Iraqi Journal of Agricultural Sciences –2026:57(7):1990-1997
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/va410619

Impact of Combined on-Farm Hatching System with Spot Chicks Brooding System on some Hatching Traits and Chick's Qualities

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ABSTRACT

The current experiment was carried out at Animal Production Department field (College of Agricultural and Engineering Sciences, University of Baghdad, Abu-Gharieb), the end target of this experiment was to pass the crucial period of newly hatched chicks during last period of incubation till the end of first week of age via combined them, so, a prototype cardboard box was designed and manufactured locally, consist of two parts, the outer cover, and the bottom part. Every 4 cardboard boxes were put together to consist a set of combined on farm hatching process with spot brooding via shredded the outer cover of cardboard box to form a circle spot brooder with 4 cardboard box bottom in it, 1800 fertile hatching eggs were used after candling at 18 ED (Embryonic Day), 600 fertile eggs were exposed to on farm hatching procedure to represent first treatment, distributed into three pens with cardboard boxes set without food wrapping film coat, and 600 fertile eggs used in second treatment via placing them into cardboard boxes set coated with food wrapping film, the third treatment consisted of 600 fertile eggs stated in conventional hatchery baskets till end of incubation. The results showed that were insignificant differences between treatments in the percentage of hatchability of fertile eggs, while significant differences between treatments were happened in late embryonic and live pipped embryo percentages. The same insignificant differences were noticed in external and internal chick's qualities, except the significant increase in relative weight of bursa. The previous results revealed that using cardboard boxes set without covering it could be a useful way to replace hatcher cabinet without any significant differences between two hatching systems, and that would be rising the incubation capacity utilization to 17 times per year instead of 13 to 14 times, leading to add values to increasing the number of batches hatch during the year.

Key words: **incubation fertile eggs parameters, nestling's parameters, relative internal organs,**

Received: 24/3/2025, Accepted: 25/6/2025, Published: 31/7/2026

INTRODUCTION

Conventional hatchery procedures had a significant impact on first day of newly hatched chicks (Mesquita et al., 2021 ;Korsheva, and. Trotsenko, 2022) the period between first pipping chicks and last at rang of 24 to 48 hours, in this period, the newly hatched chicks stay out of reaching water and feed, and exposing to extreme climate of hatcher (Yalcin et al., 2016) referred that at the end of hatching windows, chicks will pulled out and then some conventional procedures will take a place (grading, sexing, counting, vaccination, ..*etc*), and thus the moment of chick collection has usually been set at 21.5 d, in addition, uneven moment of hatch will cause gathering hatched chicks in broader curve of hatching windows, and this situation would confuse hatchery employee decisions to pull out newly hatched chicks because of hatching process fluctuation. Many experiments carried out to investigate the important of transporting newly hatched chicks in a few hours after hatching(Jhetam et

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al., 2024 ;Fahd et al., 2024 ;Norquist et al.,2022) revealed that chicks real age were up to 3 days, that mean, chicks were suffered from fasting until they reach farm, so, chicks will resist that by using their reserve energy in yolk sac, however, the modern broiler breeds had high metabolic rates which reflects to faster growth, and they may have exhausted resources energy in chick's body (Abd El-Azeem., 2024) Another disadvantage of conventional hatchery system was that hatcher basket had crowded newly hatched chicks and that leads to stressful condition till chicks pull out and transferred to commercial barn, in addition, in hatcher cabinet chicks exposed to high level of noise from machine with darkness which increases fearfulness and stressful condition due to high temperature, air velocity, dust and down (de Jong et al ., 2020) In line with previous information's, allowing fertile hatching eggs transferred from hatchery to commercial barn could overcome the disadvantages of commercial hatchery system, an innovation developed in Netherlands by Vencomatic company (Bv, Eersel, the Netherlands) between 2002 to 2006, this company examined new concept between the period 2006 to 2008, finally, they called this type of hatching system "Patio system" (Van de Ven et al .,2011). This type of hatching system consisted of combined last three days in hatcher with first period of broiler life in farm, transferring fertile eggs at 17 or 18 days of incubation to the Patio system till the chick pipped and stay for the rest of broiler growth, (Van de Ven et al., 2013): revealed that patio system differed from conventional hatching system; involved multi-tiered housing system, macro-environment in the patio system, the set point of air temperature was constant and lower than conventional hatcher (observed air temperature surrounding the eggs about 35ºC), a minimum RH of 35%, air speed was still (lower than 0.2 m/s), The air was internally circulated until the CO_2 level reached 2,000 ppm. 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. Recently, a parallel concept developed, this concept had the same procedure of hatching chicks out of hatcher cabinet, with one exception than patio system in automation degree, which involved place eggs in 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 (De Jong et al ., 2018 ; de Jong et al ., 2020) revealed that that around 4% of the broiler chickens produced in the Netherlands, Germany, and Belgium are currently on-farm hatched. Recently, (Malchow et al ., 2025)use elevated platform with on farm hatching system to improve broiler performance and its activity parameters, which means that combined last three days of incubation period with first week of brooding period could come true and applicable procedure in broiler raising, thus, new concept was developed in this experiment and hypothesize that combined on farm hatching system with spot brooding via locally manufacturing cardboard box set could pass the crucial period of newly hatched chicks and overcome the disadvantages of conventional hatchery system.

MATERIAL AND METHODS

The current experiment was a part of Master of Science project carried out at Animal Production Department field, College of Agricultural and Engineering Sciences, University of Baghdad (Abu-Gharieb), the end target of this experiment was to pass the crucial period of newly hatched chicks during last period of incubation till the end of first week of age via combined them, so, a prototype cardboard box was designed via 3DMAX program (Derakhshani and Derakhshani. 2012)and manufactured locally as illustrated in Fig (Mesquita et al.,2021) the cardboard (0.5 cm thickness) box consist of two parts, the outer cover (60 cm Long × 45 cm Width), and the bottom part containing 50 wells (2.5 cm diameter).

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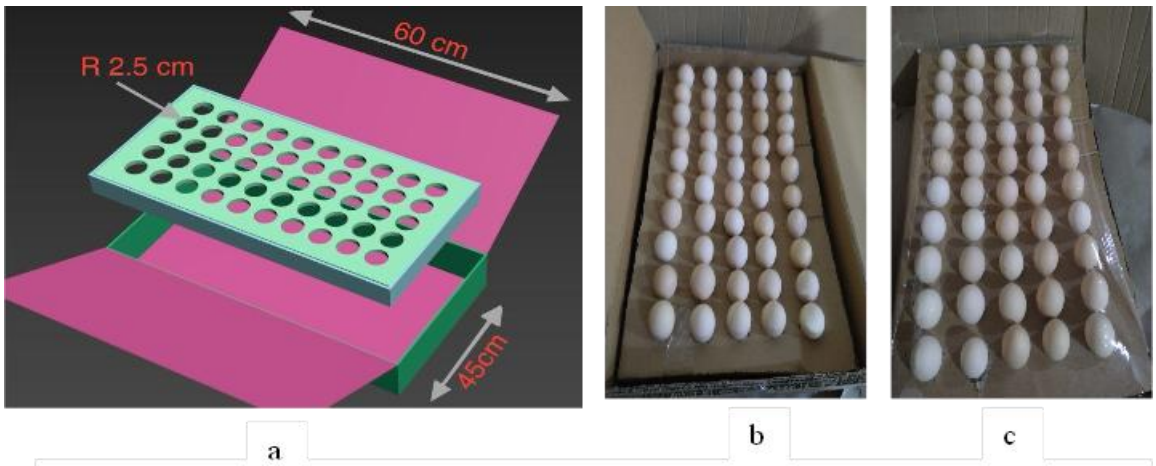

Fig. 1. Prototype of cardboard box designed to use in the current experiment; a; represent a sketch of cardboard box design in 3DMAX program (14), b; cardboard box filled with hatching eggs, c, cardboard box filled with hatching eggs and coated with food wrapping film.

The cardboard box illustrated in Fig. 1 was the unit of on farm hatching process, then every 4 cardboard boxes were put together to consist a set of combined on farm hatching process with spot brooding via shredded the outer cover of cardboard box to form a circle spot brooder (1.5 m diameter, 5.55 m^2 area) with 4 cardboard box bottom in it (50 eggs/cardboard, 200 eggs/set) as illustrated in Fig. 2.

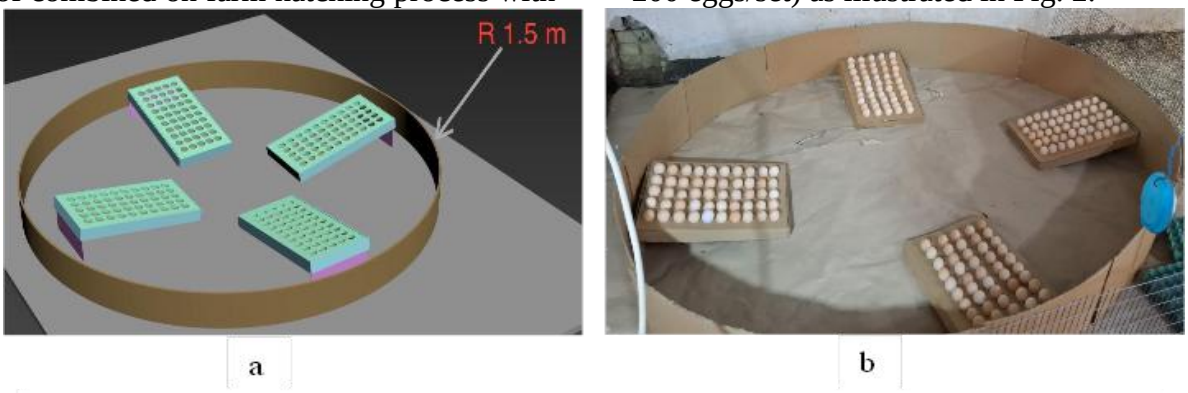

Fig. 2. Prototype of combined on farm hatching and spot brooding set used in the current experiment; a; represent a sketch of set designed in 3D Max program (14), b; set of cardboard box filled with hatching eggs.

The hatching eggs obtained from local commercial (ROSS 308) breeder flock aged 29-32 wks (63±1.29 g) were placed in setter trays under standard incubation conditions (100 ºF dry bulb temperature and wet bulb temperature 85 ºF, RH=55-60%), 1800 fertile hatching eggs were used after candling at 18 ED (Embryonic Day), standard procedure of on farm hatching were followed according to (De Jong et al ., 2018 ; de Jong et al., 2020); hence, set temperature were 35 ºC and RH were 55-60%, with still air speed, and 24 h of lighting, 1200 fertile hatching eggs were exposed to on farm hatching procedure via transformed them from incubation trays to cardboard box sets placed in experimental pens (2.7 m long× 2.5 m Width, 6.75 m^2 area), first treatment involved 600 fertile eggs placed in three pens (200 fertile eggs/pen) each of them contain cardboard boxes set without food wrapping film (Fig.1, a), and 600 fertile eggs used in second treatment via placing them into cardboard boxes set coated with food wrapping film (Fig. 1, b), the third treatment consisted of 600 fertile eggs (four basket, 150 eggs/ commercial hatcher basket) stayed under commercial hatchery conditions (dry bulb temperature was set as 97.88 ºF ;36.6 ºC, and Relative Humidity was set as 90 ºF wet-bulb temperature;RH= 65-70%, then, the set temperature were gradually decreased to 36.4 ºC till full hatching process). After full

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hatching process in both hatching systems, the percentage of late mortality, live and dead pipped egg, hatchability of fertile eggs was calculated according to (Aviagen, 2023) The first pipping process were begun at 490 h (20 ED) in on farm hatching system, chick external qualities were taken (30 chicks/treatment) for every fully hatched chicks (the same measures were taken from chick's hatched in commercial hatchery) after dried (marked with red food color to avoid re-measured in on farm hatching system) till fully hatching process. The external chick's qualities involved; individual body weight, chick length (from Beak to Toe Length, BTL and from Crown to Rump Length, CRL), TONA score, body mass index (Tona et al., 2003)After three days of fully hatching process, ten chicks per treatment were sacrificed via cervical dislocation for internal chick's qualities including relative weight of yolk, free body yolk, heart, liver, spleen, gizzard, proventriculus and bursa gland To assess the significant effects of hatching systems on selected parameters, firstly, every percentage data was transfer to arc sine, then all transformed data were analyzed using One-Way ANOVA analysis. The pen was used as a random factor to account for any confounding effect caused by pen location and different number of chick's in pens, while commercial hatching system was used as a fixed effect. The analysis were applied by using General Linear Model (GLM) procedure of statistical software package SAS version 9.1(SAS Institute. 2004) , *P- values* less than 0.05, 0.01 and 0.001 were considered to be a significant effect, results were presented as *mean/ SEM* (*pooled*).

RESULTS AND DISCUSSIONS

As showed in Fig. 3, the hatching process that happened on farm hatching system, hatching traits were illustrated in Table (1). There were insignificant differences between treatments in the percentage of hatchability of fertile eggs, this finding is in line with (da Silva et al., 2021) when they use conventional hatching system and on farm hatching system, they noticed that there were insignificant differences between two hatching systems in the percentage of hatchability of fertile eggs, also (Kustra et al., 2024)

Fig. 3. Hatching process in on farm hatching system.

Table 1. Impact of combined on-farm hatching system with spot chick brooding system on some hatching traits

Treatments	hatch of fertile eggs (%)	Late embryonic mortality (%)	Live pipped embryo (%)	Dead pipped embryo (%)
Cardboard[1]	89.46	7.82 a	0.304	0.96 b
Cardboard with cover[1]	86.00	4.57 b	0.00	8.21 a
Conventional Hatchery[2]	89.37	1.98 c	0.00	1.98 b
Prob.	0.0658	0.0001	0.3339	0.0001
Mean	88.66	3.02	0.09	4.327
SEM (*pooled*)	0.6144	0.6231	0.0926	0.6764

[1] on farm hatching treatment from 18ED onward (set temperature were 35 ºC and RH were 55-60%, with still air speed, and 24 h of lighting).
[2] commercial hatchery conditions in hatchery cabinet from 18 ED onward (dry bulb temperature was set as 97.88 ºF ;36.6 ºC, and Relative Humidity was set as 90 ºF wet-bulb temperature; RH= 65-70%).
[3] Different letters in columns indicate significant differences between treatments

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There was a significant increase in late embryonic mortality percentage (18-21 ED) in on farm hatching system (cardboard boxes) treatments (first and second treatments) in comparison with the conventional hatchery system (Table 1), and the same trend was happened in the percentage of dead pipped embryo, while, there was insignificant differences between treatments in the percentage of live pipped embryo. when they compare on farm hatching eggs with conventional hatching system and had a significant increase in the percentage of late embryonic mortality and insignificant differences in live pipped embryo, the cause of increasing the percentage of late embryonic mortality and dead pipped embryo could return to different egg storage conditions or different age of broiler breeder and sometime due to suffocation in on farm hatching system due to coated cardboard box with food wrapping film.

Table 2. Impact of combined on-farm hatching system with spot chick brooding system on external chick's qualities

Treatments	Chick wt. (g)	BTL[4] (cm)	CRL[5] (cm)	Leg length (cm)	TONA Score (%)	BMI[6]
Cardboard[1]	45.88	17.36	10.31	2.65	95.78	0.149
Cardboard with cover[1]	45.95	17.25	10.28	2.71	98.28	0.149
Conventional Hatchery[2]	45.79	17.34	10.52	2.69	98.82	0.145
Prob.	0.4532	0.7763	0.2635	0.7954	0.0582	0.2916
Mean	45.87	17.33	10.39	2.68	97.66	0.147
SEM (*pooled*)	0.1766	0.0653	0.0658	0.0326	0.5739	0.0013

[1] on farm hatching treatment from 18ED onward (set temperature were 35 ºC and RH were 55-60%, with still air speed, and 24 h of lighting).
[2] commercial hatchery conditions in hatchery cabinet from 18 ED onward (dry bulb temperature was set as 97.88 ºF ;36.6 ºC, and Relative Humidity was set as 90 ºF wet-bulb temperature; RH= 65-70%).
[3] Different letters in columns indicate significant differences between treatments
[4] CRL, Crown to Rump Length
[5] BTL, Beak to Toe Length
[6] Body Mass Index, BMI=((BTL)^2/chick wt)*100

Using on farm hatching system could not effect external chick's qualities as shown in Table (2), this results were in line with (Malchow et al.,2025 ; Hanna et al., 2024)when they noticed insignificant effect of on farm hatching system in comparison with conventional hatchery system, they stated that the poorest chick's qualities parameters characterized; as red hocks or poorly healed navels which is a part of TONA score; were happened because of the similarity effects of two hatching systems, hence, the hocks of hatching chicks had an enough time to pushing shell wall during hatch, also, navel had enough time to healed, thus, the sub-optimal incubation conditions could cause poor qualities of newly hatched chicks which did not happened in both hatching systems of the current experiment (Molenaar et al.,2023; Boyner et al .,2025)

Table 3. Impact of combined on-farm hatching system with spot chick brooding system on internal chick's qualities

Treatments	Body free yolk (%)	Yolk (%)	Liver (%)	Spleen (%)	Heart (%)	Prov. (%)	Gizzard (%)	Bursa (%)
Cardboard[1]	95.17	2.22	3.83	0.114	0.90	1.49	5.73	0.155 b
Cardboard with cover[1]	98.19	2.07	3.70	0.084	0.91	1.34	5.85	0.162 b
Conventional Hatchery[2]	98.81	1.31	3.76	0.088	0.93	1.32	5.69	0.236 a
Prob.	0.3007	0.1810	0.8914	0.4052	0.8447	0.6237	0.8383	0.0482
Mean	97.39	1.86	3.76	0.095	0.9177	1.38	5.76	0.184
SEM (*pooled*)	1.0104	0.2151	0.1038	0.0096	0.0248	0.0746	0.1112	0.0153

[1] on farm hatching treatment from 18ED onward (set temperature were 35 ºC and RH were 55-60%, with still air speed, and 24 h of lighting).
[2] commercial hatchery conditions in hatchery cabinet from 18 ED onward (dry bulb temperature was set as 97.88 ºF ;36.6 ºC, and Relative Humidity was set as 90 ºF wet-bulb temperature; RH= 65-70%).
[3] Different letters in columns indicate significant differences between treatments

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The same trend of insignificant differences was noticed in internal chick's qualities between treatments as shown in Table (3), except the significant increase in the relative weight of bursa in conventional hatching system, the current results was in accordance with (da Silva et al., 2021) when they noticed insignificant differences between two hatching systems in relative weight of body free yolk, heart and spleen, they noticed that the significant differences in relative weight of bursa return to sex effect, hence, there was increased significantly in male in comparison with female. The previous results revealed that using cardboard boxes set without covering it could be a useful way to replace hatcher cabinet, and that would be rising the incubation capacity utilization to 17 times per year instead of 13 to 14 times (Dafwang, I. I.; J. Y. Oldiba and E. I. Ikani. 1996.) in this situation adding value will have happened due to increasing the number of batches hatch during the year without any significant differences between two hatching systems in hatching traits or in chick's qualities as confirm in the previous results of the current experiment.

CONCLUSIONS

The on-farm hatching system using uncoated cardboard boxes can successfully replace the conventional hatcher cabinet without significantly affecting hatchability or overall chick quality. This approach offers a practical economic advantage by increasing annual hatchery capacity utilization from 13–14 to 17 batches per year for each hatcher set, adding significant value to broiler production.

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تأثير دمج نظامي الفقس الحقلي لبيض التفقيس مع الحضانة الموضعية في بعض صفات الفقس والمواصفات النوعية للافراخ

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قسم الإنتاج الحيواني، كلية علوم الهندسة الزراعية، جامعة بغداد، العراق

المستخلص

اجريت الدراسة الحالية في احد قاعات لدواجن التابعة لقسم الانتاج الحيواني (كلية علوم الهندسة الزراعية / جامعة بغداد ، ابوغريب) ، وكان الهدف النهائي من هذه التجربة هو تجاوز المرحلة الحرجة للافراخ الحديثة الفقس خلال الثلاثة الايام الاخيرة من التفقيس عن طريق دمجها في نظام الحضانة الموضعية للافراخ خلال الاسبوع الاول من عمر الافراخ من خلال استعمال نموذج اولي من الصناديق الكاروتونية المصنعة محليا والمتكونة من جزئين ، الاول هو خارجي يحوي بداخله على الجزء الثاني ، كل اربعة صناديق مجتمعة تكون وحدة من وحدات الفقس الحقلي لتكون بنفس الوقت هي الحضانة الموضعية الحلقية عن طريق تمزيق الجزء الخارجي من الصناديق الاربعة ، نقل 600 بيضة مخصبة من اطباق الحاضنة التجارية الى صناديق الكارتونية غير المغطاة بالنايلون الشفاف لتكون المعاملة الاولى وبثلاث مكررات لكل معاملة ، بينما غطيت 600 بيضة مخصبة بعد وضعها في صناديق الكارتونية بالنايلون الشفاف لتكون المعاملة الثانية وبثلاث مكررات ، اما المعاملة الثالثة فتضمنت نقل 600 بيضة مخصبة من اطباق الحاضنة الى سلات الفقاسة في الفقس التجاري لتحضن تحت الظروف القياسية في المفقس. يتضح من نتائج التجربة الحالية عدم وجود فروق معنوية في نسبة الفقس من البيض المخصب مع وجود فروق معنوية في نسبة الاجنة الهالكة المتاخرة ونسبة الاجنة الناقرة الميتة ، كذلك عدم وجود فروق معنوية في مواصفات الافراخ النوعية الخارجية والداخلية باستثناء الزيادة المعنوية في الوزن النسبي لغدة فابريشا ، يستنتج من هذه الدراسة انه يمكن الاستغناء عن جزء الفاقسة من مكائن الحاضنة واستبدالها بالفقس الحقلي والذي لم يختلف معنويا عن استعمال مكائن الفاقسة التجارية وبهذا يمكن ان يؤدي ذلك الى قيمة مضافة للفقس من خلال زيادة عدد مرات الفقس في السنة من 13 او 14 الى 17 مرة في السنة.

الكلمات المفتاحية: معايير الحضن ،معايير الافراخ الفاقسة حديثا، الوزن النسبي للاعضاء الداخلية للافراخ .