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The Effects of Broiler Breeder Age and Extra Oxygen Addition into Incubator at High Altitude (1700 m) on Hatching Results and Subsequent Performance in Broilers

[1]Mehmet Fatih Celen, [2]Iskender Yildirim, [2]Sinan S. Parlat and [1]Emine Alkis
[1]Department of Animal Science, Faculty of Agriculture,
University of Yuzuncu Yil, 65080 Van, Turkey
[2]Department of Animal Science, Faculty of Agriculture,
University of Selcuk, 42031, Campus, Konya, Turkey

Abstract: Breeder age and oxygen concentrations from 15-21 days of incubation were tested as factors determining on hatching and subsequent performances of broiler at high altitude. Eggs produced by breeders of 31 or 55 weeks of age. All eggs from 2 breeder ages were distributed randomly into 2 hatching cabinets, which were operated at different oxygen concentrations. The 1st cabinet was oxygenated at 25%, whereas, no oxygen added to the 2nd cabinet and called control group. Fertile hatchability was affected by the Oxygen supplementation and flock age interaction. The highest fertile hatchability was obtained when the breeders were 55 weeks of age with adding oxygen but not in breeders at 31 weeks of age. The fertile hatchability was decreased at 55 weeks of age in control group. The late embryo mortality was significantly depressed in embryos from breeders at 55 weeks of age when oxygen added. Chick weights of hatch, 1st and 3rd weeks among groups were not affected by interaction between Oxygen supplementation and flock age. Feed conversion ratio and mortality were enhanced in chicks obtained from breeders 55 weeks of age when oxygen added. It is concluded that oxygen supplement to the incubators at high altitude improves the fertile hatchability, feed conversion ratio and decreases mortality of chicks obtained from breeder of 55 weeks of age.

Key words: Oxygen, incubation, high altitude, breeder age, hatchability, extra oxygen

INTRODUCTION

Hypoxemia as a problem in high altitude has been investigated by researchers since it affects hatchability and posthatch bird performance. Oxygen (O_2) and carbon dioxide (CO_2) exchanges are crucial for embryonic development during incubation and may affect livability of the embryo, hatchability, postnatal livability and subsequent performance of chick (Deeming *et al*., 1998; Decuypere *et al*., 2001; Tona *et al*., 2005). Since, the chick embryo consumes 60% more O_2 between the start of pulmonary breathing and hatching, compared to earlier stages (Visschedijk, 1968). Tazawa (1981) reported that O_2 consumption of embryo increases as it grows rapidly during the 1st 2 weeks of incubation. Moreng (1983) reported that high altitude (above 3984 m) had detrimental affect on embryonic growth and hatchability during the incubation of both fowl and turkey eggs. It is well known that hatchability of both fowl and turkey eggs incubated above 1640 m is lower than incubated in standard conditions. Giussani *et al*. (2007) reported that incubations at high altitude of both fertilized eggs laid by sea level and fertilized eggs laid by high altitude were resulted with inhibition embryonic development. Altan *et al*. (2006) reported that the addition of extra O_2 from 18-21 days of incubation increased the hatchability of broiler eggs. Ellis and Morris (1947) reported that O_2 supplementation during incubation at an altitude of 7,200 feet (2,190 m) increased the hatchability of chicken eggs from 72-85% and the hatchability of turkey eggs from 28-67%.

Hatchability and chick quality were influenced by broiler breeder age (Mather and Laughlin, 1979; Noble *et al*., 1986; O'Sullivan *et al*., 1991; Latour *et al*., 1998; Benton and Brake, 1996; Reis *et al*., 1997; Suarez *et al*., 1997; Lapao *et al*., 1999; Silversides and Scott, 2001). Tona *et al*. (2001) reported that hatchability decreases with increasing the age of the breeder. As known commercial hatching eggs are produced by breeder flocks of different ages in the poultry industry and incubated under artificial hatchery conditions. Egg weight increases with flock age and egg weight and hatched

Corresponding Author: Mehmet Fatih Celen, Department of Animal Science, Faculty of Agriculture, University of Yuzuncu Yil, 65080 Van, Turkey

chick weight were affected directly by the breeder age (Hager and Beane, 1983; Whiting and Pesti, 1983; Yannakopoulos and Tserveni-Gousi, 1987; Burke, 1992; Suarez *et al.*, 1997; Vieira and Moran, 1998; Yildirim and Yetisir, 1998). There is a positive linear correlation between egg weight and the hatched chick weight (Wilson, 1991). Previous investigators reported that breeder age has important affects on internal and eggshell quality characteristics of egg (Peebles and Brake, 1987; Sullivan *et al.*, 1991; Benton and Brake, 1996; La-tour *et al.*, 1998; Lapao *et al.*, 1999). Tona *et al.* (2001) reported that the highest quality of hatching eggs was produced by hens that were 40-42 weeks of age. In our opinion, it may be suitable that eggs laid by young, middle, or old breeders should be incubated under different conditions in order to improve hatchability.

The objectives of this research were to investigate the effects of breeder hen age and extra O_2 supplementation at high altitude on hatchability, embryonic mortality at different stages of incubation and post hatch performances (body weight, feed conversion ratio and mortality).

MATERIALS AND METHODS

One thousand and two hundred eggs from Ross 308 broiler breeders at 31 and 55 weeks of age were obtained from a broiler breeder company. Two laboratory incubators (Cimuka) with digital thermostats and sensitivity of ±0.1°C (to control wet and dry bulb temperatures) were used in this experiment. Each incubator contained 4 trays with 150 eggs each. Eggs were randomly distributed for age treatment replication in a single tray. During the 1st 18 days of incubation, incubator temperature was set at 37.6°C with 55% relative humidity; eggs were turned once each 2 h. From day 18 of incubation until day of hatch, relative humidity and temperature changed as indicated in Table 1. One of the incubators, in which eggs were incubated with extra O_2 supplementation at 24.5±0.5% of O_2 partial pressures, was supplemented with O_2 from 15-21 days of incubation. O_2 concentrations of incubators were measured with an digital oxygen-meter and O_2 flow rates from O_2 storage tanks were adjusted hourly to maintain the desired oxygen level. Unhatched eggs were examined macroscopically to determine Late Embryo Mortality (LEM), External Pipping (EP) and Internal Pipping (IP). Fertile Hatchability (FH) was also calculated. All chicks were individually weighed at take-off and wing-banded. There were 40 chicks distributed into each of 4 pens with 2 replications per treatment. Body weight determined weekly. The data were evaluated using 2-way ANOVA (factorial design) and analyzed using GLM (General Linear Model) procedures of SAS package program (SAS Institute, 1998). Statistical differences among the groups were determined by Duncan's Multiple Comparison Test (F-test).

Table 1: Relative humidity and temperature values from 18 days of incubation until day of hatch

Incubation length (days:h)	Temperature (°C)	Relative humidity (%)
18:00	37.4	67.3
18:06	37.3	67.5
18:12	37.2	67.5
19:00	37.1	68.0
19:06	37.0	68.0
19:12	37.0	68.0
20:00	37.0	68.0
20:06	36.9	68.0
20:12	36.8	67.0
20:23	36.8	65.0

RESULTS AND DISCUSSION

Hatching traits: The effects of extra O_2 supplementation during incubation from 15 days to pull and hen age on Late Embryonic Mortalities (LEM), Internal Pipping (IP), External Pipping (EP) and Fertile Hatchability (FH) are shown in Table 2. The LEM significantly reduced in embryos from old group when extra O_2 added ($p<0.05$). The increase in late embryonic mortality observed toward the end of laying cycle. Perhaps it might be a result of increasing surface area. Bagley *et al.* (1990) reported that the surface area of the eggshell increases with age of breeder. In a current study, we speculated that because of high O_2 concentration around the eggs, the negative impact of high conductance on LEM has been eliminated in old breeder's eggs in oxygenated group. As commonly known (Wilson, 1993; Mauldin and Buhr, 1991; Coleman, 1986) O_2 deficiency at high altitude is one of main reason for late embryonic mortalities. Mauldin and Buhr (1991) reported that at high altitude (>4000 feet above sea level), O_2 concentration of incubator has a critical importance for embryonic survival. However, our data outline that the positive impact of O_2 concentration of incubator for LEM is more critical for older breeders' eggs rather than that of young.

The eggs from breeders at 55-weeks-old exhibited relatively higher FH (4.38%) compared to those from breeders at 31 weeks-old-age when extra O_2 added to the incubators. In contrast to oxygenated group, the FH was depressed in eggs from breeders at 55-weeks-old when no oxygen added ($p<0.01$). The positive impact of the oxygenated environment on old breeders' eggs might be a result of high conductance value of eggs. Actually, Christensen *et al.* (1993), have found that the eggs laid by 33-weeks-old hens had lower conductance than did eggs laid by hens of 43 and 54 weeks-old. They claimed

Table 2: Hatching traits in relation to extra oxygen supplementation and breeder age (Means±SE%)

Oxygen supplement	Breeder age (week)	LEM	IP†	EP‡	FH
O_2	55	6.50±0.40[b]	1.29±0.17	3.05±0.03	80.98±1.07[a]
	31	12.18±0.45[a]	1.14±0.14	1.43±0.59	77.43±1.23[b]
Control	55	19.95±0.61[a]	1.15±0.15	2.78±0.39	66.13±1.30[b]
	31	18.53±0.82[a]	1.00±0.00	1.83±0.36	72.00±0.89[a]
	p	***	ns	ns	**

[a,b]Means within a column with no common superscripts differ significantly (***p<0.001; ** p<0.01; *p<0.05), ns: non significant, †: Internal Pip: Beak was in the air cell, ‡; External Pip: Beak was through the shell

Table 3: Least squares means from initial to 3rd week body weight, FCR and Mortality in relation to oxygen supplement and breeder age (Means±SE)

Oxygen supplement	Breeder age (week)	CW	BW 1st week	BW 3rd week	FCR (g:g) 3rd week	Mortality (%)
O_2	55	44.75±0.42	136.60±1.02	829.23±9.75	1.33±0.08[a]	1.22±0.13[a]
	31	39.96±0.30	126.51±1.51	768.19±7.62	1.31±0.06[a]	2.04±0.15[a]
Control	55	43.53±0.40	129.41±0.98	785.46±10.82	1.60±00.9[a]	4.98±0.21[a]
	31	38.04±0.42	120.52±1.14	742.38±6.36	1.51±0.04[b]	1.70±0.13[b]
	p	ns	ns	ns	*	*

[a,b]Means within a column with no common superscripts differ significantly (*p<0.05), ns: non significant

that age of the breeder hen may be a major factor that influences egg shell permeability and length of the incubation period. Our findings also seems to agree with (Visschedijk, 1968), who reported that the impairment was caused by the reduced barometric pressure at high altitude, which not only decreased the effective O_2 tension but also increased the effective eggshell conductance. Theoretically, the hatchability at any terrestrial altitude would be normalized if the embryonic gas exchange is restored to the sea level values.

The effects of extra O_2 supplementation during incubation from 15 days to pull and hen age on chick body weight at hatch, 1st or 3rd week live body weight gains and FCR are shown in Table 3. No interaction effects were found for chick weight hatch, 1st or 3rd weeks among the groups for mean body weights. However, FCR and mortality were improved in chicks obtained from old breeder group when extra O_2 added, which suggests a possible hen age and extra O_2 supplementation effect.

Any positive impact of the extra O_2 supplementation in chicks from old age group was not observed for CW, 1st or 3rd week of BW compared to control group. But, the chicks appeared to be able to overcome problems related to old breeder age for mortality and FCR if they are provided enriched oxygenated environment from 15 days to pull. Our findings has also been supported by Christensen and Bagley (1988) reported that the embryos in intensive O_2 conditions were better prepared metabolically to cope with the rigors of pipping and hatching than were embryos in a tenuous gas environment. We speculated that ideal hatchability might be a good indicator for full performance traits of the birds. Lundy (1969) reported that ideal incubation conditions that is a result of the best hatchability, also is a result of the best chick quality.

CONCLUSION

Consequently, it is concluded that extra O_2 supplementation at high altitudes has to be considered in order to optimize hatchability, especially if the eggs from older flocks are incubated.

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