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EFFECTS OF FLOCK AGE, PRE-INCUBATION STORAGE, AND INCUBATION RELATIVE HUMIDITY ON HATCHABILITY CHARACTERISTICS OF EGGS FROM TWO LOCAL CHICKEN STRAINS

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ABSTRACT

This experiment was conducted to investigate the effects of pre-incubation storage period of hatching egg, incubation relative humidity, and parental chickens, strain and age on hatchability performance. Two preincubation storage periods (3 or 14 days) and three incubation relative humidity (RH) levels (55, 60 or 65%) were investigated. A total number of 1155 hatching eggs produced by 40- or 60-wk-old Mamourah (M) and Gimmizah (G) hens were used in this study. Prior to incubation hatching eggs were stored for 3 or 14 days (at a range of temperatures between 14-17 °C and 62-65% RH).Eggs were incubated at a temperature of 37.8 °C with RH of 55, 60 or 65% for the first 18 days, then 65% RH for the last three days.

Results showed that, post-stored egg albumen height was negatively affected for eggs from older hens (60-wk-old). Post storage egg albumen height was decreased while albumen pH was increased as the preincubation storage period extended to 14 days. Egg weight loss during the first 18 days of incubation was significantly higher for eggs of M (13.2%) than for those of G (12.9%), and, greater in eggs from 60-wk-old hens (13.2%) than in those from 40-wk-old hens (12.7%). The greatest egg weight loss (13.8%) was observed at incubation RH of 55%, and the lowest one (12.3%) was recorded under 65% RH. Eggs fertility and hatchability were not affected by strain of chickens, but they were significantly affected by parental age, length of presetting storage period, and incubation RH. Fertility and hatchability percentages were higher for eggs laid by 40-wk-old hens than for those of 60-wk-old hens, being 91 4 and 90.2%, and 87.8 and 83.45% for fertility and hatchability, respectively. The best egg fertility and hatchability percentages were obtained under incubation RH of 60%, and the worst ones were recorded at 65% RH. There were significant differences in incubation time of eggs due to the effects of chickens strain (491.9 *vs.* 492.8 h in G and M, respectively) and age (491.8 *vs.* 492.9 h in eggs produced by 40- and 60-wk-old hens, respectively), length of presetting storage period (489.7 *vs.* 495.1 h for eggs stored for 3 and 14 days, respectively), and incubation RH (490.4, 492.7 and 493.6 h at 55, 60 and 65% RH, respectively). Embryonic mortality was significantly increased in hatching eggs from older hens (60-wk-old), in eggs stored for 14 days prior to setting, and in those incubated at 65% RH. Average hatch-weight of chicks was not affected significantly by strain and age of parental chickens or the length of preincubation storage period of hatching eggs, while it was inversely related to the level of incubation RH.

Keywords: Gimmizah and Mamourah eggs, storage period, relative humidity, fertility and hatchability.

INTRODUCTION

There are several factors affecting hatching performance including genotype, egg characteristics, pre-incubation storage period and environmental conditions of incubation. Ideally, hatching eggs should be set immediately after they are laid in order to reduce storage problems and optimize hatchability. Practically, however, some storage is always necessary. Storage of hatching eggs before incubation has been reported to have a two-directional effects on eggs hatchability (Brake, *et al.*, 1993). Excessively long storage prior to incubation causes a decline in hatchability (Becker, 1964). Hatchability rate was negatively correlated with days of storage before hatching (Abdou *et al.*, 1990 and Nofal *et al.*, 1999). Ghany *et al.* (1966) indicated that eggs stored at room temperature deteriorated more rapidly than those stored at 55 °F. On the contrary, eggs stored for a few days have been reported to hatch better than those set in the incubator soon after oviposition (Lapao *et al.*, 1999).

Not only did prolonged storage of hatching eggs prior to incubation affect the hatchability, but it also had some other effects. Prolonged storage was associated with an increased incubation period (Mather and Laughlin, 1976), a retarded growth and abnormal development of embryos (Arora and Kosin, 1966 and Mather and Laughlin, 1979), a high rat of embryonic mortality (Mather and Laughlin, 1976), a decreased proportion of first quality hatching chicks (Becker, 1960 and Byng and Nash 1962), and an increased mortality of hatching chicks, even as adults (Merritt, 1964). The need to improve hatchability characteristics of incubated eggs has directed researchers to search for means and methods that can decrease embryonic mortality during incubation and improve hatchability rate as well as growth performance of hatched chicks.

The current study aimed to evaluate the effects of the length of pre-incubation storage period and different incubation conditions on hatchability characteristics of eggs produced from 40- and 60-wk-old Mamourah and Gimmizah hens.

MATERIALS AND METHODS

The present study was carried out at the Poultry Farm, El-Gimmizah Research Station (Gharbia Governorate), Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture.

A total of 500 hens with 50 cocks from each of Gimmizah (G) and Mamourah (M) strains were fed on a commercial layer ration (containing 16% CP, 2800 Kcal ME/kg, 3.50% calcium, 0.40% available phosphorus, 0.76% lysine and 0.32% methionine) and kept separately at open-sided littered house (in littered pens); where hens were pen mass mated. Then two settings of hatching eggs produced by hens of each strain at 40 and 60 weeks of age were collected, cleaned, weighed, stored in small-end-up position at a range of temperatures between 14-17 °C and 62-65% RH for a period of 3 or 14 days, and reweighed prior to the initiation of incubation. The total number of hatching eggs used in this experiment was 1155 eggs as in the following table:

Strain	Length of pre-incubation storage (day)	Age of hens		Total number of hatching eggs
		40 wk	60 wk	
Gimmizah(G)	14	196	183	379
	3	99	101	200
	Total	295	284	579
Mamourah(M)	14	199	186	385
	3	99	92	191
	Total	298	278	576
Overall		593	562	1155

At the end of each pre-incubation storage period (3 or 14 days), ten eggs from each setting batch were broken and used for determination of egg albumen height and pH value. Albumen height was measured with a tripod micrometer according to the method of Wilgus and Van Wagenen (1936). This height was measured at two points on the opposite sides of the yolk. Whereas a digital pH meter (Model CG 882) was used for determination of egg albumen pH value.

Hatchery-incubators and eggs were fumigated immediately before the commencement of incubation, using a mixture of 20 g potassium permanganate, 40 ml formalin and 40 ml tap water. Each batch of hatching eggs were set into three incubators operating at 37.8 C but at 55, 60 or 65% RH during the first 18 days of incubation. Incubation temperature was maintained at 37.8 C while that of RH was maintained at 65%in the three incubators during the last three days of incubation. Incubation RH was regulated by wet bulb contact thermometers (28.9, 30.1 and 31.3 C, respectively).

The eggs were weighed individually before setting into the incubators. On the ninth day of incubation, the eggs were candled and all the infertile eggs were estimated. The fertility rate (FR) was calculated as follows:

FR% = (Number of fertile eggs/ total number of eggs) x 100.

On the 18^{th} day of incubation, eggs were recandled and all eggs with dead embryos were recorded to determine embryonic mortality rate. Only eggs with viable embryos were reweighed to ascertain the egg-weight loss . Thereafter, eggs were transferred to the hatching compartment to allow hatching. Incubation time and hatch weight of chicks were monitored. Hatchability (HR) and embryonic mortality (EM) rates were calculated as follows:

HR% = (Number of healthy chicks/number of fertile eggs) x 100.

EM% = (Number of dead embryos/number of fertile eggs) x 100.

Data were analyzed using least-square means and maximum likelihood program of SAS (1996). Significant differences among means were separated using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Pre-storage egg weight:

Regardless of hens' age, fresh egg weight was nearly similar in M (55.7 g) and G (55.4 g) strains with no significant differences (Table 1). With regard to egg weight, several investigators also observed no significant differences between both strains ≤≤(Goher, *et al.* 1990; Goher *et al.*, 1994; El- Wardany *et al.*, 1994 and Shebl *et al.*, 1996).

On the other hand, irrespective of strain, fresh egg weight was significantly (P≤0.05) higher for eggs produced by the 60-wk-old hens than that of eggs laid earlier at 40 weeks of age (Table 1). This result agrees with those reported by Cunningham *et al.* (1960), who found an increase in egg weight as age of pullets increased from 40 to 72 weeks (50 vs. 55 g). Shanawany (1984) observed a significant increase in egg weight from 55.9 g at 28 wk to 64.8 g at 44 wk of age. Goher *et al.* (1994) reported significant increase in egg weight as pullets' age increased from 36 to 52 wk (49.2 vs. 55.8 g). El-Wardany *et al.* (1994) found also a significant increase in egg weight as the age of hens increased from 42 to 67 wk (55.2 vs. 56.4 g).

Table (1): Means and standard errors of pre-storage and post-storage egg weight as affected by hens strain and age, and pre-incubation storage period.

Variables	Egg weight (g)		Egg weight Loss %
	Fresh (Pre-storage)	pre-incubation (Post-storage)	
Strain :			
Mamourah(M)	55.72 ± 0.01	55.1 ± 0.005^{a}	1.08
Gimmizah (G)	55.40 ± 0.01	54.8 ± 0.007^{b}	1.08
Age of hens:			
40 wk	55.1 ± 0.01^{b}	54.6 ± 0.01^{b}	0.91^{b}
60 wk	56.0 ± 0.01^{a}	55.3 ± 0.01^{a}	1.25^{a}
Pre-incubation storage period			
3 days	55.6 ± 0.01	55.2 ± 0.014^{a}	0.72^{b}
14 days	55.6 ± 0.01	54.7 ± 0.007^{b}	1.62^{a}

a-b: Means within the same column, for each criterion, having different superscripts differ significantly (P≤ 0.05).

Post-storage (Pre-incubation) egg weight:

Irrespective of hens age or length of storage period, the pre-setting egg weight was significantly (P≤0.05) higher for M than in G strain (54.8 vs. 55.1 g, Table 1). This result agrees with those obtained by Nofal *et al.* (1999). Also, Soliman (2000) found significant differences among breeds in pre-incubation egg weight due to the effect of storage period (3 to 6 days), where egg weight was heavier for G than Golden Montazah strain (55.20 vs. 51.57 g).

There was significant increase (P≤0.01) in post-storage egg weight as age of hens increased from 40 to 60 weeks, being 54.6 and 55.3 g for the two ages, respectively, regardless of strain or length of storage period (Table 1).

Also the pre-incubation egg weight was significantly (P≤0.05) higher after a 3-day storage period than that of 14 days (54.7 vs. 55.2 g), irrespective of strain or hens age (Table 1). This is mainly attributed to differences in moisture lost from eggs by evaporation through eggshell pores under different storage period. Nofal *et al.* (1999) also reported significant differences in egg weight due to the effect of pre-incubation storage period, and found that it was 49.81 g after 3 days of storage and decreased to 48.6 g after 9 days of storage. Furthermore, Soliman (2000) showed significant differences in egg weight due to the effect of length of pre-setting storage period, being 53.40 and 52.86 g after three and six days of storage, respectively.

It is of interest to note that percentage of egg weight loss was not affected significantly by strain. However, weight loss was higher for eggs produced at 60 wk than for eggs laid at 40 wk of age, and, for eggs stored for 14 days than for those stored for 3 days prior to incubation (Table 1).

Egg albumen characteristics:

Albumen pH:

Means of egg albumen pH (Table 2) showed insignificant differences between G and M strains. This result agrees with that obtained by Nofal *et al.* (1999), who found insignificant differences between G and M strains regarding egg albumen pH value.

In addition, no significant differences were observed in egg albumen pH value between eggs laid at the two ages (40 and 60 wk) of hens. Albumen pH was 8.52 and 8.54 in eggs produced at 40 and 60 wk of age, respectively (Table 2). This result is in agreement with those reported by Lapao *et al.* (1999), who reported no significant differences in egg albumen pH value between eggs produced by hens of 42 and 59 wk of age.

Data in Table 2 show that egg albumen pH value was significantly ($P \leq 0.01$) higher (9.29) after 14 than after 3 days (7.17) of storage.This result is in accordance with those obtained by Hurnik *et al.* (1978); Arad *et al.* (1989); Goodrum *et al.* (1989) and Stern (1991), who found that albumen pH value rose from 7.6 at oviposition to 9.5 as the storage period increased up to 14 days. Kader *et al.* (1982) showed that albumen pH value in fresh eggs (7.9) increased significantly to 9.5 by extending the storage period of eggs to ten days. Walsh *et al.*, (1995) reported that albumen pH value increased significantly from 8.0 for eggs stored for 7 days to 8.2 for eggs stored for 14 days. Benton *and Brake.* (1996) showed that albumen pH differed significantly from 7.68 at oviposition to 8.93 in eggs stored for 5 days. Nofal *et al.* (1999) found significant differences in egg albumen pH which increased from 7.9 at 3 days to 8.8 in eggs stored for 9 days. Lapao *et al.* (1999) reported that albumen pH differed significantly in eggs stored for different periods ranged between one to 8 days, and concluded that the pH value rose from 8.20 to 9.15, but most of this increase occurred during the first 4 days (9.03) of storage.

It has been established that, hens' eggs immediately after laying, start to lose carbon dioxide resulting in a rise in egg albumen pH (Kosin and Konishi, 1973). Although the high level of egg albumen pH has a germicidal effect on the invading microorganisms, such a rise is associated with, but not necessarily the cause of, a decrease in the internal quality of eggs which, it has always been empirically assumed, can reduce hatchability (Mayes and Takeballi, 1984)

Table (2): Means and standard errors of albumen characteristics as affected by hens strain and age, and pre-incubation storage period.

Variables	Albumen height (mm)	Albumen pH value
Strain :		
Mamourah(M)	5.38 ± 0.03	8.48 ± 0.03
Gimmizah (G)	5.57 ± 0.03	8.57 ± 0.02
Age of hens:		
40 wk	5.77 ± 0.03[a]	8.52 ± 0.03
60 wk	5.25 ± 0.03[b]	8.54 ± 0.02
Pre-incubation storage period		
3 days	5.67 ± 0.03[a]	7.17 ± 0.02[b]
14 days	5.35 ± 0.04[b]	9.29 ± 0.03[a]

a - b: Means within the same column, for each criterion, having different superscripts differ significantly (P≤ 0.05).

Albumen height:

Results presented in Table 2 revealed insignificant strain differences in egg albumen height. This is in accordance with results of Nofal *et al.* (1999), who found insignificant differences in egg albumen height between G and M strains.

Age of hens significantly (P≤0.01) affected egg albumen height, being higher for eggs laid at 40 wk (5.77 mm) than at 60 wk of age (5.25 mm). This result agrees with those obtained by Lapao *et al.* (1999), who found that albumen height was decreased significantly from 6.37 mm for eggs produced by 42-wk-old hens to 5.68 mm as the hens advanced in age to 59 wk of age.

Increasing storage period (Table 2) resulted in significant (P≤0.01) reduction in average albumen height from 5.8 mm in eggs stored for 3 days to 5.4 mm in those stored for 14 days. This result is in agreement with those obtained by Hurnik *et al.* (1978), who found that egg albumen height was significantly higher (6.6 mm) in fresh eggs than in eggs stored for three weeks (4.6 mm). Walsh *et al.* (1995) showed that albumen height was significantly higher (5.7 mm) in eggs stored for 7 days than in those stored for 14 days (5.3 mm). Nofal *et al.* (1999) found that albumen height was higher (7.0 mm) in eggs stored for one day than in eggs stored for 9 days (4.0 mm). Lapao *et al.* (1999) showed that albumen height was significantly higher (7.13 mm) in fresh eggs than in eggs stored for 8 days (5.25 mm).

Hatchability characteristics:

Fertility rate (FR):

Averages of FR were 90.8 and 90.4% for eggs laid by M and G hens, respectively, with no significant strain differences (Table 3). This result agrees with those obtained by Nofal *et al.* (1999) who found that FR was not significantly affected by strain, and reported that averages of FR were 94.62, 94.86 and 94.96% for eggs produced by G, M and Bandara strains, respectively, with no significant differences.

On the other hand, eggs FR was significantly ($P \le 0.05$) affected by hens age (Table 3). Averages of FR were 91.4 and 90.2% for eggs produced by 40- and 60-wk-old hens, respectively. This result agrees with those obtained by Mather and Laughlin (1979) who showed significant differences in FR due to the effect of hens' age, and stated that values of FR were 94.2 and 79.8% for eggs laid by 41- and 57-wk-old hens, respectively. In addition, Kirk *et al.* (1980) found that FR values were 97.03 and 89.43% in eggs produced by 44- and 60-wk-old hens, respectively, with significant differences. Moreover, Reis *et al.* (1997) reported FR values of 99.2 and 97.2% in eggs produced by 34- and 50-wk-old hens, respectively.

Average FR of eggs was significantly ($P \le 0.05$) higher at incubator RH of 60% (91.5%) than those of eggs incubated at RH of 55 and 65% (90.7 and 90.3%), respectively (Table 3). Kirk *et al.* (1980) stated that incubation RH had a significant effect on eggs FR, and, reported that as RH increased from 53 to 66% during incubation, eggs FR decreased from 97.2 to 95.7%. On the contrary, Gildersleeve (1984) reported no differences in eggs FR when eggs where incubated at 55% or increasing RH profiles from 52 to 67%.

Regarding the effect of length of pre-incubation period, averages of eggs FR were 92.3 and 88.1% after 3 and 14 days pre-setting storage periods, respectively, with significant ($P \le 0.05$) differences (Table 3). In agreement with the present results, Nofal *et al.* (1999) reported that eggs FR was significantly higher (96.23%) after 3 days and declined to 92.56% after 9 days of storage prior to incubation. Recently, Soliman (2000) showed that FR reduced after 6 days (94.46%) compared with that of eggs stored for 3 days (96.3%) prior to incubation. In addition, Fasenko *et al.* (2001) found that FR of eggs was significantly higher (92.91%) after 3 days than after pre-setting 14-day storage period (91.9%).

Egg weight loss:

Percentages of egg weight loss during the first 18 days of incubation were 13.2 and 12.9 % in M and G eggs, respectively, with highly significant($P \le 0.01$) differences (Table 3). This observation agrees with those obtained by Shebl *et al.* (1996) who reported that egg weight loss differed significantly among chicken strains, being 12.9, 11.9, 11.8 and 11.7% for Alexandria, Naked Neck, Norfa and Ross 208 hybrid, respectively. Also, Soliman (2000) found highly significant differences in egg weight loss during 0-18 d of incubation between Gimmizah (11.07%) and Golden Montazah (9.89%). However, Nofal *et al.* (1999) found insignificant breed differences in egg weight loss of incubated eggs among M, G and Bandara strains.

Egg weight loss percentage was significantly ($P \le 0.05$) higher (13.2%) for eggs produced at 60 than at 40 wk of age (12.7%). In keeping with the present result, Buhr (1995) found that projected 19-d egg weight loss was higher for eggs from 49-wk-old hens (18.2, 13.6 and 9.6%) than for eggs from 34-wk-old hens (16.6, 12.7 and 9.1%) incubated at 40, 55 and 70% RH, respectively. Reis *et al.* (1997) found that egg weight loss through incubation differed significantly with varying ages of the flock, being 11.64 and 11.22%

for eggs laid by 34-wk- and 50-wk-old hens, respectively; in an opposite trend to that of the present result.

Eggs incubated at the lowest level of RH (55%) had the greatest weight loss (13.8%), followed by 13.0% weight loss at 60% RH, whereas those incubated at 65% RH exhibited the lowest loss (12.3%), with significant ($P \leq 0.05$) differences (Table 3). Kirk *et al.* (1980) found significant differences in egg weight loss due to the effect of level of RH (44, 53 and 70%) during incubation of eggs. In addition, Bruzual *et al.* (2000) found that 53% RH during incubation caused a significantly higher egg weight loss than that observed under 43 and 63% RH. In accordance with the present result, Buhr (1995) reported also that projected 19-day egg weight loss (12.9, 10.45 and 7.6%) decreased significantly with increased incubation RH of 43, 55 and 69% respectively. Contradictory results were reported, however, by Gildersleeve (1984) who found no significant differences in 18-day egg weight loss when eggs were incubated at 55% RH or increasing RH profiles from 52 to 67% during incubation. Percentages of egg weight loss during incubation were13.0 and 13.2% for eggs stored for 3 and 14 days prior to setting, respectively, with no significant difference (Table 3). This result agree with those obtained by Mather and Laughlin (1976) who found that egg weight loss during incubation was 10.4% in the control (fresh eggs) and 10.6% in eggs stored for 14 days prior to incubation, and, they stated that the rate of weight loss during incubation was similar in both stored and non-stored eggs and a weight loss of 10-12% gave the best hatchability. Nofal *et al.* (1999) observed also that egg weight loss during incubation was not affected significantly by the length of pre-setting storage period, being 11.28 and 11.13% in eggs stored for 3 and 9 days, respectively. Also, Soliman (2000) reported that egg weight loss of incubated eggs was not affected significantly by the length of pre-setting storage period, being 10.37% after 3 d and 10.77% after 6 d. On the other hand, Benton and Brake (1996) found that egg weight loss during incubation was significantly greater after 4- and 14-day pre-incubation storage periods, compared with that of freshly incubated eggs. Also, Fasenko *et al.* (2001) reported that egg weight loss of incubated eggs was significantly higher (13.16%) in eggs stored for 14 than those stored for 4 days (12.61%) prior to incubation.

Embryonic mortality (EM) %:

Embryonic mortality percentages (EM) were 14.24 and 14.38% in hatching eggs of M and G strains, respectively, with no significant differences (Table 3). Nofal *et al.* (1999) obtained similar results with both the two strains.

Regarding the effect of hens' age, EM percentage was significantly ($P \leq 0.05$) higher in eggs produced by 60-wk-old hens (16.2%) than in eggs laid by 40-wk-old hens (12.2%). Similar observations were reported by Lapao *et al.* (1999) who found that EM was significantly increased in eggs produced by 59-wk-old hens (27.6%) than in those laid by younger ones at 42 weeks of age (14.8%). In this connection, Mather and Laughlin (1979) stated that the parental age influenced the number of embryonic abnormalities in hatching eggs after extended pre-incubation storage, which was slightly higher in very young and old birds than in birds between 31-49 weeks of age. Also, incubation RH had a significant ($P \leq 0.01$) effect on EM in hatching eggs (Table 3). Embryonic mortality percentages were 13.66, 11.65 and 17.89% at incubator RH of 55, 60 and 65%, respectively. This result is in line with that obtained by Bruzual *et al.* (2000) who found that embryonic mortality in hatching eggs was significantly increased from 9.4 to 13% as incubation RH increased from 53 to 63%. In accordance with these results, Krik *et al.* (1980) reported earlier that late EM was high when eggs were incubated at increased RH.

As for the effect of the length of pre-incubation period, EM was significantly ($P \leq 0.01$) higher for eggs stored for 14 days (16.42%) than that observed in eggs stored for 3 days (12.32 %) before incubation (Table 3). This is in line with the conclusion derived by Mather and Laughlin (1976; 1979). Also, Nofal *et al.* (1999) found that EM percentage in hatching eggs was significantly increased from 6.77% to 12.57%, as the pre-incubation holding time increased from 3 to 9 days. Moreover, Fasenko *et al.* (2001) found that EM was 22.35 % in hatching eggs stored for 4 days, increased to 29.28% in eggs stored for a prolonged pre-setting period of 14 days.

Hatchability rate:

Averages of hatchability percentage were 85.76 and 85.62% for eggs produced by M and G strains, respectively, with no significant differences (Table 3). This result agrees with that obtained by Nofal *et al.* (1999) who reported hatchability percentages of 86.16, 86.14 and 87.48%,for eggs produced by M, G and Bandra hens, respectively, with no significant breed differences.

Regarding the effect of hens' age, hatchability percentages were 87.8 and 83.5% for eggs laid by 40- and 60-wk-old hens, respectively, with a significant ($P \leq 0.05$) difference (Table 3). This result is in harmony with that obtained by Mather and Laughlin (1979) who showed that hatchability percentage was significantly dropped from 83.4 to 69.3% for eggs produced by 41- and 57-wk-old hens, respectively. Also, Meijerhof (1994) found that hatchability percentage was significantly higher for eggs produced by 37-wk-old hens (91.5%) than that of eggs produced later at 59 weeks of age (85.1%). In this connection, several authors (Bresiavats *et al.,* 1997; Suarez *et al.*, 1997 and Milosevic *et al.* 1997) found significant differences in eggs' hatchability due to the effect of layers' age. After extended pre-incubation storage of hatching eggs, Krik *et al.* (1980) also reported that the rate of decline in hatchability was greater in eggs from older flocks. In addition, Buhr (1995) stated that hatchability was higher for eggs from 34-wk-old hens (93.3, 98.7 and 92.9%) than for eggs from 49-wk-old hens (90.6, 93.0 and 89.0%) incubated at 40, 55 and 70 RH, respectively.

Data of Table 3 showed also that eggs hatchability percentage was significantly ($P \leq 0.01$) influenced by incubation RH, being the highest with 60% RH (88.4%), followed by that achieved at RH of 55% (86.1%), while at 65% RH the lowest value (82.3%) of eggs hatchability was attained. This result agrees with that obtained by Bruzual *et al.* (2000) who reported that eggs hatchability was significantly affected by the level of RH in the incubator. Contradictory results were reported, however, by Gildersleeve (1984) who observed no differences in hatchability rate when eggs were incubated at 55% RH or increasing RH profiles from 52 to 67% during incubation. Also, Buhr (1995) indicated that there were no significant differences in hatchability among eggs incubated at 43, 55 or 69% RH.

Hatchability percentages were 87.7 and 83.6% for eggs stored for 3 and 14 days prior to incubation, respectively, with a significant (P≤0.01) differences (Table 3). In line with this result, several investigators found also that eggs hatchability was significantly decreased as the length of pre-setting storage period increased (Mather and Laughlin 1976; Bohren, 1978; Hurink *et al.*, 1978; Kirk *et al.*, 1980; Meijerhof, 1994 and Nofal *et al.,* 1999). In this connection, it was found that hatchability percentage was 85.72% for eggs stored for 6 d (Soliman, 2000), 42.7% for eggs stored for 21 d (Gheisari, 2001) and 42.7% for eggs stored for 14 d (Fasenko *et al.*, 2001) compared with eggs stored prior to incubation for 3 d (88.49%), one day (89.4%) or 4 days (81.3%), respectively.

Incubation time (hours):

Averages of incubation time were 492.8 and 491.9 h for hatching eggs of M and G strains, respectively, with significant (P≤0.01) differences (Table 3). This result is in line with that obtained by Nofal *et al.* (1999) who similarly found that the incubation time was significantly longer for eggs of M (491.43 h) than for those of G strain (490.78 h).

As for the effect of hens' age, averages of incubation time were 491.0 and 492.9 h) for eggs produced by 40- and 60-wk-old hens, respectively, with no significant differences (Table 3). On the other hand, incubator RH had a significant (P≤0.01) effect on incubation time (Table 3). Averages of incubation time were 490.4, 492.7 and 493.6 h when RH were maintained at 55, 60 and 65 %, respectively. It appeared that incubation time was increased with elevating incubator RH. This result is in accordance with those obtained by Bruzual *et al.* (2000) who reported that as incubator RH was increased from 53 to 63%, incubation time of hatching eggs was significantly increased from 494.4 to 499.2 h.

The length of pre-setting storage period had also a significant (P≤0.01) effect on incubation time of hatching eggs (Table 3). Averages of incubation time were 489.7 and 495.1 h for eggs stored for 3 and 14 days prior to incubation, respectively. This result is in keeping with that obtained by Nofal *et al.* (1999) who observed that the incubation time was increased significantly from 490.33 to 498.30 h for eggs stored for 3 and 9 d prior to setting, respectively.

Hatch weight of chicks:

Neither hens strain nor age had significant effects on weight of chicks hatched from their eggs. Averages of chick weight at hatch were nearly similar in both strains, being 34.8 and 34.6 g in M and G, respectively, with no significant differences (Table 3). Similarly, Soliman (2000) found that hatch weights of G and Golden Montazah chicks were 34.1 and 33.9 g, respectively, with no significant strain differences.

Table (3): Means and standard errors of hatchability characteristics of eggs as affected by hens strain and age, incubation RH and pre-incubation storage period.

Variables	Fertility (%)	Egg weight loss %	Embryonic mortality (%)	Hatchability (% of fertile eggs)	Incubation time (h)	Weight of hatching chicks(g)
Strain :						
Mamourah(M)	90.8 ± 0.011	13.2 ± 0.08^{a}	14.24 ± 0.025	85.76 ± 0.023	492.8 ± 0.23^{a}	34.8 ± 0.10
Gimmizah(G)	90.4 ± 0.010	12.9 ± 0.08^{b}	14.38 ± 0.022	85.62 ± 0.027	491.9 ± 0.25^{b}	34.6 ± 0.07
Age of hens:						
40 wk	91.4 ± 0.012^{a}	12.7 ± 0.09^{b}	12.20 ± 0.015 ^{b}	87.80 ± 0.014 ^{a}	491.0 ± 0.34	34.4 ± 0.09
60 wk	90.2 ± 0.008^{b}	13.2 ± 0.07^{a}	16.22 ± 0.027 ^{a}	83.45 ± 0.027^{b}	492.9 ± 0.36	34.7 ± 0.10
Pre- incubation storage period :						
3 days	92.3 ± 0.001^{a}	13.0 ± 0.09	12.32 ± 0.022 ^{b}	87.68 ± 0.022 ^{a}	489.7 ± 0.26^{b}	34.6 ± 0.13
14 days	89.1 ± 0.011 ^{b}	13.2 ± 0.07	16.42 ± 0.022 ^{a}	83.58 ± 0.082 ^{b}	495.1 ± 0.18^{a}	34.7 ± 0.07
Incubation relative humidity(RH):						
55%	90.7 ± 0.001^{b}	13.8 ± 0.09^{a}	13.86 ± 0.019 ^{b}	86.14 ± 0.019 ^{b}	490.4 ± 0.32^{c}	34.9 ± 0.13 ^{a}
60%	91.3 ± 0.002 ^{a}	13.0 ± 0.07^{b}	11.65 ± 0.022 ^{c}	88.35 ± 0.022 ^{a}	492.7 ± 0.28^{b}	34.7 ± 0.07 ^{b}
65%	90.3 ± 0.007 ^{c}	12.3 ± 0.06^{c}	17.69 ± 0.049 ^{a}	82.30 ± 0.049 ^{c}	493.6 ± 0.27^{a}	34.5 ± 0.06 ^{c}

a - c: Means within the same column, for each criterion, having different superscripts differ significantly ($P \leq 0.05$).

Also, averages of chick weight at hatch were 34.4 and 34.7 g for chicks hatched from eggs laid by 40-wk-old and 60-wk-old hens, respectively, with no significant differences. In contrast to the present result, Suarez *et al.* (1997) reported that hatch weight of chicks was significantly affected by the age of maternal hens being 46.4 and 48.8 g for chicks hatched from eggs preduced by 47-wk and 57-wk-old hens, respectively.

Regarding the effect of incubation RH, chick weight at hatch was significantly ($P \leq 0.05$) affected by the level of RH in the incubator (Table 3), being the highest with 55% RH (34.9 g), followed by that obtained at 60% RH (34.7 g), while at incubation RH of 65% the lowest weight of chicks at hatch was attained (34.4 g). Other reports showed also that the level of RH in the incubator had a significant effect on chick weight at hatch. In this connection, Bruzual *et al.* (2000) stated that chick weight at hatch was significantly increased from 40.2 to 41.2 g as the relative humidity increased from 53 to 63 % during incubation.

On the other hand, the length of pre-incubation holding time of eggs had no significant effect on weight of chicks at hatch (Table 3). Averages of chicks' weight at hatch were 34.6 and 34.7g for chicks hatched from eggs stored prior to incubation for 3 and 14 days, respectively, with no significant differences. In line with this result, Nofal *et al.* (1999) and Soliman (2000) reported that there was no significant effect of pre-incubation storage of hatching eggs on chick weight at hatch. On the contrary, Becker (1960) and Byng and Nash (1962) stated that prolonged storage of hatching eggs prior to incubation was associated with a decreased proportion of first quality hatching chicks.

In conclusion, it appeared from the present result that maintaining the level of RH at 65% during incubation was apparently favorable to prevent dehydration of the egg content by evaporation through the pores thereby egg weight loss was reduced, but this condition was associated with a drop in hatchability rate, a higher rate of embryonic mortality, an increase in incubation time, and a lower chick hatching weight. Nevertheless, increased incubation RH may not be the primary cause of such detrimental effects. In this connection, Hoyt (1979) and Buhr (1995) stated that avian embryo could maintain a proper water balance and a fairly stable environment for development within a wide range of incubation RH.

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تأثير عمر القطيع و فترة التخزين والرطوبة النسبية للمفرخ على خصائص الفقس لبيض سلالتين من الدجاج المحلى

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أجريت هذه الدراسة لبحث تأثيرات تخزين بيض التفريخ والرطوبة النسبية للمفرخ وسلالة وعمر الآباء على خصائص الفقس. استخدم فى هذه الدراسة عدد ١١٥٥ بيضة من سلالتى المعمورة والجميزة والمنتجة عند عمر ٤٠، ٦٠ أسبوع. تم تخزين بيض التفريخ لمدة ٣ أو ١٤ يوم على درجة حرارة تتراوح بين ١٤، ١٧ درجة مئوى ورطوبة نسبية تتراوح بين ٦٢- ٦٥ %.

تم تفريخ البيض فى مفرخات درجة حرارتها ٣٧,٨ درجة مئوية وذات رطوبة نسبية ٥٥ أو ٦٠ أو ٦٥ % خلال ١٨ يوم الأولى من التفريخ ثم ٦٥ % رطوبة نسبية خلال الثلاث أيام الأخيرة من التفريخ.

وكانت أهم النتائج المتحصل عليها على النحو التالى:

- كان للتخزين أثرا سلبيا على ارتفاع ألبيومين بيض الأمهات الأكبر عمرا (٦٠ أسبوع). انخفض ارتفاع ألبيومين البيض بينما ارتفعت درجة تركيز أيون الهيدروجين للألبيومين مع زيادة طول فترة تخزين البيض قبل تفريخه إلى ١٤ يوما.
- كانت نسبة الفقد فى وزن البيضة خلال ١٨ يوم الأولى من التفريخ أعلى معنويا فى بيض المعمورة عنها فى بيض الجميزة. وكانت أعلى أيضا للبيض المأخوذ من أمهات عمرها ٦٠ أسبوعا عنها لبيض الأمهات التى عمرها ٤٠أسبوعا. كانت أعلى نسبة فقد فى وزن البيض عند ٥٥ % رطوبة نسبية للمفرخ بينما كانت أقل نسبة فقد عند ٦٥ %.
- تأثرت نسبة الخصوبة والفقس للبيض معنويا بعمر الأمهات وفترة التخزين قبل التفريخ وكذلك الرطوبة النسبية للمفرخ بينما لم تتأثر بالسلالة.
- كانت نسبة الخصوبة والفقس أعلى لبيض الأمهات عمر ٤٠ أسبوع عنها لبيض الأمهات عمر ٦٠ أسبوع كما كانت أعلى أيضا للبيض المخزن لمدة ٣ أيام عنها للبيض المخزن لمدة ١٤ يوما. كانت أفضل نسبة خصوبة وفقس للبيض عند مستوى ٦٠ % رطوبة نسبية بينما لوحظت أقل نسبة عند مستوى ٦٥ %.
- كان هناك تأثيرا معنويا لكل من السلالة وفترة تخزين البيض والرطوبة النسبية للمفرخ على طول مدة التفريخ بينما لم يكن هناك تأثيرا لعمر الأمهات.
- ارتفعت نسبة النفوق الجنينى معنويا لبيض الأمهات عمر ٦٠ أسبوعا عنها لبيض الأمهات عمر ٤٠ أسبوع، كما ارتفعت معنويا للبيض الذى تم تخزينه لمدة ١٤ يوم عنها للبيض المخزن لمدة ٣ أيام. كانت أعلى نسبة نفوق جنينى عند مستوى ٦٥ % رطوبة نسبية بينما لم يكن هناك تأثيرا للسلالة.
- لم يتأثر وزن الكتكوت عند الفقس بالسلالة أو عمر الأمهات وكذلك طول فترة التخزين قبل التفريخ بينما تأثر عكسيا مع زيادة مستوى الرطوبة النسبية للمفرخ.