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HATCHABILITY IMPROVEMENT OF PEKING DUCK EGGS BY CONTROLLING WATER EVAPORATION RATE FROM THE EGG SHELL

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ABSTRACT: *The purpose of this work was to test the possibility of improving hatchability characters of Peking duck eggs by controlling the water vapor rate with dipping the pointed end of egg into liquid paraffin wax (LP) or increase the incubation relative humidity (RH) to 80% during different incubation periods. The birds aged 45 week-old at the beginning of this study. Total number of 2240 hatching eggs were used for the two experiments and replicated four times. Hatched eggs for each experiment were randomly distributed into four equal groups (280 eggs per each).* ***In the first experiment****, first group was randomly taken without any treatment and served as a control, other three groups were treated by dipping the pointed end of egg (about 15% from shell surface) into LP on the 0, 14th and 24th days of incubation period, respectively.* ***In the second experiment,*** *first group was randomly taken without any treatment and served as a control and the other three groups were subjected by raising the RH to 80% for periods from 0-28, 14-28 and 24-28 days of the incubation, respectively. All eggs were weighed individually on the 0, 14th and 24th days of incubation to determine egg weight loss. A sample of 30 eggs from each group were randomly taken on the 0, 14th and 24th days of incubation and broken out to determine shell thickness, pore numbers. On the 28th day of incubation (hatching day), ducklings weights were recorded. Net return and economical efficiency were calculated.*

The results showed that:

1- *The functional properties of the egg shell during incubation changed with the embryonic age from being a significant barrier to water loss to facilitate water loss. Egg permeability increased with the increase of embryonic age and incubation period as a result of the decrease of shell thickness and increase of pore concentration.*

2- The eggs of thicker shells lost less weight than the eggs of thinner shells. Egg weight loss means of eggs dipped into LP on the 0, 14th and 24th

days of incubation period were significantly (P≤0.05) lower at the end of incubation period by 23.41, 25.39 and 14.34%, respectively, than the control eggs. Also these means were affected significantly by raising the RH to 80% for the periods from 0 to 28 and 14 to 28 days of incubation and decreased by 18.63 and 20.88%, respectively, as compared to the control.

3-The means of hatchability percentages of eggs dipped into LP on the 0, 14th and 24th days of incubation were significantly (P≤0.05) higher than the control by 20.22, 22.85 and 9.19%, respectively. Raising RH% to 80% significantly (P≤0.05) increased hatchability percentages by 7.97 and 20.27%, respectively, for the periods from 0-28 and 14-28 days of incubation as compared to the control eggs.

Results suggest that hatchability of fertile eggs and ducklings weight on hatching day could be improved to a great extent and more efficient by dipping hatching Peking duck eggs into LP on the 14th days of incubation or raising the RH to 80% during the period from 14-28 day of incubation.

INTRODUCTION

Several studies have been conducted to solve the low hatchability percentage of chickens and waterfowl eggs. Temperature is the most critical physical factor of artificial incubation affecting hatchability and plays an important role in embryonic development (Bagley, 1987). Several literatures have concluded that proper RH is equally important as the optimal incubation temperature in attaining maximum hatchability (Ar and Rahn, 1980). Shell thickness, shell conductance (water vapor conductance) and pore density are important properties of eggs that influence the success of embryonic development (Balkan, *et al.*, 2006). Rate of egg weight loss should not exceed 12% otherwise, hatchability could be adversely affected (Hays and Spear, 1951 and Robertson, 1961).

Rizk, *et al.* (2004) and Shahein, *et al.* (2007) studied the effect of incubation temperature on hatchability percentage of Egyptian chicken strains and found that temperature system had realized better results on hatchability. Abd-Allah, *et al*.(1995) found that hatchability of Matrouh chickens eggs had been reduced markedly due to dipping hatching eggs into LP solution and raising the RH to 60-65% during the incubation period. Meir and Ar (1996) reported that drilling holes into the air cells on days 15 to 22 of incubation increased hatchability of early laid goose eggs when the predicted mean water loss was lower than 14%. Ghonim, *et al*.(2008) found that hatchability percentages of Muscovy duck eggs were significantly (P≤0.01) improved by dipping eggs into ascorbic acid solution of 10, 20 and 30 g/liter as compared to the control on the 0, 14th and 30th days of incubation. Hatching of duck eggs are more difficult than that of chick egg, because of the characteristics of big size, thick egg shell and much pores (Changkang, *et al*. 1999).

The purpose of the present study to determine the effects of dipping hatching Pecking duck eggs into LP or raising RH to 80% during different incubation periods as method of egg permeability control on egg weight loss, hatchability of fertile eggs and duckling weight on hatching date.

MATERIALS AND METHODS

The present study was conducted on the Peking duck stock at El-Safa Station for duck production, Public Authority for Agrarian Reform, El-Mahmodia City, Beheira Governorate during the period from March up to June 2008. Ducks aged 45 week-old at the beginning of this study were reared in floor pens under standard husbandry conditions and fed on a standard breeder ration containing16% CP and 2825 kcal of ME/kg.

Total number of 2240 hatching eggs were used for the two experiments and replicated four times. Eggs were collected daily through seven days then fumigated and stored with the pointed end down in a cooling room (18 ^{o}C and 75% RH) before setting in the incubators. Hatched eggs for each experiment were randomly distributed into four equal groups (280 eggs per each).

Experiment 1:

This trial was carried out to investigate the effects of dipping the pointed end of egg into liquid paraffin wax (LP) (B.P. 80, Batch no. 89/802/L) on the 0, 14th and 24th days of the incubation period on hatchability traits. First group was randomly taken without any treatment and served as a control. Second, 3rd and 4th groups were treated by dipping the pointed end of egg (about 15% from shell surface) into LP, where eggs surface = 3.9782 x egg weight$^{0.7056}$ as suggested by Nordstrom and Outerhout (1982). All treated eggs with control group were incubated together in one incubator. The incubator used (German-made) were electronically controlled for temperature and relative humidity. The traditional temperatures were 37.8 ^{o}C during the incubation period (0-24 days) and 37.3^{o}C during the hatching period (24-28 days). Relative humidity was 50-55% during the incubation period and 60-65% during the hatching period .

Experiment 2:

This trial was carried out to investigate the effect of raising relative humidity (RH) inside the incubator to 80% for periods from 0-28, 14-28 and 24-28 days of the incubation on hatchability traits. Four incubators used (German-made) which were electronically controlled for temperature and relative humidity. First group was randomly taken without any treatment and served as a control and the other three groups were subjected for increasing the RH for different incubation periods. The traditional temperatures were the same for all incubators as 37.8 ^{o}C during the incubation period (0-24 days) and 37.3^{o}C during the hatching period (24-28 days).

The 1st group as control had RH 50-55% during the incubation period and 60-65% during the hatching period in one incubator, 2nd group subjected by raising the RH to 80% during the total hatching period (0-28 days) in second incubator, 3rd group subjected by RH 50-55% from 0-14 days and raising to 80% from 14-28 days of the total hatching period in third incubator and 4th group subjected by RH 50-55% from 0-24 days and raising to 80% during the last four days (24-28 days) of the total incubation period in the fourth incubator.

Eggs per each treatment groups were numbered consecutively and weighed before setting in the incubator. All eggs of the two experimental trials were set in five incubators at the same time. All eggs were set and distributed randomly at different places within the same trolley of incubator to reduce possible position effects. All eggs were reweighed individually on the 14th and 24th days of incubation for both experiments trials. During the incubation period eggs were turned once every two hours with the angle of 100 and were candled on the 24th day of incubation for detection non-fertile eggs. During the period from 14 to 24 days of incubation, eggs were moved out of the incubator daily at 1.00 PM, for spraying with worm water (25-28^{o} C) and then placed again back after reducing egg temperature to 30-32^{o}C.

On the 24th days of incubation all eggs were transferred singly into pedigree hatching baskets and then placed into the hatchers for the remainder period of the incubation. On the 28th day of incubation (hatching day), ducklings that had fully emerged from eggs were removed, and weighed to the nearest gram.

The studied traits were as follow:

1- Shell thickness: 30 eggs from each group were randomly taken before treatment on the 0, 14th and 24th days of incubation, and broken out.

Three shell fragments from the blunt end, equator and pointed end were boiled in a 5% Na OH solution for 15-20 minutes to remove organic material, including shell membranes then rinsed three times in distilled water and left to dry. Shell thickness was measured with a micrometer capable of 0.01 mm accuracy (Rokitka and Rahn, 1987).

2- Pore number was counted before treatment on the 0, 14th and 24th days of incubation. Ninety fragments were removed from the trials, and their inside surface were stained with Methylene blue (0.5 g of 89% day/L of 70% ethanol). The number of pores /cm^2 was counted for three different areas of each fragment under scanner electronic microscope as described by Booth (1989) .

3- Egg weight loss (water loss) for each treatment interval was calculated for each egg within a certain incubation interval as a percentage of the initial egg weight as follow:

$$\text{Egg weight loss \%} = \left(1 - \frac{\text{Weight of egg on a certain day of incubation period}}{\text{Initial egg weight}}\right) \times 100$$

4- Embryonic mortality during incubation for each treatment group was calculated as a percentage of dead embryos of the total number of fertile eggs.

5- Hatchability percentage for each treatment group was calculated as a percentage of hatched ducklings to the total number of fertile eggs.

6- Duckling weight was measured in grams for each healthy hatched duckling on the day of hatching.

7- Net return and Economical efficiency were calculated according to the price of Paraffin wax (10 L.E/ kg), one fertile egg of Peking duck (1.25 L.E) and one hatched duckling (2.50 L.E) prevailing during year 2008.

Data were statistically analyzed by statistical program on SPSS8 (1997) Windows. The significant differences among treatment means were tested according to Duncan (1955). Phenotypic correlation coefficients between shell thickness and pore density were estimated by using SAS computation program (SAS Institute, 1997).

RESULTS AND DISCUSSION

Shell Thickness and pore density :

The results shown in Table 1 indicated that eggshell thickness significantly ($P \leq 0.05$) decreased with the increase of embryonic age and incubation period. The reduction percentage of shell thickness from 0 to 24 days of incubation was 14%. This result indicates that shell thickness becomes thinner during the incubation with the increase of the age of the embryos. Different researchers came to the same conclusion in some species. Christensen (1983) for turkey eggs, Booth and Seymour (1987) for Mallee fowl eggs, Booth (1989) for Mute swan eggs and Soliman, *et al.* (1994) for chicken eggs. Also, the our results are in accordance wit those reported by (Tuan, 1987), that towards end of incubation, calcium is dissolved from the shell and presumably diffuses through a liquid water film covering the surface of the fibers of the inner and outer membranes to the chorioallantais. Upon reaching the chorioallantois, calcium is actively transported into the blood stream. Where it is used by the embryo to ossify the developing skeleton (Packard and Packard, 1984). Moreover, Soliman *et al*. (1994) reported that decrease of egg shell thickness at the end of incubation due to the removal of calcium from the egg shell for bone formation. Balkan, *et al.* (2006) who found that incubation resulted in an average 6.4% decrease in shell thickness. Koneva (1968) found that the contribution of shell thickness of turkey eggs to their hatchability was around 40%. Also, Andrews (1972) observed that the hatchability of turkey eggs with thinner shells was higher. In a study of goose eggs, Tsarenko (1988) reported that the hatchability of eggs with thicker shells was 20% higher. Moreover Ang, *et al.* (2003) stated that egg shell of addle and piped eggs were thicker than that of normal eggs.

Besides, this table reveals that pore density (pores/cm^2) was significantly ($P \leq 0.05$) increased with the increase of incubation period and embryonic age. Low pore numbers (density) cause difficulties in oxygen exchange and these have been associated with the increased embryonic mortality (Peebles and Brake, 1985). (Booth 1989) reported that highlights the main cause of decreasing the pore density with the incubation periods. He hypothesized that some of the pores are plugged inside the shell surface when the egg is laid, and that during incubation the shell thinning process presumably leads to the unplugging of these pores, making them functional. It may be that the inside mouths of plugged pores contain loosely packed crystals of calcium carbonate and that during incubation these crystals are dissolved away. Shell porosity is one of the definitive features of shell structure and mostly influence the gas exchange of the developing embryo as reported by Narushin and Romanov (2002).

Moreover, Table 1 reveals that shell thickness in Peking duck eggs is quite variable in the different egg regions. The shell was significantly ($P \leq 0.05$) thicker in the pointed end compared with that in the equator and blunt ends. This finding of the change in the regional eggshell thickness confirms those reported early by Soliman *et al*. (1994), Massaro and Davis (2005) and Balkan *et al*. (2006). Also, pore density was significantly ($P \leq 0.05$) increased in the blunt end compared to that in equator and pointed regions of eggshell. This finding regarding the pore density egg of regions in this study support the previous observations by Booth (1989), Soliman *et al*. (1994) and Balkan *et al*. (2006).

The results of phenotypic correlation in this Table indicate that shell thickness had a significant ($P \leq 0.05$) negative correlation with pore density on the 14^{th} day of incubation (- 0.57) and on 24^{th} day (-0.74), while this correlation is positive on zero time of incubation. This result is in harmony with that reported by Satteneri and Satterlee (1994) that there was negative correlation between shell thickness and pore density during incubation. Besides, Rahn *et al*.(1979) reported that shell thickness and porosity greatly influence egg shell conductance which has been defined as the quantity of a given gas diffusing in a unit of time through the pores of an egg shell.

The functional properties of the egg shell during incubation change with the embryonic age from being a significant barrier to water loss to facilitate water loss. Therefore it is the concluded from the results of this table that egg permeability could be increase with the increase of embryonic age and incubation period as result of the decrease of shell thickness and increase of pore concentration.

Table (1): Egg shell thickness (mm), pore density (pores/cm^2) and phenotypic correlation coefficients between them for the three egg shell regions of Peking duck eggs in different incubation periods

Traits	Egg shell region	The day of incubation period (Embryo age)			
		0	14	24	Overall mean
		X±S.E			
Shell thickness (S.T)	**Blunt**	0.42±0.013	0.38±0.009	0.36±0.012	**0.38±0.011^{c}**
	Equator	0.43±0.007	0.40±0.014	0.37±0.009	**0.40±0.010^{b}**
	Pointed	0.45±0.011	0.42±0.008	0.38±0.015	**0.42±0.009^{a}**
Overall mean		**0.43±0.010^{A}**	**0.40±0.008^{B}**	**0.37±0.011^{C}**	***0.40±0.010***
Pore density (P.D)	**Blunt**	137±12.3	143±14.5	147±10.6	**142±11.8^{a}**
	Equator	121±11.5	130±13.3	136±11.7	**129±12.4^{b}**
	Pointed	111±9.7	118±11.9	122±14.2	**117±10.9^{c}**
Overall mean		**123±10.8^{C}**	**130±12.7^{B}**	**135±11.8^{A}**	***129±11.4***
Correlation coefficients between (S.T) and (P.D)		**0.03**	**-0.57**	**-0.74**	

Means having the different small or capital letter in each column or row differ significantly ($P \leq 0.05$)

Egg weight loss:

The relative weight loss during the incubation period is considered one of the major factors which influence the hatchability. From inspection of Table 2, egg weight loss percentage seemed to be significantly ($P \leq 0.05$) greatest for the control group compared that treated with LP on 0, 14th and 24th days of incubation. Also, irrespective of egg treatment, egg weight loss percentage significantly ($P \leq 0.05$) increased during 14-24 day of incubation period compared to that during 0-14 day. The lowest significant egg weight loss percentages was observed during 0-24 day of incubation in eggs treated with LP on days zero and 14th of incubation. These results are normal and expected because masking a portion of the egg with LP seals the pores of the egg and prevent partially the egg weight loss and act as cuticle layer.

These results are in agreement with those reported by Christensen and Bagley (1984) who showed that LP seals the pores and may acts as the cuticle egg layer but in different degrees and the cuticle reduces shell permeability by occluding or partially occluding the mouths of pores thus acting as a barrier for water loss. Also, Abd-Allah, *et al.* (1995), dipped hatching eggs of Matrouh chicken into LP and held for storage periods of 1, 3, 5 and 7 days before set in the incubator, and found that the average of water loss was significantly lower by 63% than the control eggs. Changkang, *et al*. (1999) reported that hatchability was normal when egg weight loss on the 10th , 24th and 33rd days of incubation were 4.57, 10.50 and 14.20%, respectively.

Also, as shown in this Table, the lowest significant ($P \leq 0.05$) egg weight loss percentage during the setting incubation period was recorded for egg groups subjected to RH increase during the periods from 0-28 and 14-28 days compared to control group. The percentages of egg weight loss decrease during the previous mentioned periods were 18.63 and 20.88%, respectively, as compared to control. Regardless of egg treatment, egg weight loss percentage significantly ($P \leq 0.05$) increased during 14-24 day of incubation period compared to that during 0-14 day. The lowest significant ($P \leq 0.05$) egg weight loss percentages were observed during 0-24 day of incubation in eggs treated by raising the RH to 80% on the period from 0 to 28 and 14 to 28 day of incubation.

It appears from these data that egg weight loss had been affected significantly ($P \leq 0.05$) with the change of RH during different intervals of incubation. This finding supports the results of El-Turky, *et al*. (1984) who found that the thicker shell eggs produced by Silver and Golden Montazha pullets which measured on the 18th day of incubation lost less weight than the eggs of thinner shells. However, they found that the thinner shell eggs produced by White Leghorn and crossbred pullets lost less weight than the thicker shell eggs. Burton and Tullett (1985) who indicated that incubation humidity control the evaporation water loss from eggs. Also, Swann and Brake (1990) showed that egg water loss was affected by the RH directly, through the establishment of the water vapor pressure gradient. Abd-Allah, *et al*. (1995) showed that the percentage of egg weight loss exhibited significant ($P \leq 0.05$) decrease due to RH increase.

As shown in Tables 1 and 2, the eggs of thicker shells lost less weight than the eggs of thinner shells. It is clear from these data that the role of egg weight loss percentage was controlled to a great extant by LP and RH of incubation. Therefore much interest has been directed at determining an appropriate incubation humidity during incubation in Peking duck eggs that would induce sufficient water loss from eggs during incubation, which would result optimal hatchability.

Table (2): Egg weight loss (%) of Peking duck eggs in different incubation periods as influenced by dipping in liquid paraffin and raising incubation humidity

Treatment	Incubation periods (days)		
	0 - 14	14 - 24	0 - 24
	X±S.E		
Eggs dipped into liquid paraffin			
Control	4.76 ± 0.18^{a}	7.37 ± 0.31^{a}	$\mathbf{12.13 \pm 0.23^{a}}$
On day 0	3.21 ± 0.13^{c}	6.08 ± 0.20^{b}	$\mathbf{9.29 \pm 0.17^{c}}$
On day 14	3.34 ± 0.09^{c}	5.71 ± 0.14^{c}	$\mathbf{9.05 \pm 0.11^{c}}$
On day 24	4.16 ± 0.23^{b}	6.23 ± 0.08^{ab}	$\mathbf{10.39 \pm 0.10^{b}}$
Overall mean	$\mathbf{3.87 \pm 0.14^{B}}$	$\mathbf{6.35 \pm 0.17^{A}}$	$\mathbf{10.22 \pm 0.15}$
Raising relative humidity to 80%			
Control	4.83 ± 0.24^{a}	7.62 ± 0.27^{a}	$\mathbf{12.45 \pm 0.24^{a}}$
From 0-28 days	3.78 ± 0.07^{b}	6.35 ± 0.25^{b}	$\mathbf{10.13 \pm 0.14^{b}}$
From 14-28 days	3.64 ± 0.20^{b}	6.21 ± 0.37^{b}	$\mathbf{9.85 \pm 0.31^{b}}$
From 24-28 days	4.45 ± 0.14^{ab}	6.83 ± 0.19^{ab}	$\mathbf{11.28 \pm 0.15^{ab}}$
Overall mean	$\mathbf{4.18 \pm 0.13^{B}}$	$\mathbf{6.75 \pm 0.25^{A}}$	$\mathbf{10.93 \pm 0.18}$

[a,b,c] Means within each column with different superscripts are significantly different ($P \leq 0.05$)
[A,B,C] Means within last row in each treatment with different superscripts are significantly different ($P \leq 0.05$)

Embryonic mortality:

Table 3 shows that the percentage of embryonic mortality were significantly ($P \leq 0.05$) decreased for groups dipped in LP on the 0, 14^{th} and 24^{th} by 20.22, 22.85 and 9.19%, respectively, as compared with control. Also, their were significant ($P \leq 0.05$) differences in embryonic mortality between eggs group treated with LP on days 0 and 14^{th} compared to control and group treated with LP on 24^{th} day.

Moreover, the same trend of embryonic mortality decrease was recorded for egg groups subjected to raising RH during the periods from 0-28 and 14-28 days compared to control and group eggs subjected to RH increase from 24-28 days. The best result of embryonic mortality were recorded for egg groups either treated with LP on day 0 and 14 and subjected to increase relative humidity from 0-28 and 14-28 days. This results is consistent with the report of Metcalfe, *et al*. (1979) who found that embryonic mortality was a result of covering portions of shell with a mater simulating the cuticle.

Regarding the increase of RH in Peking duck eggs, it is adequate evidence to support the concept that excessive or insufficient incubation humidity does exert an influence on the rate of embryonic mortality. Landauer (1967) establish a relationship between humidity and embryonic mortality through the rate at which water diffuses out of the egg. Furthermore, Lundy (1969) indicated that the amount of water lost from an egg does influence the mortality rate of embryo. Likewise, Christensen and McCorkle (1982) suggested that embryonic mortality may increase due to a failure of the embryo to lose water at an appropriate rate. Therefore, many scientists have been concerned with determining the proper humidity that will allow water loss to occur at a sufficient rate.

It is well understood that a low incubating humidity causing excessive water loss and dehydration is an obvious cause of embryonic mortality, no one can completely comprehend why insufficient water loss also leads to mortality (Lundy, 1969).

Hatchability:

As shown in Table 3, the best significant ($P \leq 0.05$) results of hatchability of fertile eggs were recorded for the groups of eggs treated with LP on 0 and 14 days of incubation or subjected to increase of RH during 0-28 and 14-28 days compared to control and other treatments. The results of Tables 2 and 3, show that dipping Peking duck eggs into LP or raising the RH through different incubation periods increased hatchability when the water loss was lower than 12%. The increase of hatchability percentage of fertile eggs as a result of treatment eggs with LP and RH is expected due to the decrease of embryonic mortality percent in these groups as treatments as a result of decreasing egg weight loss.

Humidity during incubation is the second physical factor of incubation to be considered to affect the hatchability, and the researches for determining the proper humidity for incubating duck eggs had received attention. Landauer, (1967) concluded that conditions of high humidity with low water loss or low humidity with excessive water loss or both detrimental to hatchability. Tullett (1981) indicated the best hatchability was achieved when the RH of the incubator was adjusted to produce 12% water loss for eggs setting to internal pipping. Peebles *et al.,* (1987) suggested that manipulation in the incubating humidity may be a improve hatchability.

These results disagree with those reported by Abd-Allah, *et al*. (1995) who found that hatchability of fertile Matrouh chicken eggs had been reduced markedly due to both effects of dipping eggs into LP and raising RH to 60-65%. Results which found by previous author in chicken eggs differ than those for duck eggs which characteristics with different egg size, egg shell thickness and pore number (Changkang, *et al*. 1999).

Much interest should be directed at determining an appropriate incubation humidity that would induce sufficient water loss from eggs during incubation which would resulting optimal hatchability.

Duckling weight:

As shown in Table 4, the means of duckling weight that hatched from dipped eggs into LP on the 0 and 14th days of incubation were statistically significant ($P \leq 0.05$) heavier by 6.83 and 11.67%, respectively, as compared to the control. While the mean of ducklings weight that hatched from dipped eggs on the 24th day of incubation was higher by 3.08% as compared to the control with non significant difference between them. Also, raising the RH to 80% on the 0-28 and 14-28 days of incubation produced significantly ($P \leq 0.05$) heavier duckling weight comparing with control.

Data in this Table showed that dipped eggs into LP on the 0 and 14th days or raising the RH to 80% on the 0-28 and 14-28 days of incubation decreased the embryonic mortality and increased hatchability percentage and duckling weight at hatch. Dipping Peking duck eggs into LP or raising the RH through different periods of incubation produced heavier weight ducklings when the water loss was lower than 12%.

This finding of duckling weight suggests that chick weight at hatch is indirectly influenced by incubation humidity through effects of on the rate and amount of water loss. This concept was verified by the findings of Tullett and Burton (1982) who found that variation in chick weight at hatch are dependent upon the amount of water loss from the eggs during incubation, and also they reported that chick weight at hatch is influenced by incubation humidity. Moreover, Peebles (1986) found that a low incubating humidity and cuticle removal also resulted in chicks with low weights at hatch. Abd-Allah, *et al*. (1995) reported that dipping hatching eggs of Matrouh chicken into LP produced heavier weight chicks at hatching compared to the controls but the difference between them was not statistically significant.

Table (3): Embryonic mortality (%), hatchability of fertile eggs (%) and hatched ducklings weight of Peking duck eggs in different incubation periods as influenced by dipping in liquid paraffin and raising incubation humidity

Treatment	Embryonic mortality (%)	Hatchability of fertile eggs (%)	Duckling weight (g)
	X+S.E		
Eggs dipped into liquid paraffin			
Control	37.69+4.63 ^{a}	62.31+4.15 ^{c}	45.4+2.81 ^{c}
On day 0	17.47+9.94 ^{c}	82.53+10.11 ^{a}	48.5+4.15 ^{b}
On day 14	14.84+7.35 ^{c}	85.16+7.28 ^{a}	50.7+2.31 ^{a}
On day 24	28.50+8.11 ^{b}	71.50+8.43 ^{b}	46.8+4.09 ^{c}
Overall mean	***24.63+7.81***	***75.38+6.82***	***47.85+3.17***
Raising relative humidity to 80%			
Control	36.81+3.86 ^{a}	60.35+4.02 ^{c}	44.3+3.11 ^{b}
From 0-28 days	31.68+7.56 ^{b}	68.32+7.33 ^{b}	47.0+2.51 ^{a}
From 14-28 days	19.38+6.60 ^{c}	80.62+6.71 ^{a}	47.3+3.20 ^{a}
From 24-28 days	35.98+5.01 ^{a}	64.02+4.83 ^{bc}	45.7+3.17 ^{b}
Overall mean	***30.96+5.46***	***68.32+5.34***	***46.08+2.81***

^{a,b,c} Means within each column with different superscripts are significantly different ($P \leq 0.05$)

Net return and economic efficiency:

As shown in Table 4, the net returns due to dipping hatching Peking duck eggs into LP on the 0, 14th and 24th days of incubation were higher by 154.84, 177.42 and 67.74%, respectively, as compared to the control. While the net returns due to raising the RH to 80% during the periods from 0-28, 14-28 and 24-28 days of incubation were higher by 76.92, 196.15 and

34.62%, respectively, as compared to the control. The economic efficiencies of dipping hatching eggs into LP on the 0, 14th and 24th days of incubation are higher by 150.81, 172.98 and 64.92%, respectively, as compared to the control. The corresponding values for raising the RH to 80% during the periods from 0-28, 14-28 and 24-28 days of incubation were higher by 76.92, 196.15 and 34.62%, respectively, as compared to the control.

The best results of net return and economic efficiency were recorded with the treatment of hatched duckling eggs with LP on 14th day of incubation or subjected the hatched eggs to RH% increase during the period of 14-28 days of incubation.

Table (4): Net return and economic efficiency of hatched Peking duck eggs for the different treatment groups

Treatment	Number of fertile eggs	Price of eggs (L.E)	Price pf paraffin wax (L.E)	Total cost (L.E)	Number of hatched ducklings	Total price (L.E) of ducklings	Net return (L.E)	Economic efficiency
Eggs dipped into liquid paraffin								
Control	250	312.5	0.0	312.5	156	390.0	77.5	24.8
On day 0	250	312.5	5.0	317.5	206	515.0	197.5	62.2
On day 14	250	312.5	5.0	317.5	213	532.5	215.0	67.7
On day 24	250	312.5	5.0	317.5	179	447.5	130.0	40.9
Overall mean		***312.5***	***3.75***	***316.25***	***188.50***	***471.25***	***155.00***	***48.9***
Raising relative humidity to 80%								
Control	250	312.5	0.0	312.5	151	377.5	65.0	20.8
From 0-28 days	250	312.5	0.0	312.5	171	427.5	115.0	36.8
From 14-28 days	250	312.5	0.0	312.5	202	505.0	192.5	61.6
From 24-28 days	250	312.5	0.0	312.5	160	400.0	87.5	28.0
Overall mean		***312.5***	***0.0***	***312.50***	***171.00***	***427.50***	***115.00***	***36.8***

CONCLUSION

These results suggest that hatchability of fertile eggs and ducklings weight on hatching day could be improved to a great extent and more efficient by dipping hatching Peking duck eggs into liquid paraffin wax on the 14th day of incubation or raising the relative humidity to 80% during the period from 14-28 days of incubation. Dipping eggs into liquid paraffin after two weeks of the incubation period may be a useful way to overcome the low hatchability percentage as a result of egg weight loss decrease. The best results of net return and economic efficiency were recorded with the treatment of hatched duckling eggs with LP on 14th day of incubation or subjected the hatched eggs to RH% increase during the period of 14-28 days of incubation.

We can recommend the increase of RH% during the period of 14-28 days of incubation as a method of increasing hatchability percentage because it is more easier in use than the egg dipping in LP.

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الملخص العربى

تحسين نسبه الفقس في بيض البط البكينى عن طريق التحكم في معدل بخر الماء من القشرة

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يهدف ذلك البحث إلى اختبار احتماليه تحسين نسبه الفقس لبيض البط البكينى عن طريق التحكم في معدل بخر الماء بواسطة غمس جزء من قشره البيضة في شمع البرافين السائل أو زيادة الرطوبة النسبية المحيطة إلى 80% خلال فترات التحضين المختلفة. كان عمر الطيور المستخدمة 45 أسبوع عند بداية إجراء الدراسة. تم استخدام إجمالي عدد 2240 بيضه تفريخ لإجراء تجربتين وتم تكرار التجربتين أربعه مرات متتالية. تم توزيع البيض المفرخ في كل تجربه عشوائيا على أربعه مجاميع متساوية بكل منها 280 بيضه.

في التجربة الأولى: تم أخذ المجموعة الأولى عشوائيا و بدون أي معاملات (للمقارنه) أما الثلاثة مجاميع الأخرى فتم معاملتها بغمس جزء من الطرف المدبب للبيضه (حوالي 15 % من مساحة سطح القشرة) في شمع البرافين السائل عند اليوم صفر، 14 ، 24 من فتره التحضين على التوالي.

في التجربة الثانية: تم أيضا أخذ المجموعة الأولى عشوائيا و بدون أي معاملات (للمقارنه) أما الثلاثة مجاميع الأخرى فتم إخضاعها إلى زيادة الرطوبة النسبية إلى 80% خلال الفترات صفر- 28 ، 14-28 ، 24-28 يوم من التحضين على التوالي. كل البيض المستخدم تم وزنه فرديا عند صفر ، 14، 24 يوم من التحضين لقياس معدل الفاقد. تم أخذ عينه عشوائية مقدارها 30 بيضه من كل مجموعه عند اليوم صفر، 14 ، 24 من فتره التحضين وتكسيرها لتحديد سمك القشرة وعدد الثغور بها. عند اليوم 28 (يوم الفقس) تم إخراج البط ووزنه. تم حساب العائد الصافي والكفاءة الاقتصادية.

يمكن تلخيص النتائج فيمايلى:

1- يحدث تغير للتركيب البنائى لقشره البيض خلال فتره التحضين مع التقدم في عمر الجنين ممايؤثر على نسبه الفاقد فى البيضه خلال فتره التحضين. حيث تزيد نفاذيه البيضة مع التقدم فى عمر البيضه داخل الماكينه كنتيجة لنقص سمك القشرة وزيادة تركيز الثغور.

2- متوسطات الفاقد في الوزن للبيض المغموس في شمع البرافين السائل عند الأيام صفر ، 14 و24 من فتره التفريخ كانت أقل معنويا عند نهاية فتره التفريخ بنحو 23.41 ، 25.39 ، 14.34% على التوالي بالمقارنه بمجموعه المقارنة. أيضا هذه المتوسطات تأثرت معنويا برفع الرطوبة النسبية إلى 80% للفترتين من صفر- 28 ومن 14-28 يوم من التفريخ حيث انخفضت بنحو 18.63 و 20.88% على التوالي بالمقارنة بعشيرة المقارنة.

3- متوسطات نسب التفريخ للبيض المغموس في شمع البرافين السائل عند الأيام صفر ، 14 ، 24 من التفريخ كانت أعلى جوهريا ($P\leq0.05$)عن مجموعه المقارنة بنحو 20.22 ، 22.85 ، 9.19% على التوالي. ورفع نسب الرطوبة النسبية إلى 80% أدى إلى زيادة معنوية في نسب التفريخ بنحو 7.97، 20.27% على التوالي للفترتين من صفر-28 ومن 14-28 يوم من التفريخ بالمقارنة بمجموعه المقارنة.

وهذه النتائج تقترح أنه يمكن تحسين نسبه تفريخ البيض المخصب ووزن البط عند يوم الفقس إلى مدى كبير عن طريق غمس بيض تفريخ البط البكينى في شمع البرافين السائل عند اليوم 14 من التفريخ أو برفع الرطوبة النسبية إلى 80% خلال الفترة من 14-28 يوم من التفريخ.