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# CHICK QUALITY OF HUBBARD BROILER BREEDERS TRAIN WITH THREE DIFFERENT EGG WEIGHTS AND STORAGE PERIODS AT FOUR PRODUCTION PHASES

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## ABSTRACT

The present study was conducted at a commercial hatchery with the objective to evaluate the chick quality (average day-old chick weight, chick to egg ratio, A+ Chicks, A, US and B grade chicks) from fertile eggs of Hubbard broiler breeder strain during four production phases, categorized into 3 egg weights and 3 different storage periods maintained at. For this purpose, eggs during 4 production phases (pre-peak; 25-28, peak; 29-36, post-peak; 37-52 and terminal; 53-56$^{th}$ weeks of age) were categorized into three different weight categories (small, medium and large; subject to change in each production phase), stored for three different durations (1, 4 and 7-days) and replicated 6 times. A total of 93312 fertile eggs; pre-peak: 11664, peak: 23328, post-peak: 46656 and terminal: 11664 eggs in 4 production phases were collected. During each week of the experiment, a total number of 972 eggs per storage period from three egg weight categories replicated 6 times (each replicate containing 54 eggs) were incubated in a commercial hatchery. The data were analyzed by ANOVA technique under randomized complete block design in 4×3×3 factorial arrangement and means were compared by using DMR Test. The results of the present study showed that the egg weight categories and length of storage period significantly ($p<0.05$) influenced the average chick weight, chick to egg ratio, $A^+$ chick's 'A' grade chick's US chick's and 'B' grade chicks percent. The highest average chick weight, chick to egg ratio, $A^+$ chick's and 'A' grade chick's percent was observed in large egg weight category followed by those in medium and small ones in all the production phases, while, the highest 'US' and 'B' grade chick's percent was observed in small egg weight category in all production phases. Higher average chick weight, chick to egg ratio and US chick percent were observed in one and four day's storage than that of seven days storage in all the production phases. Higher $A^+$ chick percent in one and four days storage was observed than that of seven days in peak and post-peak, while, higher 'A' grade chick percent was recorded in one and four days storage than that of seven days in pre-peak and peak.

**Key Words:** Broiler breeder strain, average chick weight, chick grade, chick to egg ratio, production phase

## INTRODUCTION

The quality of day-old chicks is the uppermost preference in the minds of most poultry managers. Among different chick quality measurement methods, either quantitative or qualitative, chick weight, a quantitative method is the most widely used indicator for day-old chick quality assessment (Peter *et al.* 1997; Deeming, 2000; Decuypere *et al.* 2002). Most of the broiler producers require higher day- old chick weight and every hatchery manager try to produce maximum 'A' Grade chicks. Poor quality hatches have been reported to increase early chick mortality from 0.8-1.3% (Shane, 1999). There are many factors that affect chick weight and ultimate chick quality in broiler breeders such as egg weight and quality (Wiley *et al.* 1950). The egg size is important because of its direct relationship (Moran, 1990) or positive correlation (Wilson and Suarez, 1993; Seker *et al.* 2004 and Lourens *et al.* 2006) with the size of the day-old chick, which comprises about 64-70% of the weight of the egg (Merritt and Gowe, 1965). Correspondingly, Among *et al*. (1984) and Farooq *et al*. (2001) reported that small eggs produced smaller chicks with a lower performance than chicks hatched from larger eggs. Chick quality is also influenced by pre-incubation storage conditions and duration (Crittenden and Bohren 1961; Bohren, 1978; Wilson, 1991) and incubation conditions (Reis *et al.* 1997) The eggs incubated on the day of lay produced heavier chicks than eggs stored for a number of days and long-term storage can affect chick quality adversely (Reis *et al.* 1997 and Tona *et al.* 2003). Similarly, Boerjan, (2010) observed that eggs stored longer than a week increased deterioration of chick quality. In contrast to above findings Hassan *et al*. (2005) reported a negative correlation between egg storage and chick quality. Contrarily, Ayorinde *et al.* (1994) and Nahm (2001) reported strong positive correlations among pre-incubation egg weight, storage periods and chick weight. However, Petek *et al.* (2003) found no effect of length of storage period on body weight at hatch. Conflicting view point expressed in respect of effects of egg weight and pre-incubation storage on chick quality has necessitated conduct of comprehensive investigations' on the subject. Therefore the present study was planned with the objectives to investigate the effect of different egg weight and storage durations on chick quality in Hubbard strain of broiler breeder.

## MATERIALS AND METHODS

**Experimental plan:** The present study was conducted at a commercial hatchery with the objective to evaluate the chick quality (average day-old chick weight (g), chick to egg ratio, $A^+$ Chicks, A, US and B grade chicks) from fertile eggs of Hubbard broiler breeder strain during four production phases, categorized into 3 egg weights, maintained at 3 different storage periods. For this purpose, eggs during 4 production phases (pre-peak; 25-28, peak; 29-36, post-peak; 37-52 and terminal; 53-56$^{th}$ weeks of age) were categorized into three different weight categories (small, medium and large; subject to change in each production phase), stored for three different durations (1-day, 4-days and 7-days) and replicated 6 times. A total of 93312 fertile eggs; pre-peak: 11664, peak: 23328, post-peak: 46656 and terminal: 11664 eggs in 4 production phases were collected. During each week of the experiment, a total number of 972 eggs per storage period from three egg weight categories replicated 6 times (each replicate containing 54 eggs) were used. After categorization according to weight, the eggs were stored under room conditions (temperature 65 – 68$^{o}$F and relative humidity 75 – 80 %). Then the eggs were set in fully automatic multi-stage Chick-Master setter machine with standard hatching conditions (99.5$^{o}$F temperature, 50% relative humidity and hourly based turning). The eggs were kept in the setter from 18 – 18.5 days and then were transferred to Chick-Master Hatcher machine at temperature 98.5$^{o}$F and relative humidity 70 % for a period of 2.5 – 3 days.

**Statistical analysis:** The data thus collected were analyzed using analysis of variance (ANOVA) technique (Steel *et al.* 1997) with Randomized Complete Block Design (RCBD) in 4×3×3 factorial arrangements. The statistical procedure was assumed after Ishaq *et al.* (2014). The comparison of means was made using Duncan's Multiple Range (DMR) test (Duncan, 1955).

## RESULTS AND DISCUSSION

**i. Average chick weight (g):** The results of the present study showed that the different egg weight categories significantly ($p<0.05$) affected the average chick weight (g) throughout the experimental period (Table 1). The highest average chick weight (g) was observed in large egg weight category followed by in medium and small ones in all production phases. This could be due to variations in residual yolk mass (Joseph *et al.* 2006) and higher albumen and yolk weights in large eggs compared with small eggs (Lourens *et al.* 2006). Thus the surplus availability of nutrients in large eggs was therefore held responsible for the absolute and relative higher weight of residual yolk in chicks that hatched from large eggs compared with small eggs, which might have resulted in heavy chicks. Similarly, Among *et al*. (1984) and Farooq *et al*. (2001) reported that small eggs produced smaller chicks than from larger eggs. Furthermore, Wilson and Suarez (1993); Seker *et al.* (2004) and Lourens *et al*. (2006) also reported positive relationship between chick weight and egg weight. The results of the present study also showed that the storage durations significantly ($p<0.05$) affected the average chick weight (g) throughout the experiment. In interaction between egg weight categories and storage time, the highest average chick weight was observed in one and four days storage of large egg weight category and the lowest in seven days storage of small egg weight category during all the production phases (Table 1). Higher average chick weight in one and four days storage than that of seven days storage recorded in all the production phases could be attributed to higher moisture loss in seven days storage (Romao *et al.* 2008). Similar findings have also been reported by Reis *et al.* (1997), who indicated that eggs incubated on the day of lay produced heavier chicks than eggs stored for longer periods. While, Ayorinde *et al.* (1994) and Nahm (2001) reported strong positive correlations among pre-incubation egg weight, storage periods and chick weight at hatching. However, Tona *et al*. (2004) reported that the length of storage period had no effect on chick weight at hatching.

**ii. Chick to egg ratio:** The results of the present study showed that the egg weight (g) categories significantly ($p<0.05$) affected the chick to egg ratio throughout the experiment. The highest chick to egg ratio was observed in large egg weight category followed by in medium and small ones in all the production phases (Table 2). This could be attributed to maximum utilization of egg components for higher body development during incubation in chicks form large eggs (Skewea *et al.* 1988; Lourens *et al.* 2006). These results are in-line with those of Merritt and Gowe (1965) and Moran (1990). Storage times significantly ($p<0.05$) affected the chick to egg ratio throughout the experiment. In interaction between egg weight categories and storage time, the highest chick to egg ratio was observed in one and four days storage of large egg weight category and the lowest in seven days storage of small egg weight category storage in all the production phases (Table 2). Higher chick to egg ratio in one and four days storage than that of seven days storage in all the production phases in this study could be attributed to degradation of albumen quality due to prolong egg storage causing higher moisture loss during incubation (Lapao *et al.* 1999). This dehydration also occurred in chicks hatched from eggs stored for longer period, as egg stored for longer period hatch earlier so chicks have to stay more time in Hatcher (Reis *et al.* 1997). Similarly, Boerjan (2010) reported that egg storage beyond one week increased deterioration of chick quality.

**iii. $A^+$ grade chick ratio:** The results of the present study indicated that the egg weight categories significantly ($p<0.05$) affected $A^+$ chicks ratio in peak and post-peak phases (Table 3). The highest $A^+$ chick % was recorded in large egg weight category followed by medium and small ones which could be due to increase in egg size with advancing age (Roque and Soares, 1994; Tona *et al.* 2004), as large chicks are hatched from larger eggs (Lourens *et al.* 2006). Results of the present study are in line with those of Skewea *et al*. (1988), who also found increase in chick weight with increasing age. During terminal phase, non-significant ($p>0.05$) effect of egg weight categories on $A^+$ chick percent could be attributed to little differences in egg weights used in this study. Results of present study are in agreement with those of Skewea *et al.* (1988), who also found increase in chick weight with increasing age. Storage periods significantly ($p<0.05$) affected $A^+$ chick percent in peak and post-peak phases (Table 3). The higher $A^+$ chick percent in one and four days storage durations than that of seven days in peak and post-peak could be attributed to increase in egg weight (Roque and Soares, 1994), decreased shell thickness (Peebles *et al.* 2000) and increase in the proportion of yolk at the expense of albumen and eggshell (Suarez *et al.* 1997) with advancing age, This increment in egg contents along with normal weight loss during storage and incubation helps in producing chicks with higher body weight. During terminal phase non-significant ($p>0.05$) effect of storage on $A^+$ chick percent could may be attributed to negligible hatching loss due to storage. The results of this study are in agreement with those of Petek *et al.* (2003) who found that chicks hatched from eggs stored for 1, 3, 5, and 7 days had similar weights at hatching. In interaction between egg weight categories and storage time, the highest chick to egg ratio was observed in one and four days storage of large egg weight category and the lowest was observed in seven days storage of small egg weight category during all the production phases (Table 3).

**iv. A-grade chick percent:** Egg weight categories significantly ($p<0.05$) affected the A-grade chick percent throughout the experimental period (Table 4). The highest A-grade chick percent was observed in large egg weight category followed by those in medium and small ones in pre-peak and peak production phases. This could be attributed to presence of maximum number of eggs in large category that fall in weight range enough to produce A-grade chicks. The highest A-grade chick percent was recorded in small egg weight category followed by those in medium and large ones in post-peak which could be attributed to increase in egg size with increase in age and large and medium weight eggs had much weight to produce $A^+$ chicks than A-grade chicks in post-peak which results in lower percentage (Alkan *et al.* 2008). Similar finding have also been reported by Caglayan *et al.* (2010) who found positive correlation between egg weight and chick weight at hatching. Storage periods significantly ($p<0.05$) affected the A grade chick percent in pre-peak and peak phases (Table 4). Higher A-grade chick percent in one and four day's storage than that of seven days might be due to increased egg size and moisture loss with advancing age (Roque and Soares, 1994) and also due to more weight loss with increasing storage length (Lapao *et al.* 1999). Similar findings have also been reported by Lourens *et al.* (2006) who also found that larger eggs produce large chicks. During post-peak period, non-significant ($p>0.05$) effect of storage on A-grade chick percent was observed which could be attributed to negligible weight loss due to egg storage. The results of present study are also in agreement with those of Petek *et al.* (2003). In interaction between egg weight categories and storage time, the highest A-grade chick percent was observed in one day storage of large egg weight category and the lowest was in seven days storage of small egg weight category in pre-peak and peak production phases (Table 4).

**v. US chick percent:** Egg weight categories significantly ($p<0.05$) affected the US chick % throughout the experiment except during terminal phase of this study (Table 5). The highest US chick percent was observed in small egg weight category followed by those of medium and large ones in all the production phases. This could be attributed to lesser amount of egg contents in small eggs which provided fewer nutrients for body development of the chick. These results are in-line with those of Merritt and Gowe (1965) and Moran (1990) who also reported that size of the day-old chick had direct relationship with the size of egg and comprises 64-70 percent of it. Storage periods significantly ($p<0.05$) affected the US chick percent in all production phases except in the terminal phase (Table 5). Higher US chick percent in seven days storage than those of one and four days storage could be attributed to degradation of albumen quality due to prolonged egg storage causing higher moisture loss during incubation (Lapao *et al.* 1999). Similar findings were also reported by Reis *et al*. (1997). In interaction between egg weight categories and storage time, the highest US chick percent was observed in four days storage of small egg weight category in all the production phases (Table 5).

**Table 1. Average chick weight (g) (Mean ± SE) influenced by 3 egg weight categories and storage period at 4 production phases in Hubbard broiler breeder strain**

| *S.O.V Phases | | Pre-peak | Peak | Post-peak | Terminal |
|---|---|---|---|---|---|
| **Egg weight categories** | | | | | |
| **Large** | | 37.90±0.0.12$^{A}$ | 40.06±0.19$^{A}$ | 45.01±0.06$^{A}$ | 47.77±0.04$^{A}$ |
| **Medium** | | 34,33±0.14$^{B}$ | 38.50±0.21$^{B}$ | 41.06±0.08$^{B}$ | 44.14±0.04$^{B}$ |
| **Small** | | 30.62±0.13$^{C}$ | 33.82±0.13$^{C}$ | 37.54±0.08$^{C}$ | 88.99±0.07$^{C}$ |
| **Storage periods** | | | | | |
| **1-Day** | | 34.60±0.37$^{A}$ | 36.45±0.34$^{AB}$ | 41.61±0.19$^{A}$ | 44.51±0.33$^{A}$ |
| **4-Day** | | 34.61±0.37$^{A}$ | 36.74±0.28$^{A}$ | 41.62±0.19$^{A}$ | 44.53±0.33$^{A}$ |
| **7-Day** | | 33.65±0.36$^{B}$ | 36.13±0.25$^{B}$ | 40.37±0.19$^{B}$ | 43.87±0.32$^{B}$ |
| **Egg weight categories x Storage periods** | | | | | |
| | **1-Day** | 38.19±0.20$^{a}$ | 39.20±0.13$^{b}$ | 45.45±0.01$^{a}$ | 48.02±0.04$^{a}$ |
| **Large** | **4-Day** | 38.27±0.18$^{a}$ | 41.75±0.31$^{a}$ | 45.46±0.09$^{a}$ | 48.01±0.04$^{a}$ |
| | **7-Day** | 37.24±0.18$^{b}$ | 39.22±0.13$^{b}$ | 44.10±0.08$^{b}$ | 47.28±0.03$^{b}$ |
| | **1-Day** | 34.67±0.23$^{c}$ | 41.71±0.30$^{a}$ | 41.47±0.13$^{c}$ | 44.35±0.04$^{c}$ |
| **Medium** | **4-Day** | 34.67±0.24$^{c}$ | 38.69±0.13$^{b}$ | 41.47±0.13$^{c}$ | 44.37±0.04$^{c}$ |
| | **7-Day** | 33.68±0.22$^{d}$ | 41.25±0.30$^{a}$ | 40.23±0.12$^{d}$ | 43.72±0.04$^{d}$ |
| | **1Day** | 30.93±0.20$^{e}$ | 35.92±0.07$^{d}$ | 37.90±0.13$^{e}$ | 41.17±0.03$^{e}$ |
| **Small** | **4Day** | 30.91±0.21$^{e}$ | 37.28±0.17$^{c}$ | 37.94±0.13$^{e}$ | 41.22±0.03$^{e}$ |
| | **7Day** | 30.02±0.22$^{f}$ | 35.90±0.07$^{d}$ | 36.77±0.12$^{f}$ | 40.60±0.03$^{f}$ |

Different alphabets on means show significant differences at $p<0.05$ *S.O.V = Source of variance

**Table 2. Chick to egg ratio (Mean ± SE) influenced by 3 egg weight categories and storage period at 4 production phases in Hubbard broiler breeder strain**

| *S.O.V Phases | | Pre-peak | Peak | Post-peak | Terminal |
|---|---|---|---|---|---|
| **Egg weight categories** | | | | | |
| **Large** | | 68.86±0.11$^{A}$ | 67.99±0.00$^{A}$ | 66.15±0.05$^{A}$ | 66.34±0.06$^{A}$ |
| **Medium** | | 68.81±0.11$^{B}$ | 67.32±0.03$^{B}$ | 66.13±0.05$^{B}$ | 66.29±0.05$^{B}$ |
| **Small** | | 68.76±0.11$^{C}$ | 67.77±0.03$^{A}$ | 66.12±0.05$^{C}$ | 66.26±0.05$^{C}$ |
| **Storage periods** | | | | | |
| **1-Day** | | 69.47±0.00$^{A}$ | 67.99±0.01$^{A}$ | 66.80±0.003$^{A}$ | 66.63±0.01$^{A}$ |
| **4-Day** | | 69.47±0.00$^{A}$ | 67.82±0.03$^{A}$ | 66.80±0.003$^{A}$ | 66.63±0.01$^{A}$ |
| **7-Day** | | 67.49±0.00$^{B}$ | 67.29±0.04$^{B}$ | 64.80±0.003$^{B}$ | 65.63±0.01$^{B}$ |
| **Egg weight categories x Storage periods** | | | | | |
| **Large** | **1-Day** | 69.52±0.01$^{a}$ | 68.00±0.01$^{a}$ | 66.81±0.004$^{a}$ | 66.67±0.005$^{a}$ |
| | **4-Day** | 69.53±0.01$^{a}$ | 68.00±0.01$^{a}$ | 66.81±0.004$^{a}$ | 66.68±0.004$^{a}$ |
| | **7-Day** | 67.54±0.01$^{d}$ | 67.98±0.01$^{b}$ | 64.82±0.004$^{f}$ | 65.66±0.008$^{d}$ |
| **Medium** | **1-Day** | 69.47±0.01$^{b}$ | 67.98±0.01$^{a}$ | 66.80±0.004$^{b}$ | 66.63±0.009$^{b}$ |
| | **4-Day** | 69.47±0.01$^{b}$ | 66.98±0.01$^{c}$ | 66.80±0.004$^{b}$ | 66.62±0.009$^{b}$ |
| | **7-Day** | 67.49±0.01$^{e}$ | 67.01±0.01$^{b}$ | 64.79±0.004$^{e}$ | 65.63±0.009$^{e}$ |
| **Small** | **1Day** | 69.40±0.01$^{c}$ | 68.00±0.01$^{a}$ | 66.78±0.005$^{a}$ | 66.59±0.009$^{c}$ |
| | **4Day** | 69.42±0.01$^{c}$ | 68.01±0.01$^{a}$ | 66.79±0.004$^{a}$ | 66.59±0.009$^{c}$ |
| | **7Day** | 67.44±0.01$^{f}$ | 67.01±0.01$^{b}$ | 64.79±0.005$^{d}$ | 65.60±0.009$^{f}$ |

Different alphabets on means show significant differences $p<0.05$ *S.O.V = Source of variance

**vi. B-grade chick percent:** The results of the present study showed that the egg weight categories significantly ($p<0.05$) affected B-grade chick percent in pre-peak and peak production phases. The highest 'B' grade chick percentage was observed in small egg weight category followed by those in medium and large ones (Table 6). This could be attributed to lower nutrients along with less moisture loss due to higher shell thickness in small eggs. Similarly, Lourens *et al.* (2006) found lower albumen and yolk weight in smaller eggs. The results of the present study are fully in-line with those of Caglayan *et al.* (2010) who also found positive correlation between egg weight and chick weight at hatching. Egg weight categories did not-significantly (p>0.05) influence 'B' grade chick percent in post-peak and terminal production phases. Egg storage period had non-significant (p>0.05) effect on 'B' grade chick percent in all the production phases except during pre-peak period (Table 6). As for as interaction between egg weight categories and storage time is concerned, the highest 'B' grade chick's percent was observed in seven days storage of small egg weight category in all the production phases (Table 6).

**Table 3. A+ chick's percent (Mean ± SE) influenced by 3 egg weight categories and storage period at 4 production phases in Hubbard broiler breeder strain**

| Phases<br>*S.O.V | | Pre-peak | Peak | Post-Peak | Terminal |
|---|---|---|---|---|---|
| | | **Egg weight categories** | | | |
| **Large** | | 0 | 23.25±3.73$^{A}$ | 98.72±0.13$^{A}$ | 98.74±0.24 |
| **Medium** | | 0 | 17.87±2.28$^{B}$ | 59.31±2.86$^{B}$ | 98.58±0.28 |
| **Small** | | 0 | 0$^{C}$ | 0$^{C}$ | 99.11±0.24 |
| | | **Storage periods** | | | |
| **1-Day** | | 0 | 11.88±2.35$^{A}$ | 55.68±2.90$^{A}$ | 98.99±0.22 |
| **4-Day** | | 0 | 11.38±2.1$^{A}$ | 55.14±2.89$^{A}$ | 98.55±0.29 |
| **7-Day** | | 0 | 0$^{B}$ | 47.20±2.90$^{B}$ | 98.90±0.25 |
| | | **Egg weight categories x Storage periods** | | | |
| **Large** | **1-Day** | 0 | 58.28±6.61$^{a}$ | 98.98±0.21$^{a}$ | 98.47±0.46$^{a}$ |
| | **4-Day** | 0 | 6.79±1.90$^{b}$ | 98.65±0.24$^{a}$ | 98.78±0.44$^{a}$ |
| | **7-Day** | 0 | 4.68±0.84$^{c}$ | 98.52±0.25$^{a}$ | 98.95±0.37$^{d}$ |
| **Medium** | **1-Day** | 0 | 52.61±6.93$^{a}$ | 68.07±4.71$^{b}$ | 99.19±0.35$^{b}$ |
| | **4-Day** | 0 | 8.22±1.77$^{b}$ | 66.75±4.73$^{b}$ | 97.79±0.59$^{b}$ |
| | **7-Day** | 0 | 45.25±3.75$^{ab}$ | 43.08±5.01$^{c}$ | 98.77±0.49$^{e}$ |
| **Small** | **1-Day** | 0 | 0$^{c}$ | 0$^{d}$ | 99.29±0.31$^{c}$ |
| | **4-Day** | 0 | 0$^{c}$ | 0$^{d}$ | 99.08±0.46$^{c}$ |
| | **7-Day** | 0 | 0$^{c}$ | 0$^{d}$ | 98.96±0.47$^{f}$ |

Different alphabets on means show significant differences at p<0.05 *S.O.V = Source of variance

**Table 4. A-grade chick's percent (Mean ± SE) influenced by 3 egg weight categories and storage period at 4 production phases in Hubbard broiler breeder strain**

| Phases<br>*S.O.V | | Pre-Peak | Peak | Post-Peak | Terminal |
|---|---|---|---|---|---|
| | | **Egg weight categories** | | | |
| **Large** | | 88.28±1.28$^{A}$ | 75.77±3.73$^{A}$ | 0$^{C}$ | 0 |
| **Medium** | | 18.88±2.87$^{B}$ | 61.37±2.86$^{B}$ | 39.44±2.85$^{B}$ | 0 |
| **Small** | | 1.09±0.27$^{C}$ | 14.12±1.74$^{C}$ | 84.20±2.06$^{A}$ | 0 |
| | | **Storage periods** | | | |
| **1-Day** | | 38.02±4.98$^{A}$ | 45.80±3.37$^{A}$ | 41.13±2.87 | 0 |
| **4-Day** | | 38.46±4.95$^{A}$ | 42.53±2.99$^{A}$ | 41.44±2.87 | 0 |
| **7-Day** | | 31.77±4.57$^{B}$ | 30.02±3.56$^{B}$ | 41.06±2.87 | 0 |
| | | **Egg weight categories x Storage periods** | | | |
| | **1-Day** | 88.36±2.58$^{a}$ | 91.79±1.93$^{a}$ | 0$^{e}$ | 0 |
| **Large** | **4-Day** | 91.27±2.13$^{a}$ | 40.76±6.66$^{d}$ | 0$^{e}$ | 0 |
| | **7-Day** | 85.21±1.78$^{a}$ | 94.79±0.87$^{a}$ | 0$^{e}$ | 0 |
| | **1-Day** | 24.97±6.07$^{b}$ | 46.956.95$^{cd}$ | 31.00±4.72$^{d}$ | 0 |
| **Medium** | **4-Day** | 21.80±5.64$^{b}$ | 91.34±1.84$^{a}$ | 31.86±4.73$^{d}$ | 0 |
| | **7-Day** | 9.89±1.44$^{c}$ | 54.21±3.72$^{bc}$ | 55.47±5.02$^{c}$ | 0 |
| | **1-Day** | 0.72±0.38$^{d}$ | 11.39±2.09$^{e}$ | 92.41±2.51$^{a}$ | 0 |
| **Small** | **4-Day** | 2.33±0.64$^{cd}$ | 60.30±5.42$^{b}$ | 92.46±2.46$^{a}$ | 0 |
| | **7-Day** | 0.21±0.14$^{d}$ | 55.42±1.86$^{bc}$ | 67.73±4.69$^{b}$ | 0 |

Different alphabets on means show significant differences at p<0.05 *S.O.V = Source of variance

**Table 5. US chick's percent (Mean ± SE) influenced by 3 egg weight categories and storage period at 4 production phases in Hubbard broiler breeder strain**

| *S.O.V Phases | | Pre-Peak | Peak | Post-Peak | Terminal |
|---|---|---|---|---|---|
| | | **Egg weight categories** | | | |
| **Large** | | 10.51±1.24$^{C}$ | 0$^{C}$ | 0$^{B}$ | 0 |
| **Medium** | | 61.47±2.12$^{B}$ | 20.01±2.81$^{B}$ | 0$^{B}$ | 0 |
| **Small** | | 70.08±4.64$^{A}$ | 84.83±1.75$^{A}$ | 14.37±2.05$^{A}$ | 0 |
| | | **Storage periods** | | | |
| **1-Day** | | 43.32±4.18$^{B}$ | 42.03±3.68$^{B}$ | 2.05±0.83$^{B}$ | 0 |
| **4-Day** | | 52.81±4.38$^{A}$ | 49.54±3.38$^{B}$ | 2.04±0.83$^{B}$ | 0 |
| **7-Day** | | 45.93±4.40$^{AB}$ | 56.91±4.29$^{A}$ | 10.27±1.78$^{A}$ | 0 |
| | | **Egg weight categories x Storage periods** | | | |
| **Large** | **1-Day** | 10.37±2.59$^{d}$ | 0$^{c}$ | 0$^{b}$ | 0 |
| | **4-Day** | 7.53±1.95$^{d}$ | 0$^{c}$ | 0$^{b}$ | 0 |
| | **7-Day** | 13.63±1.69$^{d}$ | 0$^{c}$ | 0$^{b}$ | 0 |
| **Medium** | **1-Day** | 53.82±3.80$^{c}$ | 0$^{c}$ | 0$^{b}$ | 0 |
| | **4-Day** | 57.87±3.53$^{c}$ | 0$^{c}$ | 0$^{b}$ | 0 |
| | **7-Day** | 72.71±2.48$^{b}$ | 0$^{c}$ | 0$^{b}$ | 0 |
| **Small** | **1-Day** | 65.75±8.20$^{bc}$ | 87.78±2.11$^{a}$ | 6.16±2.45$^{b}$ | 0 |
| | **4-Day** | 93.05±1.04$^{a}$ | 38.28±5.633$^{b}$ | 6.14±2.44$^{b}$ | 0 |
| | **7-Day** | 51.45±9.61$^{c}$ | 44.02$^{b}$ | 30.81±4.69$^{a}$ | 0 |

Different alphabets on means show significant differences at p<0.05
*S.O.V = Source of variance

**Table 6. 'B' grade chick's percent (Mean ± SE) influenced by 3 egg weight categories and storage period at 4 production phases in Hubbard broiler breeder strain**

| *S.O.V Phases | | Pre-Peak | Peak | Post-Peak | Terminal |
|---|---|---|---|---|---|
| | | **Egg weight categories** | | | |
| **Large** | | 1.16±0.21$^{C}$ | 0.74±0.19$^{B}$ | 1.28±0.13 | 1.26±0.24 |
| **Medium** | | 19.69±1.43$^{B}$ | 0.97±0.11$^{A}$ | 1.25±0.13 | 1.41±0.28 |
| **Small** | | 28.82±4.72$^{A}$ | 0.96±0.11$^{AB}$ | 1.43±0.21 | 0.89±0.24 |
| | | **Storage periods** | | | |
| **1-Day** | | 18.71±3.27$^{A}$ | 1.17±0.17 | 1.12±0.21 | 1.01±0.22 |
| **4-Day** | | 8.71±1.40$^{B}$ | 0.78±0.11 | 1.37±0.14 | 1.45±0.29 |
| **7-Day** | | 22.25±3.99$^{A}$ | 0.78±0.11 | 1.46±0.14 | 1.10±0.25 |
| | | **Egg weight categories x Storage periods** | | | |
| **Large** | **1-Day** | 1.26±0.31$^{d}$ | 1.42±0.36$^{a}$ | 1.01±0.21 | 1.52±0.46$^{ab}$ |
| | **4-Day** | 1.19±0.43$^{d}$ | 0.96±0.33$^{ab}$ | 1.34±0.24 | 1.21±0.44$^{ab}$ |
| | **7-Day** | 1.02±0.37$^{d}$ | 0.53±0.27$^{b}$ | 1.48±0.25 | 1.04±0.37$^{ab}$ |
| **Medium** | **1-Day** | 21.35±2.62$^{bc}$ | 0.43±0.17$^{b}$ | 0.92±0.20 | 0.81±0.35$^{ab}$ |
| | **4-Day** | 2.32±2.80$^{c}$ | 0.44±0.22$^{b}$ | 1.38±0.24 | 2.21±0.59$^{a}$ |
| | **7-Day** | 17.39±2.00$^{c}$ | 0.52±0.26$^{b}$ | 1.44±0.24 | 1.22±0.49$^{ab}$ |
| **Small** | **1-Day** | 33.51±8.31$^{b}$ | 0.82±0.32$^{ab}$ | 1.43±0.55 | 0.71±0.31$^{b}$ |
| | **4-Day** | 4.61±1.02$^{d}$ | 0.70±0.27$^{ab}$ | 1.41±0.24 | 0.91±0.46$^{ab}$ |
| | **7-Day** | 48.33±9.65$^{a}$ | 0.54±0.27$^{b}$ | 1.46±0.25 | 1.04±0.47$^{ab}$ |

Different alphabets on means show significant differences at p<0.05 *S.O.V = Source of variance

**Conclusion:** The results of present study suggested that the average chick weight, chick to egg ratio, A$^{+}$ chick's and 'A' grade chick's percent had positive relationship with egg weight, while, 'US' and 'B' grade chick's percent had negative relationship. Average chick weight, chick to egg ratio, A$^{+}$ chick's 'A' and US chick percent showed negative relationship with storage length. Based on the findings of this study, it may be stated that large size eggs with 1 and 4 days storage duration could be used for production of A$^{+}$ as well as 'A' grade chicks.

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