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Impacts of Breeder Age, Storage Time and Setter Ventilation Program on Incubation and Post-Hatch Performance of Broilers

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■Keywords

Breeder age, broiler, egg storage, incubation, setter ventilation program.

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ABSTRACT

The impacts of breeder age (32 and 55 weeks), egg storage time (2-12 days), setter ventilation program (control-test) on incubation and post-hatch performance of broilers were investigated in this study. Young (Y) and old (O) breeders' hatching eggs were incubated in two different setters operated by two different ventilation programs as control (C) and test (T). Incubation took place after a short (S) and long (L) time of storage in this study. According to the trial design, eight treatment groups were as YSC, YST, YLC, YLT, OSC, OST, OLC and OLT. In total 9600 eggs and 6400 chicks were used. Early stage embryonic mortality (ED) rates were lower and accordingly hatchability of fertile eggs (HF) were higher ($p<0.05$) in YS than the other treatment groups. In contrast, incubation performance in eggs hatched in C and T programs were found to be similar. However, interaction between treatments were significant ($p<0.05$) and ED and HF were significantly ($p<0.05$) improved at OC. Liveability in growing period was affected ($p<0.05$) by breeder age but it wasn't affected by storage time and incubation program. Higher post-hatch performance was achieved in chicks of OST but differences between groups weren't significant except for chick weights in comparison by breeder age. However, interactions between treatments were significant ($p<0.05$) and reached the highest post-hatch performance in YST ($p<0.05$). In conclusion, the long time storage of old breeders' eggs improved incubation and post-hatch performance when they were incubated at test program.

INTRODUCTION

The hatchery is one of the most important and fragile integral part of the poultry production chain that requires serious amount of investment. The relationship between incubation and growing period began to increase gradually through the use of high-yielding breeds and hybrids. To see the best performance characteristics of broiler chicks in the field, a lot of attention should be paid to the hatchery. In the hatcheries, chick production is carried out based on information about the physiology of embryonic development. The whole immune system and body development of chicks takes place in the hatcheries with contribution of nutritional and genetic aspects of the breeders. Thus the hatchery has an important impact on liveability and post-hatch performance of birds. According to incubation research data (embryonic mortality rate, hatchability of fertile eggs, hatchability etc.) incubation affects the results of the whole production chain. Thus it is very important to analyse and improve the incubation results (*Boerjan, 2011*).

Incubation performance is affected by genetics, breeder age, egg quality, air pressure, oxygen demand, temperature, humidity, turning, storage time, storage conditions, management conditions of breeders and breeders' health conditions. Performance of the incubation sequence can also be determined by economic criteria such as fertility and hatchability of fertile eggs. The post-hatch performance is influenced by factors such as genetics, breeder age, incubation process, management conditions of breeders and condition of the growing house, season and disease. All these factors of management may have some effect on criteria such as average slaughter weight, feed conversion rate, liveability and European productivity index (*Turkoglu et al., 2014*).

Reaching to the highest incubation performance and achieving high quality chicks in the hatchery depends on reducing deviations in egg quality and the embryonic development. Researches are being taught to understand and identify natural variations in egg quality with embryonic development and some equipment are being developed to provide a uniform incubation. English Buckeye and Belgian Petersime companies suggest the idea that embryonic development may be encouraged via carbon dioxide (CO_2) accumulation. They developed a technology allowing CO_2 to rise for a certain period, then this high level is reduced in a controlled manner by help of infrared CO_2 sensor (Elibol & Turkoglu, 2014).

Researches in the field determined that breeder age, storage time and CO_2 levels affected incubation and post-hatch performance. The increase in breeder age (Mather & Laughlin, 1979; Tona *et al., 2004*) and storage time (Becker *et al.*, 1968; Butcher 2004; Mather & Laughlin, 1976; Reis *et al.*, 1997; Tona *et al., 2004*) negatively affects embryonic mortality (Mather & Laughlin, 1979; Bruzal *et al.*, 2000; Ross Tech 2003; Elibol & Brake, 2003) and hatchability of fertile eggs (Mather & Laughlin, 1976 and 1979; Mc Daniel, 2000; Tona *et al.*, 2004). Generally, embryonic mortality during the incubation period varies between 3-7% in the early and late stage but it is less than 1% in mid-term (Romanoff, 1949; Salamon & Kent, 2014). Embryonic deaths is associated with storage conditions for early stage, malnutrition or infections for mid-term deficits, deficits in incubator and previous periods for last stage (Hodgetts 1993; Bruzal *et al. 2000*). Depending on embryonic mortality and hatchability of fertile eggs, it is well known that live weight values are also negatively affected by similar conditions (Reis et al., 1997; Tona *et al.*, 2004). Body weight (Christensen *et al.*, 1996), feed conversion ratio (Hill, 2002) and liveability worsens with increasing storage time and breeder age. However, there are studies showing a difference in live weight values especially of first week (Quintana *et al.*, 2000; Tona *et al.*, 2004) this difference closes subsequently (Bowling & Howarth, 1981; Elibol, 1997). In contrast, different results were obtained through studies on the effects of the CO_2 level in the machine (Everaert et al., 2007; 2008).

There are studies that show positive (Ross Tech, *2003*) and negative (Taylor, 2000) effects of raising CO_2 levels to a certain level or operating CO_2 control system (Onagbesan *et al.*, 2007). The first studies on the effects of CO_2 during the incubation period reported negative impact on hatchability of chicken eggs when incubator CO_2 levels exceeded 1% during very early incubation (Romanoff & Romanoff 1933; Barrott, 1937). More recent studies have shown that a gradual increase in CO_2 levels up to 1.5% in the first 10 days of incubation enhanced embryo growth, stimulated early hatching and increased hatchability of chicken and turkey eggs (Gildersleeve & Boeschen, 1983; Hogg, 1997; De Smit *et al.*, 2006; Tona *et al.*, 2006) and is shown that this effect changed with strain (De Smit *et al.*, 2008; Tona *et al.*, 2013). When ventilation system of the incubator was not operated and the ventilation holes of incubator were closed for this aim, albumen pH and egg weight loss decreased, embryonic body weight and hatchability increased. Also, earlier hatch (approximately 8,68h) and narrower hatch window was obtained where lesser embryonic mortality (because of a reduction in embryo mal positioning) and higher chick body weight was found. Hormonal levels as triiodothyronine (T_3), thyroxine (T_4) and corticosterone with records of blood haematology parameters as haemoglobin (Hb), % packed cell volume (PCV) and red blood cell (RBC) count were determined therewithal (De Smit *et al.*, 2008; Fares *et al.*, 2011; Tona *et al.*, 2007; Willemsen *et al.*, 2008). At the same time during the post-hatch period, first week (De Smit *et al.*, 2008) final body weight, body weight gain, feed consumption and feed conversion ratio were shown to be slightly higher (Fares *et al., 2011*). It was concluded that the effects of high CO_2 levels were found to be differentiating on incubation and post-hatch performance according to applied levels and times, after the first 10 days of incubation period. It was shown that high (9%) CO_2 after 9^{th} days of incubation increased blood bicarbonate and pH values (Dawes *et al., 1971*), high (4%) CO_2 between 12^{th}-18^{th} days did not change hatching parameters and first week body weight where corticosterone and T_4 levels were found to increase in contrast (Everaert *et al.*, 2007; 2008).

Studies to provide more uniform hatchability of fertile eggs and lesser distortions in performance are continuing by improvisations of incubation and post-hatch conditions. In particular, to determine the effects of applied processes from breeder farms to hatchery till the slaughter age, and to produce solutions are becoming more and more important. This research was conducted in the light of these information and it was aimed to reach higher hatchability of fertile eggs and reduce the deviations in performance by determining the effects of breeder age, storage time and ventilation program in the setters.

MATERIALS AND METHODS

The impacts of breeder age, storage time and setter ventilation program on incubation and post-hatch performance were examined in this study trial design shown on Table 1. For this purpose, percentage of embryonic mortality and hatchability of fertile eggs as a hatchery criteria and liveability, chick weight (CW), body weights on 41st day of growing period (BW), daily weight gain (DWG), feed conversion ratios (FCR), European efficiency index (EPEF) data as field criteria were gathered.

In this study, 9600 hatching eggs obtained from young (32 weeks) and old (55 weeks) Ross 308 broiler breeders and 6400 broiler chicks (randomly selected to test house compartment capacity from hatched healthy day old chicks) were used in this study. Average hen housed egg productions and egg weights of flocks were 82 - 49 % and 60.88 - 61.34 g respectively during the study. The incubation phase of the research was conducted at the hatchery of beypiliç® in Bolu, Turkey. Eggs were set in programmable, fully automatic Petersime 57600 eggs capacity setter and Petersime 19200 eggs capacity hatcher with CO_2 controlling system in the hatchery. Growing phase of the research was carried out in beypiliç's® broiler research house and 32 compartments (2x6.5m) in this house equipped with pan feeders, nipple drinkers and special radiant heaters were used.

Table 1 – Trial design and used hatching eggs and broiler chick amounts in the study.

Flock Age	Young (Y), 32 weeks age				Old (O), 55 weeks age			
Egg Number	4800				4800			
Storage Time	Short (S)				Long (L)			
Egg Number	4800				4800			
Ventilation Programme	Control (C)				Test (T)			
Egg Number	4800				4800			
Treatment Groups	YSC*	YSN*	YLC*	YLN*	OSC*	OSN*	OLC*	OSN*
Egg Number	1200	1200	1200	1200	1200	1200	1200	1200
Chick Number	800	800	800	800	800	800	800	800

* YSC: Young flock, short storage time, control setter ventilation programme. YSN: Young flock, short storage tine, different (test) setter ventilation programme. YLC: Young flock, long storage time, control setter ventilation programme. YLT: Young flock, long storage time, different test setter ventilation programme. OSC: Old flock, short storage tine, control setter ventilation programme. OST: Old flock, short storage time, test setter ventilation programme. OLC: Old flock, long storage time, control setter ventilation programme. OLT: Old flock, long storage time, test setter ventilation programme.

First, hatching eggs obtained from young and old flocks were divided randomly into two equal parts and stored for 2 and 12 days. Eggs were stored at 18°C temperature and approximately 75% of relative humidity. Later, the same eggs were divided into 2 equal parts and randomly placed in two different setters which were operated at two different ventilation programs (Figure 1 and Table 2). The first setter was operated by normal ventilation program (control), where the certain level of CO_2 in the machine was allowed by deactivating CO_2 control system. The second machine was operated by a different ventilation program (test) to provide rapidly accumulating and increasing CO_2 levels in the machine up to 9 days and later gradually reducing by using CO_2 control system and by arranging the openings of the ventilation flaps. 150 eggs were placed on each setter trays and each tray was accepted as a replicate. Accordingly 32 replications (tray) in total have been used as 8 replications per treatment during the incubation stage of the study.

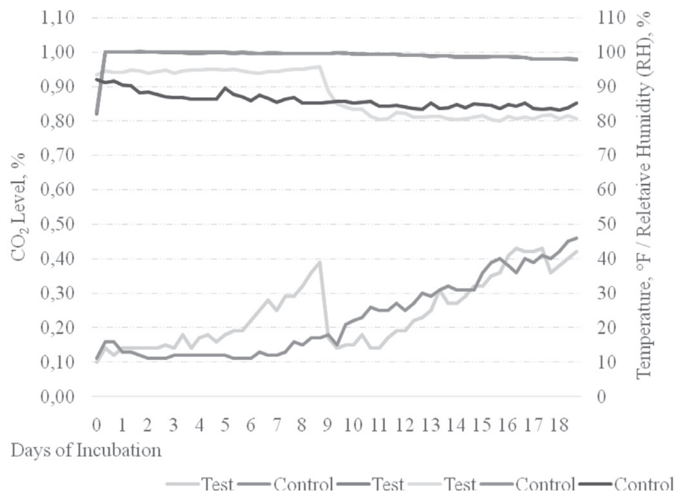

Figure 1 – Actualized temperature (°F), relative humidity (%) and CO_2 (%) levels during incubation phase in the study.

Table 2 – Actualized temperature (°F), relative humidity (RH) and CO_2 (%) values in main days of incubation in the study.

	Temperature, °F		Relative Humidity (RH), %		CO_2	
Incubation days	Control (C)	Test (T)	Control (C)	Test (T)	Control (C)	Test (T)
2	99.9	100.0	87.6	96.1	0.11	0.14
9	99.7	99.5	85.7	91.4	0.17	0.39
18.5 (transfer)	98.0	98.2	83.2	70.1	0.46	0.42

Eggs have been placed on different setters till the transfer time (at 18.5 day) and then transferred to the same hatcher and the program recommended by Petersime was applied to all as same. After the completion of the hatching process, culls and unhatched eggs in hatcher trays have been separated for hatch breakout analysis. Early (0-7 day), mid-term (8-17) and late (18-21) stage embryonic mortality rates and pipped but unhatched embryo rates were detected according to Hodgetts (*1993*) by opening unhatched eggs.

Treatment chicks have been sexed and vaccinated. Chicks arriving the house were weighed and randomly distributed to the pen as 16 chicks/m² (200 chicks/compartment) stocking density and 50% male+50% female for each subgroup. Totally 4 subgroup were used with 4 replications per treatment during the rearing period.

Table 3 – Raw material composition of feed used in the study

	Chick Starter[1]	Chick Grower[2]	Finisher[3]	Pre-Slaughter[3]
Anticoccidial[4]	0.50	0.50	0.00	0.00
Anticoccidial[5]	0.00	0.00	0.50	0.00
Barley	20.00	20.00	20.00	20.00
Broiler Starter Vitamin	1.00	0.00	0.00	0.00
Broiler Chick Vitamin	0.00	1.00	0.00	0.00
Broiler Vitamin	0.00	0.00	1.00	1.00
Choline Chloride-75	0.36	0.33	0.24	0.24
DCP-18[6]	6.20	4.70	3.50	3.50
Corn	494.84	562.82	604.39	604.89
Corn Gluten, 60	30.00	20.00	15.00	15.00
Full-fat Soybean Meal	144.56	139.59	132.67	132.67
Lysine-99[7]	3.12	2.80	1.52	1.52
Marble Powder	10.94	8.64	8.50	8.50
MDCP[6]	6.50	4.50	3.80	3.80
Methionine, dry[8]	2.00	1.20	1.00	1.00
Methionine, liquid[9]	1.18	1.30	1.00	1.00
Phytase Enzyme[10]	0.30	0.30	0.30	0.30
Poultry Offal Meal	25.00	44.00	52.00	52.00
Poultry Trace Elements	1.00	1.00	1.00	1.00
Salt	2.30	2.10	2.00	2.00
Sodium Bi carbonate	2.00	1.60	1.50	1.50
Soybeean Meal-48	213.90	142.32	121.68	121.68
Vegetable Oil, soybean	8.00	16.00	28.00	28.00
Wheat	20.00	20.00	20.00	20.00
Total	1,000.00	1,000.00	1,000.00	1,000.00

[1] Supplied per kg diet: Vit A 13000IU; Vit D_3 5000IU; Vit E 100mg; Vit B_1 3mg, Vit B_2 8mg; biotin 0,2mg; Vit B_6 5mg; Vit B_{12} 0,016mg; Vit K_3 4mg; niacin 70mg; folic acid 2mg; Ca pantothenate 20mg; Mn 120mg; Zn 100mg; Se 0.3mg; Cu 16mg; Fe 50mg; I 2mg and antioxidant 125mg.

[2] Supplied per kg diet: Vit A 11000IU; Vit D_3 5000IU; Vit E 80mg; Vit B_1 2mg, Vit B_2 6mg; biotin 0,2mg; Vit B_6 4mg; Vit B_{12} 0,016mg; Vit K_3 3mg; niacin 70mg; folic acid 1.75mg; Ca pantothenate 20mg; Mn 120mg; Zn 100mg; Se 0.3mg; Cu 16mg; Fe 50mg; I 2mg and antioxidant 125mg.

[3] Supplied per kg diet: Vit A 11000IU; Vit D_3 4000IU; Vit E 80mg; Vit B_1 2mg, Vit B_2 5mg; biotin 0,05mg; Vit B_6 3mg; Vit B_{12} 0,012mg; Vit K_3 2mg; niacin 40mg; folic acid 1.5mg; Ca pantothenate 20mg; Mn 120mg; Zn 100mg; Se 0.3mg; Cu 16mg; Fe 50mg; I 2mg and antioxidant 125mg.

[4] Clinacox, anticoccidial (Lly İlac, Istanbul Turkey)

[5] Salinomycin, anticoccidial (Lily İlaç, Istanbul Turkey)

[6] DCP-18 ve MDCP (Rotem Turkey, Istanbul Turkey)

[7] Lysine-99, Lysine HCL 99 (Rotem Turkey, Istanbul, Turkey)

[8] Dry Methionine, DL Methionine Feed Grade; (Evonik Turkey, Istanbul Turkey)

[9] Liquid Methionine, Alimet; (Novus Turkey, Istanbul Turkey)

[10] Phytase enzyme, Phyzyme (Nutriline Feed and Food Additives L.L.C., Istanbul, Turkey)

ROSS® (2.0-2.5kg ALW) recommendations (Ross Broiler, 2007) and feed were provided by Bolu Feed Mill of Beypi Inc. Chickens were fed in four phase as follows, 0-10th, 11-22nd, 23-35th and 36-41st days (Table 3). Feed ingredients and nutrient compositions of compound feeds were analysed to methods were given by AOAC (1990).

Diets were formulated at international standards (NRC, 1994) and grand parent company Feed consumption in each sub-group was determined by weighing the birds at the end of each feeding phase. Liveability was determined by recording the number of dead chicks (mortality) in sub-groups daily. Treatments were designed to the randomized complete block experiment design. The data were evaluated by using one-way ANOVA (factorial design) and analysed using GLM (General Linear Model) procedures of IBM SPSS 22.0 software package program (*SPSS, 2013*) Statistical differences among the groups were determined by Duncan's Multiple Comparison Test (F-test) (*Duncan, 1955*).

RESULTS

Statistical analyses of the data on the incubation and post-hatch performance has been carried out separately and the results are summarized in tables (Table 4, 5 and 6).

Table 4 – The effect of different incubation practices on incubation performance.

	Embryonic Mortality			Hatchability of Fertile Eggs
	Early Stage 0 – 5th days	Mid-term Stage 6 – 17th day	Late + Pipped Unhatched	
	(ED), %	(MD), %	(LPU), %	(HF), %
Breeder Age (BA), week				
32, young (Y)	5.43±0.38^{b}	0.86±0.11	2.62±0.29	89.90±0.56^{a}
55, old (O)	8.71±0.53^{a}	1.07±0.17	2.74±0.28	85.40±0.63^{b}
Storage Time (ST), day				
2, short (S)	6.26±0.63^{b}	0.86±0.13	2.14±0.22^{b}	89.43±0.69^{a}
12, long (L)	7.88±0.43^{a}	1.07±0.16	3.21±0.31^{a}	85.88±0.62^{b}
Setter Ventilation Program (SVT)				
Control (C)	7.71±0.67	0.95±0.16	2.41±0.17	87.76±0.71
Test (T)	6.43±0.38	0.98±0.13	2.95±0.36	87.55±0.77
Breeder Age X Storage Time				
Young 2 days (YS)	4.34±0.36^{c}	0.90±0.15	1.95±0.30^{b}	91.86±0.55^{a}
Young 12 days (YL)	6.52±0.52^{b}	0.81±0.16	3.29±0.42^{a}	87.95±0.64^{b}
Old 2 days (OS)	8.19±0.97^{ab}	0.81±0.21	2.34±0.32^{ab}	87.00±0.88^{b}
Old 12 days (OL)	9.24±0.45^{a}	1.34±0.26	3.14±0.46^{a}	83.81±0.71^{c}
Breeder Age X Setter Ventilation Program				
Young Control (YC)	5.29±0.54^{c}	0.90±0.15	2.43±0.24	90.52±0.67^{a}
Young Test (YT)	5.57±0.54^{c}	0.81±0.16	2.81±0.52	89.29±0.89^{a}
Old Control (OC)	10.14±0.82^{a}	1.00±0.29	2.38±0.25	85.00±0.68^{b}
Old Test (OT)	7.29±0.45^{b}	1.14±0.19	3.10±0.50	85.81±1.09^{b}
Storage Time X Setter Ventilation Program				
2 days Control (SC)	7.38±1.14^{ab}	0.67±0.17	2.52±0.25^{b}	88.52±1.15^{a}
2 days Test (ST)	5.14±0.39^{b}	1.05±0.18	1.76±0.33^{b}	90.33±0.73^{a}
12 days Control (LS)	8.05±0.74^{a}	1.24±0.26	2.29±0.23^{b}	87.00±0.82^{ab}
12 days Test (LT)	7.71±0.45^{ab}	0.90±0.18	4.14±0.45^{a}	84.76±0.84^{b}
p Value				
BA	0.000	0.298	0.768	0.000
ST	0.038	0.297	0.006	0.000
SVT	0.103	0.908	0.174	0.838
BA X ST	0.000	0.212	0.046	0.000
BA X SVP	0.000	0.702	0.553	0.000
ST X SVP	0.033	0.244	0.000	0.001

[abcd] The difference between the averages indicated by different letters in the same column are statistically significant (p<0,05).

When the data on the incubation performance was analysed, it was found that breeder age affected early embryonic mortality (ED) and hatchability of fertile eggs (HF) ($p<0.05$). ED values of young flocks was lower than older one and accordingly HF was higher. It was found that increasing storage time affected ED and late stage embryonic deaths plus pipped and unhatched embryo rate significantly ($p<0.05$). Because of higher ED and late stage embryonic deaths plus pipped and unhatched embryo rate, lower HF was obtained from 12 days stored eggs than the ones stored for 2 days ($p<0.05$). No significant differences between ventilation programs have been found about the criteria. Also, interactions between breeder age-setter ventilation program, storage time-setter ventilation program were significant ($p<0.05$) statistically. It was detected that an improvement were provided in early stage embryonic deaths when hatching eggs of old breeders were incubated in setters operated to test the ventilation program of accumulated CO_2 (Table 4).

Post hatch performance data obtained from old breeders' hatched chicks has been achieved numerically higher from the accumulated CO_2 ventilation program. However, differences between treatments were not found statistically significant ($p>0.05$) except for the differences between chick weights and liveability. Liveability of young breeder flocks were lower than old breeders in both first week and last week ($p<0.05$). It was determined that liveability in rearing period was affected by breeder age whereas not affected by storage time and setter ventilation program (Table 5).

The chick weight differences of young and old flocks were high and significant ($p<0.05$). But then they got closer in time and by the end of rearing period, average live weight and daily weight gain values were similar.

Table 5 – The effect of different incubation practices on liveability.

	Liveability, %					
	7th day	14th day	21st day	28th day	35th day	41st day (Slaughter)
Breeder Age (BA), week						
32, young (Y)	99.16±0.12[a]	98.59±0.16[a]	98.10±0.20[a]	97.88±0.24	97.57±0.27	96.94±0.35[a]
55, old (O)	99.53±0.12[b]	99.06±0.16[b]	98.81±0.23[b]	98.62±0.29	98.40±0.32	98.96±0.31[b]
Storage Time (ST), day						
2, short (S)	99.35±0.13	98.95±0.13	98.56±0.22	98.25±0.31	98.06±0.33	97.60±0.35
12, long (L)	99.34±0.13	98.70±0.19	98.35±0.24	98.25±0.25	97.91±0.30	97.32±0.36
Setter Ventilation Program (SVP)						
Control (C)	99.28±0.12	98.69±0.18	98.28±0.25	98.00±0.30	97.60±0.34	97.00±0.38
Test (T)	99.41±0.13	98.94±0.19	98.62±0.21	98.50±0.25	98.37±0.25	97.90±0.28
Breeder Age (BA) X Storage Time (ST)						
YS	99.38±0.18[ab]	98.88±0.18[b]	98.57±0.22[b]	98.19±0.41	98.01±0.40	97.51±0.49[ab]
YL	88.94±0.11[a]	98.13±0.23[a]	97.63±0.23[a]	97.57±0.22	97.13±0.31	96.38±0.42[a]
OS	99.31±0.18[ab]	99.00±0.25[b]	98.56±0.41[b]	98.30±0.50	98.12±0.55	97.68±0.52[ab]
OL	99.75±0.09[b]	99.25±0.21[b]	99.16±0.22[b]	98.94±0.27	98.69±0.34	98.25±0.35[b]
Breeder Age (BA) X Setter Ventilation Program (SVP)						
YC	99.00±0.13	98.25±0.13[a]	97.82±0.19	97.44±0.29[a]	97.00±0.30[a]	96.19±0.49[a]
YT	99.32±0.19	98.75±0.30[ab]	98.38±0.33	98.32±0.33[ab]	98.13±0.36[ab]	97.69±0.33[ab]
OC	99.56±0.15	99.13±0.24[b]	98.75±0.40	98.56±0.46[b]	98.19±0.55[ab]	97.82±0.44[ab]
OT	99.50±0.19	99.12±0.23[b]	98.87±0.27	98.68±0.38[b]	98.62±0.35[b]	98.11±0.47[b]
Storage Time (ST) X Setter Ventilation Program (SVP)						
SC	99.25±0.16	98.75±0.23	98.25±0.34	97.81±0.46	97.63±0.51	97.19±0.53
ST	99.44±0.19	99.13±0.18	98.87±0.27	98.68±0.39	98.50±0.38	97.99±0.43
LC	99.31±0.19	98.63±0.28	98.32±0.38	98.19±0.40	97.57±0.48	96.82±0.57
LT	99.38±0.18	98.75±0.33	98.38±0.32	98.31±0.31	98.25±0.35	97.81±0.39
p Value						
BA	0.031	0.045	0.026	0.056	0.055	0.036
ST	0.995	0.297	0.515	0.991	0.735	0.585
SVT	0.479	0.339	0.302	0.210	0.076	0.068
BA X ST	0.007	0.008	0.010	0.095	0.082	0.047
BA X SVP	0.095	0.041	0.088	0.097	0.049	0.019
ST X SVP	0.894	0.565	0.534	0.490	0.358	0.309

[abc] The difference between the averages indicated by different letters in the same column are statistically significant (p<0,05).

Also, it was found that interactions were significant ($p<0.05$) between breeder age-storage time and breeder age-setter ventilation program for post-hatch performance (Table 6). Similarly, BW and DWG values were higher ($p<0.05$) in chicks obtained from the eggs of young flocks placed to setter operated with normal ventilation program (control treatment) than the test program (accumulated CO_2).

Table 6 – The effect of different incubation practices on post-hatch performance.

	CW, g	BW, g 41st day	DWG, g	FCR, 41st day	EPEF, 41st day
Breeder age (BA), week					
32 (Young)	39.32±0.19^{b}	2,302±5	55.20±0.12	1.778±0.006	306.27±2.14
55 (Old)	47.42±0.11^{a}	2,304±10	55.05±0.25	1.772±0.010	310.81±2.35
Storage Time (ST), day					
2	43.63±0.99	2,310±8	55.29±0.20	1.774±0.005	309.97±1.62
12	43.12±1.12	2,297±8	54.97±0.19	1.776±0.011	307.10±2.81
Setter Ventilation Program (SVP)					
Control (C)	43.33±1.08	2,304±6	55.13±0.15	1.775±0.009	307.28±2.23
Test (T)	43.41±1.03	2,303±10	55.11±0.24	1.776±0.007	309.80±2.37
Breeder Age (BA) X Storage Time (ST)					
Young 2days (YS)	39.84±0.25^{b}	2,311±6^{a}	55.40±0.15	1.767±0.006	311.10±1.95
Young 12days (YL)	38.80±0.08^{b}	2,294±7^{b}	54.99±0.18	1.789±0.010	301.45±3.02
Old 2days (OS)	47.42±0.15^{a}	2,309±15^{ab}	55.17±0.38	1.781±0.008	308.85±2.66
Old 12days (OL)	47.43±0.17^{a}	2,299±15^{ab}	54.93±0.36	1.763±0.018	312.76±3.95
Breeder Age (BA) X Setter Ventilation Program (SVP)					
Young Control (YC)	39.17±0.14^{b}	2,313±6^{a}	55.47±0.15^{a}	1.780±0.007	305.03±2.91
Young Test (YT)	39.47±0.35^{b}	2,292±7^{b}	54.93±0.16^{b}	1.776±0.010	307.51±3.27
Old Control (OC)	47.50±0.12^{a}	2,294±8^{ab}	54.80±0.20^{ab}	1.770±0.018	309.53±3.38
Old Test (OT)	47.35±0.19^{a}	2,315±19^{ab}	55.30±0.47^{ab}	1.775±0.010	312.08±3.44
Storage Time (ST) X Setter Ventilation Program (SVP)					
2days Control (SC)	43.59±1.56	2,313±9	55.34±0.23	1.775±0.007	308.88±1.97
2days Test (ST)	43.67±1.33	2,308±14	55.23±0.34	1.774±0.008	311.07±2.65
12days Control (LC)	43.08±1.60	2,295±6	54.93±0.17	1.774±0.018	305.69±4.09
12days Test (LT)	43.16±1.67	2,298±16	55.00±0.36	1.778±0.012	308.52±4.07
p Value					
BA	0.000	0,867	0.601	0.622	0.164
ST	0.736	0,237	0.255	0.865	0.386
SVP	0.959	0,945	0.940	0.925	0.445
BA X ST	0.000	0,679	0.653	0.353	0.058
BA X SVP	0.000	0,341	0.297	0.942	0.481
ST X SVP	0.990	0,689	0.713	0.994	0.724

CW: Chick Weight, BW: Body Weight, DWG: Daily Weight Gain, FCR: Feed Conversion Ratio, EPEF: European Production Efficiency Index

[ab] The difference between the averages indicated by different letters in the same column are statistically significant ($p<0,05$).

DISCUSSION

This research was designed to obtain higher incubation and growing performance and to reduce the deviation in performance by determining the effects of breeder age, storage time and setter ventilation program. Embryonic deaths and fertile hatchability of fertile eggs (HF) for incubation performance, liveability, and chick weight (CW), body weight (BW), daily live weight gain (DWG), feed conversion ratio (FCR) and European Productivity Index (EPEF) values for growing performance were evaluated.

ED of young flocks and accordingly HF was higher than older flock eggs. Similarly, lower early stage embryonic deaths and late stage embryonic deaths plus pipped and unhatched embryo rates and accordingly higher hatchability of fertile eggs in short time stored eggs have been obtained from experimental data. In contrast, incubation performances of eggs incubated in setters operated to different ventilation program were similar. Also, depending on the important interactions between treatment groups. It has been found that ED and HF were improved, when hatching eggs of old flocks incubated in setter operated to by accumulated CO_2.

The results of this study supported the findings of Mc Daniel (*1995*) showing that early and late stage embryonic mortality is 3-5% and this seems to be consistent with the general statement in this regard. The results of setter ventilation program trial in this study was supported by researches (Ross Tech*, 2003*) showing that setter accumulated CO_2 ventilation program has positive effects and negative effects have not been identified yet.

In terms of post-hatch performance, differences between treatments were not found significantly different (p>0.05) except for the difference between chick weights and liveability (p<0.05). Liveability of young breeder flocks were lower in both the first week and slaughter. But, differences between CW values during the rearing period and BW and DWG values of treatment groups were found to be similar at the end of growing period. In addition, higher chick weight, BW and DWG values have been achieved in eggs of YC than YT.

These results were supported by data from Christensen *et al.* (*1996*) that liveability decreased with flock age and storage. Also, liveability data seems to be consistent with the data of (Bowling & Howarth, 1981; Elibol, 1997) who observed live weight differences in the first week and also closed up later in the rearing period. Similarly, data showing impairment in live weight are supported in terms of flock age (Christensen *et al.*, 1996), but data suggesting deterioration in feed conversion ratios are supported (Hill, 2002). In contrast, unlike the incubation performance, in terms of growing performance, similar results were obtained from the study showing that raising CO_2 levels to a certain level or operating the CO_2 control system has negative effect on post-hatch performance (Taylor, 2000).

As a result, higher incubation and post-hatch performance were obtained from the eggs of young flocks stored for a short period. In addition, it was found that incubation and growing period performances of long time stored old flock eggs can be improved by incubating with accumulated CO_2 ventilation program. Thus, a more healthy and with higher quality chick production can be achieved and consequently production costs can be reduced and the competiveness of poultry companies can be improved.

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