altuntas [24]. In circumstances where shell weight, shell percentage and shell thickness are good but shell breaking strength is relatively poor, the explanation probably lies with the shell ultrastructure, or how well the shell has been constructed [27].

Table 2. Correlation coefficients between egg weight and quality traits of chicken egg.

Egg quality property	Small (48.937g)	Medium (54.885 g)	Large (60.385 g)	Overall (54.736 g)
Shape index	-0.271	0.125	-0.002	0.390**
Shell color	0.079	-0.054	0.156	-0.140
Shell strength	0.127	-0.047	0.000	0.099
Shell thickness	-0.067	0.052	-0.139	0.428**
Shell weight	-0.222	-0.366	-0.203	-0.261*
Yolk weight	0.055	-0.033	-0.277	-0.534**
Albumen weight	0.089	0.353	0.341	0.603**
Albumen height	-0.176	0.064	0.178	0.092
Haugh unit	-0.270	-0.009	0.086	-0.139
Yolk color (DSM)	0.018	-0.202	-0.209	-0.046

*P < 0.05; ** P < 0.01.

Egg weight had a significantly positive effect on yolk weight percentage and a significantly negative effect on albumen weight percentage in current study (P<0.05). Also other authors found significant differences in yolk and albumen percentage with different egg sizes [5, 24]. The proportion of yolk tended to be greater and the proportion of albumen smaller in small eggs than in larger eggs. It was concluded that egg size accounted for most of the differences in proportion of yolk and albumen.

Haugh unit is an expression relating egg weight and the height of the thick albumen. It is generally accepted that the higher the Haugh unit value, the better the quality of the egg [28]. Generally, a negative relation was reported between EW and Haugh unit [12, 29]. However, Emsley *et al.* demonstrated that heavy eggs had higher Haugh unit [13]. The negative association between EW and Haugh unit in this study is in agreement with literature [24, 30]. In addition, positive relation between EW and AH was determined in this study as stated by earlier studies [18, 19, 24].

Conclusions

Egg weight had significant effect on shape index, shell thickness, yolk weight percentage, albumen weight percentage, albumen height and Haugh unit. There were significant positive correlations between EW and shape index, EW and shell thickness and EW and albumen weight percentage, but EW showed significant negative correlations with shell weight percentage and yolk weight percentage in eggs overall. These suggest that it could be feasible to assess some egg quality traits through the egg weight.

Acknowledgements

This work was financially supported by Public Welfare Industry Project of Ministry of Agriculture, P. R. China.

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