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Impact of hatching systems and different storage periods on hatching parameters of broiler breeder eggs

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Abstract. This experiment hypothesized that using on farm hatching system (OFHS) could decrease the negative effects of prolonged cold storage periods on hatchability parameters of broiler breeder eggs in comparison with traditional hatching system (THS). Five hundred and forty hatching eggs (57.37+1.29g) were distributed randomally into six treatments and 90 (eggs) replicates per treatment, as follows; eggs that did not expose to cold storage (12 to 15 °C and RH was 60-70%) and incubated under THS and OFHS in first and second treatments respectively, in third and fourth treatments, eggs were cold stored for 4 days and incubated under THS and OFHS respectively, whereas, in fifth and sixth treatments eggs were cold stored for 9 days and incubated under THS and OFHS respectively. OFHS procedure involving combined last phase of incubation (in the hatcher) with first brooding period in farm, by putting fertile eggs in baskets 30 cm above the floor, and exposed fertile eggs to special environement (34-35 °C, RH>40%), wheares, THS use a standard procedure followed in commercial hatcheries Most of hatched chicks (59.14%) spereaded for 12 hours, from 468 to 480 h, wheares, the rest of chicks hatched after that, in addition, THS had a significant increase hatchability of fertile eggs compared with OFHS, furthermore, the interactions between two factors revealed that using OFHS with 4 days of cold storage had no significant differences compared with THS without cold storage, which mean that OFHS could decrease the effect of storage periods, and the same trend appeared with 9 days of cold storage. In conclusion, OFHS could participate in constrained hatching windows and improve hatchability of fertile eggs with prolong periods of cold storage in comparison with THS.

1. Introduction

On traditional hatchery process, chicks were hatched in hatcher machines and stay in until <85-90% of eggs were pipped, this process spread on more than 24 to 36 hours, causing stressful conditions to earlier hatched chicks [1], in addition, some treatments in hatchery involved selection of good quality chicks, vaccination and transportation to the farm will contribute to increase the time till chicks access to water and feed (48 hours) [2], also, hatcher environment had sub-optimal conditions for modern broiler breeds, causing accumulating of heat and gases in hatcher due to high metabolism rate, this situation leads to decreasing hatchability percentages, as well as increases of second chicks quality due to hyperthermia, leading to decrease next growth performance [3].

To overcome the disadvantages of traditional hatchery process especially in last three days (mentioned above), in the period of 2002 to 2006 Vencomatic company (BV, Eersel, the Netherlands) developed a system for broiler chicks, thereafter, this system named patio, and tested in Netherlands from 2006-2008 [4], thereby transformed fertile eggs at 17 or 18 days of incubation in the same setter trays into patio system, for rest of growth broiler cycle, this circumstances will facilitate newly hatched chicks to access water and feed earlier.

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Patio system consists of multi-tiered housing system, macro-environment in the patio system differe from those in traditional hatching systems; eggs did not turn, the set point of air temperature was constant and lower than traditional hatcher (observed air temperature surrounding the eggs about 35°C), a minimum RH of 35%, air speed was still (lower than 0.2 m/s), The air was internally circulated until the CO2 level reached 2,000 ppm [5]. From that moment on, a gradually increasing fraction of the air was taken from outside. After hatching, the temperature was decreased by 0.5°C per day during the first week, and a gradual further decrease according to the recommendations of the breeding company [6]. Minimum RH was increased to 45% and ventilation was increased with the growth of the birds and/or when the temperature in the Patio system was higher than the set point.

Another hatching system appeared recently, on-farm hatching system had the same concept of being chicks hatched out of hatcher machines, with exception to the degree of automation; eggs can be placed in the broiler house on simple cardboard trays at the litter or on trays situated above the litter. After hatching process complete the residual of hatching (e.g. shells and non-hatched eggs) can either be removed manually or transported automatically on a conveyor belt to be discarded [7].

Recently global markets demand mass production of broilers, and this will have verified through large capacities of setters and hatcher, in addition, the numbers of eggs during production were not uniformity, in these situations incubators will not fill with eggs, so, prolonged storage periods were demand, the negative effect of prolonged storage periods will influence on hatchability percentages, chicks quality and windows of hatching, hence, the objective of the present experiment was to investigate the effect of different storage periods via using on farm hatching system.

2. Materials and Methods

This experiment was conducted at university of Anbar, college of agriculture, at animal production department field, as a part of Master science project in poultry management field.

2.1. Experimental Design.

Five hundred and forty hatching eggs $(57.37\pm1.29g)$ were distributed randomally into six treatments and 90 eggs replicates per treatments, as follows; eggs that did not expose to cold storage and incubated under traditional hatching system (THS) and farm hatching system (OFHS) in first and second treatments respectively, in third and fourth treatments, eggs were cold stored for 4 days and incubated under THS and OFHS resp., whereas, in fifth and sixth treatments eggs were cold stored for 9 days and incubated under THS and OFHS resp.

2.1.1 Hatching egg sources.

Hatching eggs were obtained from a local commercial ROSS 308 breeder flock aged 27-28 wk.

2.1.2. Cold storage procedures

Hatching eggs were stored for 0, 4, and 9 days before incubation procedure, the ambient temperature of cold storage was 12 to 15 °C and RH was 60-70% [8].

2.1.3 Hatching system procedures.

For a traditional and on farm hatching treatments, a multi-stage machine was used (weiqian wq-1056), during first phase of incubation (18 days), standard incubation procedures were followed; temperature was set at 99.68 °F (37.6 °C) and relative humidity was set as 85 °F wet-bulb temperature (RH=50-55%), and then decreasing to 36.5°C at d 18 of incubation [9].

At second phase of incubation (440 h or d 18), eggs were candlly tested for fertility, then fertile eggs of experimental treatments were exposed either to tranditional hatching or on farm hatching system. For traditional hatching system, hatcher machine temperature was set as 97.88 °F (36.6 °C) and relative humidity was set as 90 °F wet-bulb temperature (RH= 65-70%), then, the set temperature were gradually decreased to 36.4 °C at 504 h (21 day) of incubation [9].

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On farm hatching system involved transferred fertile eggs (at 440 d, 18 d) to farm, every 30 eggs were placed in floor pen (1 m L * 1 m W) in plastic basket placed 30 cm above the floor, standard procedure of on farm hatching were followed according to [7]; hence, set temperature were 35 °C and RH were 35-40%, with still air speed, and 24 h of lighting.

2.2. Hatching parameters.

From 468 h of incubation onward (traditional and on farm hatching system), the number of hatched chicks at 2 h intervals were recorded to determine the actual hatch window. The data of hatching windows were presented as a percentage every 6 hours in the results section. At the end of incubation, embryonic mortality and infertile eggs were detected according to [10] to determine embryonic mortality percentage. Healthy and deformed chicks from each replicate was recorded to determine hatchability of fertile eggs percentage by using the equation of ROSS 308 parent guide; hatchability of fertile eggs= (no. of hatched chicks divided by fertile eggs) * 100.

2.3. Statistical Analysis

Data of percentage; hatchability parameters and windows of hatching were first transfer to arc sine, then all transformed data were analyzed using Two-Way ANOVA analysis to assess the effect of hatching systems and storage periods on selected parameters. The analysis were applied by using General Linear Model (GLM) procedure of statistical software package SAS version 9.1 [11], *P-values* less than 0.05, 0.01 and 0.001 were considered to be significant for the main effect, results were presented as mean/ SEM (pooled).

3. Results and Discussions

3.1. Hatching windows

The percentage of chicks hatching in 6 hours intervals were illustrated as hatching windows in Table 1. The significant effect of storage periods were obvious in 468 h and 480 h, whereas, hatching system significantly effected at 480h, 492h ,498h and 504h on the percentage of hatched chicks.

As expected from the objective of this experiment, hatching system significantly decrease the negative effects of prolonged storage periods especially at 480h, 492h and 504h, hence, the significant interactions between two factors obviously toward on farm hatching system (Table 1).

Storage period was one of the factors that effect time of hatching (Table 1), but hatching systems OFHS could decrease the effects of storage period on the percentage of hatching chicks as obviouse from the interactions between two factors in Table (1).

The optimum range of hatching windows ranged from 24 to 48 hours [12], so, there was a problem with chicks hatched early or late of this range, late hatched chicks had many problems, their naval will not heal sufficiently and had wet down because of short time in hatcher, leading to decrease their quality [13]. Early hatched chicks will expose to sever environement of hatcher, and will sufferring water and food deprivation, and consequently, reduced experssion of digestive enzymes and slower organ development leading to depression in next growth performance [14].

Most of hatched chicks in THS and OFHS (59.14%) spereaded for 12 hours, from 468 to 480 h (Table 1), whereas, the rest of chicks hatched after that, the range of spread hatch was better than the normal of hatching windows which was 24 h in commercial hatcheries, especially, in OFMT most of the chicks hatched in this range, whearse, THS chicks hatched most of them out of this range (Table 1), [4] revealed that in THS the incubation process was terminated when <85-90% of chicks were out of their eggs, in comparison to OFHS, so, long periods of pipping permit the unhatched eggs to pipp in later time, in addition, long storage periods allow prolonge pipping time and participate to increase hatching windows out of range (more than 24 h), and that could be the reason of delay hatching time in THS and long storage periods (Table 1).

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Storage periods	Type of hatching	Hatching chicks (%)							
$(day)^1$	system ²	468 h	474 h	480 h	486 h	492 h	498 h	504 h	510 h
	Interaction	on between	storage pe	eriod and ty	pe of hatcl	ning systen	n		
Without storage	Traditional	16.39 ab	17.07	13.22 b	6.77	1.31	9.35 ab	3.41 b	32.47
without storage	On farm	24.79 ab	15.63	32.04 ab	6.56	chicks (%) 492 h hing syster 1.31 8.68 0.00 6.44 0.00 8.04 0.9750 4.99 3.22 4.02 0.8842 0.43 b 7.72 a 0.0226 1.5072 4.07	0.00 b	1.56 b	10.73
4	Traditional	39.84 a	22.35	13.34 b	10.01	0.00	1.08 b	0.00 b	13.37
4	On farm	17.32 ab	9.20	14.20 b	7.98	6.44	18.50 a	12.04 a	13.18
9	Traditional	5.14 b	29.76	23.93 ab	8.98	0.00	1.78 b	0.00 b	28.49
	On farm	9.92 b	7.48	42.68 a	0.00	8.04	13.79ab	6.46 ab	11.62
Prob.		0.050	0.4493	0.0329	0.3641	0.9750	0.0319	0.0532	0.4401
Storage period factor									
Without storage		20.58 ab	16.34	22.63 ab	6.66	4.99	4.67	2.48	21.59
4		28.57 a	15.77	13.77 b	8.99	3.22	9.79	6.02	13.27
9		7.528 b	18.61	33.31 a	4.49	4.02	7.78	3.23	20.05
Prob. 0.0		0.0575	0.9331	0.0346	0.3820	0.8842	0.5827	0.3932	0.5986
		Тур	be of hatch	ing system	factor				
Traditional		20.45	23.05	16.83 b	8.59	0.43 b	4.07	1.13 b	24.77
On farm		17.34	10.76	29.64 a	4.84	7.72 a	10.76	6.69 a	11.84
Prob. 0		0.6477	0.0788	0.0343	0.1647	0.0226	0.1110	0.0196	0.0826
Pooled SEM		3.7699	3.3173	3.3847	1.3268	1.5072	2.2905	1.3071	3.6050
Tota	al mean	18.89	16.91	23.24	6.71	4.07	7.42	3.91	18.30

Table 1. Influence of hatching systems and storage periods on the percentage of chicks in windows of hatching.

¹ The ambient temperature of cold storage was 12 to 15 °C and RH was 60-70%

² Traditional Hatching System (THS), followed standard incubation procedures, whereas, on farm hatching system consist of transport fertile eggs after 480 h of incubation to farm (set temp. = $35 \,^{\circ}$ C and RH =35-40%, with still air speed, and 24 h of lighting)

3.2. Hatching parameters

Hatching parameters results were showed in Table (2), there was a significant differences among treatments in hatching of fertile eggs percentage, cold storage for 4 days significantly increase the hatchability of fertile eggs percentages in comparison with nil and 9 days of cold storage.

The interaction between two factors (storage periods and hatching systems) revealed that OFHS with 4 days of cold storage had no significant differences with THS and without cold storage (Table2).

Mid and late embryonic mortality percentage in OFHS were significantly increased (Table 2) in comparison with THS, the same was in nil and 9 days of cold storage in comparison with 4 days. In spite of highly significant increase in mid and late embryonic mortality percentages, type of hatching system decreases the effect of storage period, as obvious in interactions in Table (2) between two factors, except in OFHS and nil day in cold storage with highly significant increase in comparison with the rest of interactions. There was no significant differences between treatments in live and dead pipped chicks percentage (Table 2), as a main factor, or interactions between two factors.

Hatching system could improved hatchability parameters for eggs storage for long period could be due to; firstly: second grade chicks quality, which calculate as hatched chicks, which was excluded in THS. Secondly, highly air volume in OFHS (still air) may have contributed to dissipate accumulate heat produced from eggs in last phase of incubation due to high metabolic rate, which was a effective way to prevent overheating of eggs and consequently increase hatchability perecentage [15].

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		0,				01	
Storage	Type of hatching	Hatching fertile	Embryonic mortality (%)		Live pipped	Dead	
periods (day) ¹	system ²	eggs (%)	early	Mid	late	(%)	pipped (%)
Interaction between storage period and type of hatching system							
Without	Traditional	81.94 a	1.66	3.33 b	8.33 b	1.66	1.66
storage	On farm	36.36 c	0.89	19.34 a	25.56 a	0.89	8.90
4	Traditional	73.94 a	3.55	2.25 b	11.36 b	2.25	2.78
	On farm	85.40 a	3.50	1.25 b	3.97 b	1.25	1.86
9	Traditional	62.54 ab	4.63	8.53 ab	9.96 b	1.81	4.53
	On farm	42.36 be	3.43	12.94 ab	35.66 a	1.39	3.04
Prob. 0.0034			0.9378	0.0500	0.0019	0.9698	0.2332
Storage period factor							
Without storage 59.1		59.15 b	1.28	11.33 a	16.94 a	1.27	5.28
	79.66 a	3.52	1.75 b	7.66 b	1.75	2.32	
9		52.45 b	4.03	10.74 a	22.81 a	1.60	3.78
Prob. 0		0.0036	0.2226	0.0332	0.0052	0.9183	0.5696
		Type of hatchi	ng system	factor			
Traditional 72.80 a		3.28	4.70 b	9.88 b	1.91	2.99	
On farm 54.70		54.70 b	2.60	11.17 a	21.73 a	1.17	4.60
I	<i>Prob.</i> 0.0063		0.6161	0.0479	0.0021	0.4516	0.4823
Pooled SEM 4.6921		4.6921	0.6418	1.9124	2.7368	0.4316	1.1168
Total mean		63.75	2.94	7.94	15.81	1.54	3.79

Table 2. Influence of hatchin	g systems and sto	orage periods on son	ne hatching parameters.
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¹ The ambient temperature of cold storage was 12 to 15 °C and RH was 60-70%

² Traditional Hatching System (THS), followed standard incubation procedures, whereas, on farm hatching system consist of transport fertile eggs after 480 h of incubation to farm (set temp. = 35 °C and RH =35-40%, with still air speed, and 24 h of lighting)

4. Conclusions

using one system (OFHS) gather hatching phase and brooding phase, could attribute to constraint hatching windows and improve hatchability of fertile eggs, in comparison with THS.

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