A STUDY OF INCUBATION PARAMETERS IN SIX BREEDS OF LOCAL CHICKENS

Do Ngoc Ha, Hoang Thi Bich, Nguyen Thi Huong, Khuong Van Nam

Received: 17 May 2016 / Accepted: 10 October 2017 / Published: November 2017

Abstract: *In this study, we investigated the differences of incubation parameters traits in six breeds of Taiwanese chickens: Hua-Tung (HT), Hsin-Yi (HY), Ju-Chi (JC), Shek-Ki (SK), Nagoya (NG) and Quemoy (KM) breeds. The incubation traits, including loss of egg weight during storage (storeloss), 18 days in the setter (inculoss), 21 days of incubation (hatchloss), time to hatch, and hatchability were tested for the effect of breed, egg weight and storage period. The results showed that eggs weight, chick weight, and storeloss (%) in Generation 1 were higher than Generation 2, whereas, inculoss (%), hatchloss (%), and hatchability in Generation 2 were higher than Generation 1. The highest inculoss (%) and hatchloss (%) were found in Quemoy, while the lowest was Shek-Ki. The longest hatchtime was found in Quemoy and the shortest was Ju-Chi. The highest hatchability was found in Hua-Tung breed, while the lowest was Shek-Ki breed. Heritabilities estimated from regression of Generation 2 to Generation 1 were very high for egg weight and hatchtime while storeloss was nil. Furthermore, long egg storage time increases egg weight loss and incubation duration (hatch time), but reduces hatchability. When eggs were stored for one more day, egg weight loss increased 0.03 % during storage period, 0.03% during 18 days in the setter, and 0.07% for entire incubation period, increased the hatch time by 0.73 hr, but reduced hatchability by about 0.03%.*

Keywords: *Egg weight loss, incubation, hatchability.*

1. Introduction

The fate of chicks largely depends on the quality of hatching eggs. Various breeding practices and handling of eggs from egg laying to hatching, particularly pre-incubation storage condition, and incubation parameters have affected hatchability and quality of day old chicks (Tona et al., 2001). Hatching eggs are collected at breeding farm, stored for some time there, or directly transferred to the hatchery. Here, these are stored for a certain limit of time under

Do Ngoc Ha, Hoang Thi Bich, Nguyen Thi Huong, Khuong Van Nam
Faculty of Agriculture, Forestry and Fishery, Hong Duc University
Email: Dongocha.tx36@gmaij.com (✉)
Hoangthibich@hdu.edu.vn (✉)
Nguyenthihuong@hdu.edu.vn (✉)
Khuongvannam@hdu.edu.vn (✉)

specific environmental conditions. The main objective of holding period is to maintain the fertility of hatching eggs.

Hua-Tung, Hsin-Yi, Ju-Chi, Quemoy, Nagoya, and Shek-Ki are six breeds of local Taiwan chickens (Chen et al., 1994; Lee, 2006) kept at the research farm of National Chung Hsing University. During the annual reproduction period, their eggs were collected from farm and kept there for one to two weeks in storage before moved to the University for incubation. During this stage, there were many changes of egg's characteristics. Brake et al., (1997) reviewed the changes in eggs components associated with egg handling, storage and concluded that hatchability and chick quality varied by age of flock, age of egg, ambient temperature, strain and handling procedures. Better understanding of these details, the aim of this study, we investigate the differences of incubation parameters among six breeds of local chickens during the incubation period.

2. Material and methods

2.1. Animals and samples collection

1800 hatching eggs used in this study were obtained from six breeds of local chickens in research farm of National Chung Hsing University, Taichung, Taiwan: Hua-Tung (HT), Hsin-Yi (HY), Ju-Chi (JC), Shek-Ki (SK), Nagoya (NG) and Quemoy (KM) breeds. Hatching eggs were collected when hens were 59-60 and 29-30 weeks of age respectively for Generation 1 and 2.

2.2. Measurement of traits

2.2.1. Egg weight and storeloss

Eggs in each breed after laid were collected and were individually weighed and stored on farm every day to 12 days of experiment. Temperature and humidity in storage period were maintained at 18^0C, and 75%. At day 12 after storage, they were reweighed to determine egg weight loss. Eggs weight loss in storage period were determined as follow:

$$Store\,loss\,(\%) = \left(\frac{Eggwt - Storewt}{Eggwt} \right) x100\%$$

Where, Eggwt is eggs weight on the day laid, Storewt is eggs weight to be measured in the farm at 12 days stored before moved to incubator.

2.2.2. Inculoss and hatchloss, hatch time and chicks weight

After reweighed at farm, eggs were moved to incubate in the campus of the university. All eggs were incubated for 18 days at 37.8^0C and relative humidity 50-55%. After 18 days of incubation, all eggs were removed from the incubator, individually weighed and transferred to the hatcher. The eggs were further incubated for an additional 4 days in hatcher at temperature 36.7^0 C and relative humidity 65-70%. The trays were designed to separate hatching chicks and do not allow them to move from their places and mix. Hatched chicks were individually determined hatch time and weighed in 2 hours interval. Inculoss and hatchloss were determined as follow:

$$Inculoss\,(\%) = \left(\frac{Storewt - Wt18}{Storewt}\right) x100\%$$

$$Hatchloss\,(\%) = \left(\frac{Storewt - Chickwt}{Storewt}\right) x100\%$$

Where, *storewt* is eggs weight to be measured in the farm at 12 days stored before moved to incubator, Wt18 is eggs weights to be measured after 18 days of incubation. Chickwt is chicks to be weighted at hatched time.

2.3. Statistical analysis

1. Observation of incubation parameters of eggs laid by hens of six local breeds chicken for two generations were analyzed together using General Linear Models procedures of SAS Institute (version 9.3.1), based on the following statistical model:

$$Y_{ijkl} = \mu + G_i + B_j + (GB)_{ij} + e_{ijkl}$$

Where Y_{ijkl} is the observation of the *l*th egg laid by the *k*th hen in the *j*th breed of the *i*th generation, μ is the general mean. G_i is the fixed effect of the *i*th generation i = 1, 2, $\sum_{i=1}^{2} G_i = 0$. B_j is the fixed effect of the *j*th breed, j = 1, 2, 3,.., 6, $\sum_{j=1}^{6} B_j = 0$, and . $(GB)_{ij}$ is the fixed interaction between the *i*th generation and the *j*th breed $\sum_{i=1}^{6}\sum_{k=1}^{2} (\alpha\beta)_{ik} = 0$, and e_{ijkl} is the random error.

2. For the estimation of the effect of storage duration, egg weight, and egg shape on the hatching traits, following analysis of covariance statistical model was used:

$$Y_{ijk} = \mu + B_i + \beta X_{ijk} + \varepsilon_{ijk}$$

where, Y_{ijk} is the hatching trait observation of the *k*th hen egg laid by the *j*th hen in the *i*th breed. μ is the general means. β is the partial regression coefficient of the covariate. (X_{ij} , e.g., storage day, egg weight or egg shape of egg) on the hatching traits and ε_{ij} is the random error.

3. Results and discussions

3.1. Generations

The analysis of variance (Mean square) and least-square means of egg weight, egg weight loss, hatch time, chick weight at hatch, and hatchability are shown in Table 1. The significance of effects between two generations were found in egg weight, storeloss (%), hatchloss (%), inculoss (%), chick weight and hatchability (P<0.05), but not found in hatch time (P<0.1).

Egg weight and chick weight in Generation 1 were higher than Generation 2. The cause is hen's age. Egg weight increases with age (Anderson et al., 2004; Sukanya, 2007) and chick weight increases with egg weight increases (Alsobayel, 1992).

Egg weight loss (%) during storage period (storeloss) in Generation 1 was significantly (P<0.01) higher than Generation 2. However, hatchloss (%), inculoss (%) and hatchability in Generation 2 were significantly (P<0.01) higher than Generation 1 (Table 1). Eggs from older hens tended to lose more weight in grams but less in percentage than those from younger birds (Reis et al., 1997). The effect of breeds*generations interaction was highly significant (P<0.01) on the percentage of egg weight loss during 18 days in setter (inculoss) (Table 1).

3.2. Breeds

3.2.1. Egg weight and Chick weight

The heaviest chick weight was Hua-Tung breed, whereas the lightest was Quemoy (Table 1). Overall, day-old chick weights increased with the egg weights (Tona et al., 2003). The quality of newly hatched chick is a major factor in determining its livability, growth, and health. There was a highly significant correlation between egg weight and chick weight at hatched time. Thus, the heavier egg weight will produce the heavier chick weight.

3.2.2. Egg weight loss

The highest egg weight loss (%) during storage period was found in Nagoya breed, while the lowest was Hua-Tung breed (Table 1). The Ju-Chi and Quemoy breeds had the highest inculoss (%) while the lowest were found in Shek-Ki and Hua-Tung breeds (P<0.01). In hatchloss (%), however, the highest were found in Quemoy and Hsin-Yi breeds while the lowest were still Shek-Ki and Hua-Tung breeds. Reis et al., (1997) demonstrated that there is an inverse relationship between egg weight and hatchloss. Thus, egg which had smallest egg weight had largest hatchloss. This is the same as our results of eggs laid by Shek-Ki hens. The present results goes well with the observations obtained by Kirk et al., (1980), North and Bell (1990), and Roque and Soares (1994), who reported that proportional weight loss decreased slightly with flock age, probably because of the associated increase in egg weight. As larger eggs have less shell area per unit of interior egg weight than do smaller eggs. Another explanation of the breed's difference in inculoss might be caused by the shell difference.

3.2.3. Hatchtime

There were no difference in hatchtime between two generations, however, among six breeds, we found that the Hsin-Yi breed hatched earlier than other breeds (478.68*h*) (Table 1), whereas the longest hatchtime was found in Quemoy and Shek-Ki breeds (492.02 and 491.82*h*, respectively).

Although there had no significant effect between two generations, the effect of breeds*generations interaction was highly significant (P<0.01) on hatch time (Table 1). Hsin-Yi breed hatched earlier than other breeds in both Generations 1 and 2, whereas, Quemoy and Shek-Ki breeds hatched later than other breeds in both generations.

Table 1. *Analysis of variance (mean square) and least-square means of hatching traits in six breeds of local chickens*

Source of Variation	df	Egg weight (*g*)	Storeloss[1] (%)	Inculoss[2] (%)	Hatchloss[3] (%)	Hatch time[4] (*hr*)	Chick weight (*g*)	Hatchability (%)
Generation	1	2388.44 **	38.33 **	38.89 **	1006.72 **	216.92 +	2264.93 **	16.67 *
Breed	5	810.52 **	0.21	212.83 **	388.57 **	12741.81 **	589.91 **	16.77 *
Generation*breed	5	63.80 **	1.02	58.18 **	53.18 **	363.25 **	71.06 **	1.09
Error	3087	12.79	0.18	4.03	4.29	74.63	8.00	2.41
Generation 1		46.68 ± 0.10^{a}	0.46 ± 0.01^{a}	12.59 ± 0.06^{b}	27.89 ± 0.06^{b}	486.07 ± 0.24	33.52 ± 0.08^{a}	85.48 ± 0.45^{b}
Generation 2		44.87 ± 0.09^{b}	0.23 ± 0.01^{b}	12.83 ± 0.05^{a}	29.06 ± 0.05^{a}	486.62 ± 0.20	31.76 ± 0.07^{b}	87.52 ± 0.63^{a}
Hua-Tung		47.56 ± 0.16^{a}	0.32 ± 0.02	12.05 ± 0.09^{c}	27.86 ± 0.10^{d}	484.96 ± 0.39^{b}	34.22 ± 0.13^{a}	88.84 ± 0.95^{a}
Hsin-Yi		45.12 ± 0.15^{d}	0.35 ± 0.02	13.02 ± 0.08^{b}	29.00 ± 0.09^{b}	478.68 ± 0.35^{c}	31.93 ± 0.12^{d}	87.62 ± 0.95^{a}
Ju-Chi		46.90 ± 0.15^{b}	0.34 ± 0.02	13.29 ± 0.08^{a}	28.56 ± 0.08^{c}	484.90 ± 0.35^{b}	33.39 ± 0.12^{b}	88.48 ± 0.95^{a}
Quemoy		44.37 ± 0.16^{e}	0.36 ± 0.02	13.25 ± 0.09^{ab}	29.57 ± 0.09^{a}	492.02 ± 0.38^{a}	31.15 ± 0.13^{e}	83.59 ± 0.95^{b}
Nagoya		46.12 ± 0.17^{c}	0.38 ± 0.02	13.04 ± 0.09^{ab}	28.96 ± 0.10^{b}	485.72 ± 0.40^{b}	32.64 ± 0.13^{c}	87.40 ± 0.95^{a}
Shek-Ki		44.61 ± 0.19^{e}	0.33 ± 0.02	11.63 ± 0.10^{d}	26.90 ± 0.11^{e}	491.82 ± 0.45^{a}	32.52 ± 0.15^{c}	83.09 ± 0.95^{b}

[a-e] For each measure, means of different breeds without the same superscript are significantly different ($P<0.05$).

*$^{+}$ $P < 0.1$; * $P < 0.05$; ** $P < 0.01$.*

[1]Storeloss is loss of egg weight during storage period. [2]Inculoss is loss of egg weight during 18 days of incubation. [3]Hatchloss is loss of egg weight entire 21 days of incubation. [4]Hatch time is number of hours required to hatch.

3.3. Effect of storage time on hatching traits

The partial regression coefficients of storage time on hatching traits in two generations were shown in Table 2. Long egg storage time increased storeloss (%), inculoss (%), hatchloss (%) and incubation duration (hatch time) but hatchability. In Generation 1, when eggs were stored for one more day, egg weight loss increased by 0.024% during storage period (storeloss %), 0.03% during 18 days in the setter (inculoss %), and 0.07% for entire incubation period (hatchloss %), increased the hatch time longer by 0.73hr, while hatchability decreased by 0.034%. In Generation 2, when eggs were stored for one more day, egg weight loss increased 0.034% during storage period (storeloss %), 0.017% during 18 days in the setter (inculoss %), and 0.037% for entire incubation period (hatchloss %), the hatch time was longer by 0.723 hr, but hatchability decreased by 0.026%. Reis et al. (1997) reported that eggs submitted to 1 day storage hatched about 3hrs earlier than eggs which were not stored. Yassin et al., (2008) showed that each day of storage up to 7 days reduced hatchability by 0.2%, whereas, further storage reduced hatchability by 0.5% daily. Theses suggest that the effect of pre-storage incubation on hatchability when storage time is prolonged depends on the developmental stage of the embryo after pre-storage incubation.

Table 2. *Estimates of partial regression coefficients of hatching traits in two generations*

Source of variation	**Storeloss[1] (%)**		**Inculoss[2] (%)**		**Hatchloss[3] (%)**		**Hatch time[4] (hr)**		**Hatchability (%)**	
Generation1										
Storage (*d*)	0.024	**	0.03	*	0.07	**	0.73	**	-0.034	*
Egg weight (*g*)	0.019	*	-0.09	*	-0.04	+	0.03	ns	0.17	+
Egg shape (%)	-0.003	ns	0.01	ns	0.03	ns	0.12	ns	-0.06	ns
Generation 2										
Storage (*d*)	0.034	**	0.017	*	0.037	**	0.723	**	-0.026	*
Egg weight (*g*)	-0.001	ns	-0.091	**	-0.005	ns	-0.162	ns	0.019	ns
Egg shape (%)	-0.003	ns	0.015	ns	-0.053	*	-0.088	ns	-0.043	ns

*(+ $P < 0.1$; * $P < 0.05$; ** $P < 0.01$; ns: none significant)*

[1]Storeloss is loss of egg weight during storage,

[2]Inculoss is loss of egg weight during 18 days in the setter,

[3]Hatchloss is loss of egg weight entire 21 days of incubation and

[4]Hatch time is number of hours required to hatch.

4. Conclusions

Eggs weight, chick weight, and storeloss (%) in Generation 1 were higher than Generation 2, whereas, inculoss (%), hatchloss (%), and hatchability in Generation 2 were higher than Generation 1.

The highest egg weight loss (%) was found in Quemoy breed, while the lowest was Shek-Ki breed. The highest hatchability was Hua-Tung breed, while the lowest was found in Shek-Ki breed. Long egg storage time increases egg weight loss, incubation duration (hatch time), and decreases hatchability. When eggs stored for one more day, egg weight loss increased by 0.03% during storage period, 0.03% during 18 days in the setter, and 0.07% for entire incubation period, and it also increased the hatch time by 0.73hr and decreased hatchability by about 0.03%.

Referrences

[1] Alsobayel, A. A. (1992), *Effect of protein rearing diet and age on fertility and hatchability parameters of Saudi Arabian Baladi Chickens*, J. King Saudi Univ. 4: 47-54.

[2] Anderson, K. E., J. B. Tharnington, P. A, and F. T. Jones. (2004), *Shell characteristics of eggs from historic strains of single comb White Leghorn chicken and the relationship of egg shape of shell strength*, J. Poult. Sci. 3: 17-19.

[3] Brake, J., T. J. Walsh, C. E. Benton Jr., J. N. Petitte, R. Meijerhof, and G. Penalva. (1997), *Egg handling and storage*, Poult. Sci. 76: 144-151.

[4] Chen, C. F., Y. P. Lee, Y. K. Fan, S. Y. Huang, and H. H. Huang. (1994), *The conservation of Taiwan's local chickens*, J. Chin. Soc. Anim. Sci. 23 (3): 339-346.

[5] Kirk, S., G. C. Emmans, R. McDonald, and D. Arnot. (1980), *Factors affecting the hatchability of eggs from broiler breeders*, Br. Poult. Sci. 21: 37-53.

[6] Lee, Y. P. (2006), *Taiwan country chicken: A slow growth breed for eating quality*, Symposium COA/INRA Science Cooperation in Agriculture, Tainan (Taiwan, R.O.C), November 7-10: 121-132.

[7] North, O. M., and D. D. Bell. (1990), *Commercial Chicken Production Manual*, Fourth edition. Pp 31-135. An avi book Published by Van Nostrand Reinhold New York

[8] Reis, L. H., L. T. Gama, and M. C. Soares. (1997), *Effects of short storage condition and broiler breeder age on hatchability, hatchinh time, and chick weights*, Poult. Sci. 76: 1459-1466.

[9] Roque, L., and M. C. Soares. (1994), *Effects of eggshell quality and broiler breeder age on hatchability*, Poult. Sci. 73: 1838-1845.

[10] Sukanya, Y. (2007), *Influences of shell color, Genetic background and Hen age on eggshell quality traits of chickens eggs*, Master's thesis. National Chung- Hsing University, Taiwan.

[11] Tona, K., F. Bamelis, B. De Ketelaere, V. Bruggeman, V. M. B. Moraes, J. Buyse, O. Onagbesan, and E. Decuypere. (2003), *Effects of storage time on spread of hatch, chick quality, and chick juvenile growth*, Poult. Sci. 82: 736-741.

[12] Tona, K., F. Bamelis, W. Couke, V. Bruggeman and E. Decuypere (2001), *Relationship between broiler breeder's age and egg weight loss and embryonic mortality during incubation in large-scale condition*, J. Appl. Poult. Res. 221-227

[13] Yassin, H., A. G. Velthuis, M. Boerjan, J. van Riel, and R. B. Huirne. (2008), *Field study on broiler egg's hatchability*, Poult. Sci. 87: 2408-2417.